

12.

The evolution of healthcare educational methodologies: From teacher-centred to technology-enhanced student-centred learning

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Abstract

Ongoing advancements in technology and knowledge, alongside systemic challenges like social marginalisation (Fluit et al., 2024), call for adaptive educational strategies in healthcare. This chapter explores the potential of generative artificial intelligence (genAI) as a complementary tool within a Problem-Based Learning (PBL) educational approach, a cornerstone of Student-Centred Learning (SCL), to enhance healthcare education.

Grounded in constructivist, humanist, and behaviourist principles (Mukhalalati & Taylor, 2019), PBL facilitates critical thinking, collaboration, and authentic engagement with complex, real-world problems. Thoughtfully integrated, genAI tools can benefit both students and academic staff by generating tailored learning materials, fostering critical reflection through Socratic questioning (Ho et al., 2023; Overholser & Beale, 2023),

and aiding personalised learning. Through coaching (Coumans & Wark, 2024; Hurlow, 2022), positive psychology (Passmore & Lai, 2019; Peláez Zuberbuhler et al., 2024; Seligman, 2011) and neuroeducational principles (Coumans & Wark, 2024), these can create inclusive, emotionally supportive learning environments that nurture growth mindsets, reduce stress, and promote neuroplasticity – elements crucial for effective, student-centred learning (Immordino-Yang et al., 2019; Voss et al., 2017).

To address persistent systemic challenges, including entrenched inequities and ongoing practitioner shortages (Mukhalalati & Taylor, 2019), broader strategies are also proposed. These include service learning (SL) and alignment with the United Nations (UN) Sustainable Development Goals (SDGs), all designed to cultivate socially responsible and adaptive healthcare practitioners. Ethical risks, such as passive learning or diminished critical thinking, are also discussed (Michel-Villarreal et al., 2023). These underscore the need for skilled facilitation, ensuring AI remains a reflective, supplementary aid, rather than a substitute for human judgment. By implementing genAI within current pedagogical frameworks, this chapter envisions a future-ready educational ecosystem. This system will equip healthcare professionals to navigate complex, technology-driven environments while contributing to the sustainability of society.

Keywords

Problem-Based Learning (PBL), generative Artificial

Intelligence (genAI), healthcare education, coaching psychology, neuroeducation, health equity, Sustainable Development Goals (SDGs), curriculum innovation

Introduction: Transforming education

Healthcare education in the 21st century continues a shift from static teacher-centred methods towards dynamic student-centred approaches that emphasise active learning and personalisation (Spencer & Jordan, 1999). This reflects an evolving understanding of adult learners' active role in acquiring, retaining, and applying knowledge. Student-Centred Learning (SCL), grounded in educational psychology theories of constructivism, humanism, and behaviourism (Mukhalalati & Taylor, 2019), places students at the heart of education. It emphasises critical thinking, collaboration, and personalised learning experiences tailored to diverse needs, including differences in prior knowledge, personal experiences, and learning preferences (Dewey, 1938; Rogers, 1969; Schön, 1992; Weimer, 2013).

Historically, healthcare has been seen as both an art and a science. Embracing generative artificial intelligence (genAI) within the tri-modal creativity framework – visceral, ideational, and observational – mirrors core aspects of healthcare education: clinical skills, diagnostic reasoning, and reflective practice. This supports future professionals' capacity to adapt and innovate (Creely et al., 2020). Achieving this requires a shift in educational

priorities toward data analysis, innovative problem-solving, effective teamwork, and digital literacy; all competencies essential for preparing graduates for a complex world and global challenges (Xu et al., 2024).

Problem-Based Learning (PBL) is a student-centred, constructivist approach where learners engage with real-world problems, such as clinical cases, to develop problem-solving, reasoning, and self-directed learning through collaborative inquiry. It is a cornerstone of SCL in healthcare (Coumans & Wark, 2024; Hartling et al., 2010). Bridging theory to practical application, PBL fosters critical thinking, teamwork, and adaptability in future healthcare practitioners who will need to navigate evolving professional environments (Barrows & Tamblyn, 1980; Mukhalalati & Taylor, 2019; Wood, 2003). A deliberate, structured integration of positive psychology principles, such as those outlined within the PERMA (positive emotion, engagement, relationships, meaning, and accomplishment) model, further enriches the PBL approach by fostering individual resilience, goal-setting, and emotional well-being (Passmore & Lai, 2019; Peláez Zuberbuhler et al., 2024; Seligman, 2011).

The emergence of new technologies, particularly genAI, is reshaping healthcare education. GenAI can ameliorate PBL facilitation through enabling real-time production of realistic patient scenarios, identifying learning issues, developing practice questions, and enhancing productivity (Kasula, 2024; Kitsios et al., 2023; Wu, Zerner, et al., 2024; Wu, Zheng, et al., 2024). Tutors' proactive use of genAI to develop patient scenarios, address knowledge gaps, suggest responses to medical enquiries, and generate exam questions, assists in scaffolding student inquiry and problem-solving (Divito et al., 2024; Sauder et al., 2024; Wu, Zerner, et al., 2024).

This requires mastering ‘promptgramming’, a structured approach to crafting prompts that optimise AI outputs to foster critical thinking (Gattupalli, 2024). However, widespread integration of genAI requires consideration of ethical challenges, including potential over-reliance leading to passive learning, diminished critical thinking, and secure data handling practices (Kasneci et al., 2023; Michel-Villarreal et al., 2023).

As healthcare education evolves to meet the demands of a rapidly changing environment, it must equip learners with technical and cognitive skills to address systemic challenges, including healthcare disparities, practitioner shortages, and societal marginalisation (Fluit et al., 2024). By considering individual growth with societal impact and leveraging insights from neuroeducation and innovative technologies, educators can cultivate adaptive, future-ready professionals for complex, technology-driven settings (Hurlow, 2022; Pavlović, 2021; Stănciulescu, 2024). AI is increasingly embedded into healthcare services, supporting diagnostic decision-making and efficiency while reducing error and cost (Alowais et al., 2023). However, healthcare professionals require foundational AI literacy and critical reflection skills to use AI tools effectively. This shift calls for new educational strategies integrating technical competencies, ethical awareness, and pedagogical adaptability from undergraduate to ongoing professional development.

This chapter examines the transformative shift in healthcare education through student-centred methodologies, emphasising how tertiary-level academics can integrate genAI within PBL facilitation. It proposes complementary approaches, grounded in evidence-based frameworks, to prepare healthcare professionals to meet

individual and systemic challenges, supporting a more inclusive and impactful future.

Foundations of Student-Centred Learning (SCL)

SCL focuses on students' development by recognising unique strengths and growth areas (Martin-Alguacil et al., 2024). In healthcare education, this requires scaffolding to transition from teacher-led instruction to autonomous learning by building confidence, agency, and ownership (Bhardwaj et al., 2025). Lectures and similar relevant expert inputs provide foundational knowledge that PBL facilitators use to implicitly guide inquiry, reflection, and collaboration in line with SCL. However, many facilitators trained in teacher-centred systems face challenges in making this transition. Much of the literature still emphasises teacher-controlled strategies over deeper shifts in epistemology or classroom power dynamics (Bhardwaj et al., 2025; Bremner, 2021). This is evident in healthcare education, where high-stakes curricula limit the sharing of power. SCL, supported by constructivist, humanist, and behaviourist theories, emphasises active engagement, collaboration, and personalisation. These are all applicable in PBL to develop critical thinking, teamwork, and adaptability. Positive psychology and neuroeducation concepts further enrich PBL by fostering emotional well-being and cognitive development (Coumans & Wark, 2024). The following section outlines these pedagogical approaches' historical development and theoretical foundations.

Key principles of SCL

Three key principles underpinning SCL in tertiary education include:

Constructivism

Constructivism postulates that learners construct knowledge by integrating prior experiences with new information to prioritise skills essential for lifelong learning, such as deep learning, critical thinking, and navigating complex problems (Bruner, 1961; Dewey, 1938).

Humanism

Humanism emphasises autonomy, intrinsic motivation, and personal growth. These concepts empower students to take ownership of their learning, develop emotional intelligence and resilience, and thrive both personally and academically (Mukhalalati & Taylor, 2019; Rogers, 1969).

Behaviourism

Behaviourism advocates for frequent feedback, reinforcement, and clear learning objectives to support skill acquisition and autonomy through iterative feedback loops (Carlile & Jordan, 2005).

PBL: A core strategy

PBL is a core strategy of many SCL approaches, particularly within healthcare education. It engages students in solving real-world problems, blending theoretical knowledge with practice. Key aspects of effective PBL include:

- Facilitation by an academic who guides rather than instructs. This is a shift from knowledge transmitter to learning facilitator and supports the development of critical thinking, self-directed learning, teamwork, and adaptability skills to help navigate complex and dynamic workplaces (Barrows & Tamblyn, 1980; Wood, 2003).
- Promoting mastery through ongoing individualised feedback. This aids students to progressively refine their thinking and improve their problem-solving strategies, and it prepares them for professional challenges (Almusaed et al., 2023; Ellikkal & Rajamohan, 2024; Jayasinghe, 2024).
- Incorporating positive psychology and neuroscience principles which emphasise emotional safety, resilience, and engagement. Tools like the PERMA model – Positive Emotion, Engagement, Relationships, Meaning, and Accomplishment – help prepare students for complex, high-pressure environments while fostering a well-rounded approach to learning (Immordino-Yang et al., 2019; Seligman, 2011).

Technology already supports PBL through learning management systems, virtual patients, and video-based cases, enabling interactive, collaborative clinical reasoning and flexible access to content (Jin & Bridges, 2014). Recent advances in genAI build on this foundation, enabling the creation of adaptive scenarios and Socratic questions to personalise and enrich the problem-solving process (Coumans & Wark, 2024; Kasneci et al., 2023). GenAI assists students' progress from rote recall to analytical and synthetic reasoning and supports evidence-based practice and clinical excellence (Chang, 2023; Chen et al., 2024; Hswen & Nguyen, 2024).

To facilitate personal growth and resilience in PBL, careful and ethical use of genAI can suggest tailored feedback that promotes inclusion, psychological safety, and reflective thinking (Seligman, 2011; Xu, Weng, et al., 2024). Figure 12.1 illustrates how it ensures progress toward the relational integration of knowledge that fosters active enquiry, creativity, and critical thinking while aligning with constructivist and humanist theories. This general prompt strategy was designed to enhance comprehension through Bloom's and the structure of observed learning outcomes (SOLO) taxonomy (Brabrand & Dahl, 2009; Krathwohl, 2010) through generating topics supporting student engagement and creative problem-solving in foundational medical education. This ensures progress toward relational integration of knowledge and scaffolds meaningful exploration of clinical concepts. An example of output from this prompt is included in [Supplemental Data 1](#).

Start by giving genAI this prompt:

Act as a healthcare curriculum advisor.

Your task is to help me design a foundational lesson for students learning about healthcare.

Please follow these steps.

If design rigour is required, instead, ask:

Please confirm your understanding of what makes a topic ‘foundational’ in healthcare education.

Then, ask genAI:

Step 1: Please specify the <student group (e.g. course and year), city, state, and country> to customise the difficulty level.

Step 2: Based on my response, list 10 illnesses that can help students understand foundational healthcare concepts in engaging and creative ways. For each illness, include:

- Name
- Brief description
- Why is it foundational

After receiving the information, if required, you might want further assistance in identifying suitable resources to suggest to students. If so, follow up with:

Please, I would like assistance in finding:

1. Recommended textbooks and

learning materials suitable for this student group, region and activities.

2. Recent (last five years) open-access, peer-reviewed reviews in English via Scholar GPT.

For (introduce here the illness from the suggestion provided by the genAI)

Figure 12.1. Enhancing student comprehension through genAI

GenAI in healthcare education

Undergraduate healthcare students often struggle with complex concepts, such as integrating knowledge across body systems in a system-based curriculum. Foundational knowledge gaps intensify these difficulties (Badenhorst et al., 2021; Weurlander et al., 2014), and are exacerbated by a reliance on less effective learning techniques (Franz et al., 2022; Lerchenfeldt & Nyland, 2016), and disruptions caused by the COVID-19 pandemic's shift to online learning (Dost et al., 2020). These barriers can hinder academic performance, reduce learning efficacy, impact student well-being, and ultimately affect future patient-centred care (Duffy et al., 2020). However, genAI is revolutionising education by introducing innovative tools to enhance teaching and learning (Michel-Villarreal et al.,

2023). Within the SCL framework, genAI can complement strategies like clinical reasoning by offering dynamic solutions that support personalised learning, critical thinking, and collaborative problem-solving.

GenAI as a transformative tool

Applications in clinical scenarios and personalised learning

GenAI can enhance PBL by generating realistic, context-specific clinical cases incorporating diverse patient demographics, cultural and socioeconomic factors, and systemic considerations. These tailored cases challenge students to explore differential diagnoses, appropriate investigations, and provisional treatment plans that consider both clinical and broader social determinants of health (Barrows & Tamblyn, 1980; Mukhalalati & Taylor, 2019; Sauder et al., 2024).

GenAI supports personalised learning by adapting content to students' prior knowledge and cognitive style. It enables interactive dialogue that supports learners to explore clinical scenarios, receive real-time feedback, and refine their reasoning (Gordon et al., 2024). This assists self-directed and collaborative learning through customised materials including investigative pathways, structured objectives, and peer interaction strategies. By considering both correct and incorrect responses, genAI fosters curiosity, creativity, and analytical thinking while promoting effective teamwork (Kasneji et al., 2023; Xu et

al., 2024). Figure 12.2 provides a more detailed AI-generated prompt than Figure 12.1. It suggests clinically important topics, learning objectives, and peer interaction strategies aligned with PBL frameworks and the PERMA model. An example output is included in [Supplemental Data 2](#).

Start by giving genAI this prompt:

Act as a medical education expert specialising in Problem-Based Learning (PBL) and the PERMA model from Positive Psychology.

Your task is to help design contextually appropriate, engaging clinical education content that fosters creativity, curiosity, and emotional and societal engagement while encouraging self-directed learning in clinical, cultural, and structural scenarios.

First, confirm genAI's knowledge of the PBL approach and PERMA models.

Before continuing, please confirm your understanding of:

1. **The goals of the Problem-Based Learning (PBL) approach**
2. **The goals of the PERMA model**

Summarise each in two-three sentences. Only proceed if both are confirmed and well understood.

If rigour is required, ask:

How will you apply these frameworks in the content you generate?

Then, ask genAI:

Start by requesting the user specify the <specific organ> on which the clinical topic should focus and <student population, City, State, Country> for the difficulty level.

If rigour is required, ask:

If the user input is vague, clarify or confirm assumptions before continuing.

Next, ask genAI to suggest clinically important topics, learning objectives, and peer interaction strategies:

Suggest four clinically important topics that are related to <specific organ> and align with the learning needs of these students.

For each topic, include:

1. **A summary of the clinical importance of the topic.**
2. **Learning goals based on the PBL approach and the PERMA model (fostering curiosity, responsibility, and creativity).**
3. **Peer interaction strategies for stimulating critical reflection.**
4. **Recommended textbooks and learning materials suitable for this student group. Please use relevant resources to <City, State, Country>.**

Figure 12.2. Structuring clinical learning objectives with genAI

Socratic questioning

Socratic questioning challenges students to deepen their understanding by asking questions that clarify ideas, test assumptions, request evidence, and examine reasoning behind a choice (Overholser & Beale, 2023). It is critical in developing clinical reasoning and helps students to reflect and engage in analytical discussions (Ho et al., 2023). GenAI can support facilitators by generating tailored questions that explore complex ideas and connections.

These may range from conceptual queries (e.g. ‘What are the underlying physiological mechanisms of this condition?’) to integrative ones (e.g. ‘How might cultural factors influence healthcare outcomes for this patient?’). Facilitators refine and scaffold these questions to match students’ developmental level. SCL environments support students to generate and explore such inquiries independently, and genAI can assist by offering general considerations to prompt deeper reflection (Coumans & Wark, 2024; Xu et al., 2024). Figure 12.3 illustrates a general prompt for generating Socratic questions. It illustrates how genAI can assist facilitators in crafting Socratic questions tailored to clinical and cultural contexts. [Supplemental Data 3](#) includes an example of an output.

Start by giving genAI this prompt:

Act as a PBL facilitator skilled in clinical education and culturally responsive teaching.

Your task is to help generate Socratic questions that guide students in deep reflection and clinical reasoning.

If rigour is required, ask:

Confirm your understanding of Socratic questioning in clinical education and how it supports clinical reasoning and cultural responsiveness.

Then, ask genAI:

Start by requesting the user to specify the <clinical topic> and <student population, City, State, Country> for the difficulty level.

Based on the input, generate **open-ended** questions that:

- **Encourage diagnostic thinking.**
- **Highlight cultural, structural, and ideological healthcare factors.**
- **Can be categorised by theme (e.g. bias, ethics, access).**

Figure 12.3. Generating Socratic questions for PBL

Ethical and practical considerations

While genAI offers immense potential, its integration into education raises ethical and practical challenges that require careful consideration:

Risks of over-reliance and misinformation

Over-reliance on genAI can reduce students' engagement and critical thinking by encouraging passive learning habits. Additionally, inaccuracies or biases in AI-generated content pose risks of misinformation, compromising educational quality and trust by the learner (Kasneci et al., 2023; Michel-Villarreal et al., 2023).

Guidelines for secure data handling and AI-generated content verification

Ethical use of genAI requires robust data protection protocols and validation of AI outputs. Facilitators must ensure the content accuracy and curricular alignment through human oversight, peer review, and iterative validation (Wu, Zheng, et al., 2024).

Facilitators' roles in balancing genAI use with reflective practices

Facilitators play a pivotal role in integrating genAI as a supportive tool rather than a substitute for active learning.

By curating and reviewing AI-generated content, they can encourage more profound understanding and foster reflective practices that reinforce critical thinking (Anggraeni et al., 2023; Coumans & Wark, 2024). However, they must actively support ongoing student engagement in the PBL process to minimise the potential for students to revert to passive learning.

Coaching and neuroeducation for holistic SCL

Integrating coaching and neuroeducation into SCL provides a transformative approach to holistic learning as healthcare education evolves to meet the demands of professionals. They prioritise emotional well-being, resilience, and personal growth, aligning with SCL frameworks such as PBL, and are grounded in the principles of positive psychology and neuroscience. The following section summarises some key concepts within these fields.

Positive psychology

Positive psychology can inform educational practices that promote well-being and resilience. The PERMA model provides a framework for PBL facilitators to strengthen students' emotional and cognitive resilience. It aligns with PBL goals by creating a psychologically safe environment conducive to curiosity, critical thinking, collaboration, and

innovation (Peláez Zuberbuhler et al., 2024; Seligman, 2011).

Coaching frameworks

In tertiary education, coaching develops student self-awareness through structured goal setting and adaptive problem-solving skills. Coaching models like GROW (Goal, Reality, Options, Will) and ISMART (Important, Specific, Measurable, Achievable, Realistic, Time-bound) help students define their objectives, assess challenges, and implement actionable strategies. These models promote reflective practices, emotional intelligence, and accountability. In PBL, coaching can support students in navigating patient-specific contexts while addressing systemic challenges like healthcare disparities and practitioner shortages (Coumans & Wark, 2024; Hurlow, 2022).

Expectations

Establishing clear expectations is essential in fostering an empowering learning environment, especially in tertiary education, where the ‘hidden curriculum’ – the informal, often unintended lessons, values, and behaviours – shapes how students perceive their roles and responsibilities (Koutsouris et al., 2021). In healthcare education it encompasses social dynamics, cultural norms, and unspoken expectations that influence students’ understanding of professionalism and identity. When educators fail to set clear expectations, provide unequal

or inequitable access to resources, or ignore unproductive behaviours, students may experience confusion, emotional dissonance, and a diminished sense of purpose and well-being (Brown et al., 2020).

GenAI can influence the hidden curriculum through its language patterns and embedded assumptions, which may unintentionally reflect dominant norms or systemic biases. This reinforces standardised narratives and may discourage critical reflection (Kasneci et al., 2023; Xu et al., 2024). These assumptions risk reinforcing what constitutes ‘normal’ or ‘ideal’ knowledge and behaviour. However, when critically facilitated, genAI can also expose these assumptions, prompting reflective dialogue and encouraging students to question both human and algorithmic biases. Recognising and addressing the hidden curriculum, whether from educators, institutions, or digital tools, is essential for creating inclusive, ethically aware learning environments that support students’ professional identity formation and critical engagement (Gupta et al., 2024).

Insights from neuroscience for SCL

Chronic stress undermines both effective learning and cognitive performance (Schneider & Preckel, 2017). Neuroscience highlights the value of emotional safety, which can enhance memory, attention, and problem-solving through non-judgmental feedback and positive reinforcement (Immordino-Yang et al., 2019; Mendl, 1999). Neuroplasticity, the brain’s ability to reorganise and form new connections, facilitates lifelong learning. Emotionally supportive and engaging environments enhance cognitive flexibility and adaptability, key skills

for future healthcare practitioners who will navigate evolving clinical landscapes with innovation (Bhargava & Ramadas, 2022; Voss et al., 2017). In the SCL setting, genAI can assist PBL facilitators in addressing emotional and behavioural issues by tailoring feedback to individual factors, such as cultural background, personality, and age. Figure 12.4 provides a prompt to help students evaluate their behaviours. It demonstrates how facilitators can use frameworks to guide constructive changes. An example of the output is provided in [Supplemental Data 4](#).

Start by confirming the understanding of genAI in relation to the Educational Alliance Framework (or other options):

Briefly outline the Educational Alliance Framework and how it applies to the feedback process in educational settings.

Then, ask genAI:

Act as a facilitator experienced in the Educational Alliance Framework.

Your task is to help generate feedback strategies that support positive behavioural change in students, while strengthening group learning and trust.

Please start by asking the <gender, age, cultural, linguistic background, and problematic behaviour> so that the feedback can be adjusted.

Then, ask genAI to recommend constructive, positive changes:

Please suggest constructive, culturally sensitive

feedback strategies that align with the Educational Alliance Framework

Ensure the strategies:

- **Promote positive behavioural change.**
- **Respect the student's cultural and individual background.**
- **Improve or maintain group learning dynamics.**

If the information is vague or incomplete:

- **Ask follow-up questions for clarification (e.g. behaviour frequency, group impact).**
- **State any assumptions you are making before proceeding.**
- **Provide two-three feedback strategy options based on different possible interpretations.**

Include example phrases or conversation openers to model how a facilitator might deliver the feedback in a respectful, alliance-focussed way.

If appropriate, recommend follow-up actions to monitor or support behavioural change after the feedback session.

Figure 12.4. Supporting positive behavioural changes

Addressing systemic challenges in education

Healthcare education is uniquely positioned to address systemic challenges, including societal inequities, workforce shortages, and sustainability issues. Integrating genAI, Service Learning (SL), and the United Nations (UN) Sustainable Development Goals (SDGs), into SCL/PBL frameworks can cultivate socially responsible, adaptable learners equipped for multifaceted issues (Rodríguez-Zurita et al., 2024).

Tackling societal inequities through education

Community engagement

SL connects theoretical learning with mentored, community-based practice through partnerships with non-government organisations (NGOs) or public health services. SL fosters reciprocal student-community relationships and experiential learning grounded in real-world challenges. Supporting SDG 3 (good health and well-being) and SDG 4 (quality education), SL promotes empathy, communication skills, cultural competence, and systemic awareness (Rodríguez-Zurita et al., 2024). Within an SCL/PBL framework, SL encourages co-creation of

solutions, reinforcing reflective practice and social accountability.

Equity

GenAI can enhance equity-focused education by creating culturally-contextualised community-based scenarios and evidence-based interventions (Sauder et al., 2024). When embedded within SCL/PBL, this supports inclusive, responsive learning and exposes systemic biases and knowledge gaps, supporting the establishment of innovative approaches towards contributing to SDGs 3, 4, 10 (reduced inequalities), and 11 (sustainable cities and communities) (Kasula, 2024).

Marginalisation

Education prepares learners to address healthcare disparities, including practitioner shortages in regional areas. Combining coaching models with SL empowers students to contribute to structural solutions, like rural initiatives and community projects. These experiences promote adaptability, ethical awareness, and social responsibility, equipping students towards addressing SDG 3, SDG 4, and SDG 17 (partnerships for the goals) (Fluit et al., 2024; Stănciulescu, 2024).

Integrating sustainable development goals

Educating for sustainable impact

Aligning healthcare education with SDGs supports interdisciplinary learning and societal transformation (Department of Economic and Social Affairs, 2024). Embedding SDG-focused projects into the curricula supports students in considering global challenges like climate change, health inequities, and social disparities. These initiatives cultivate critical skills, collaboration, and innovation, empowering students to contribute meaningfully to societal progress (Rodríguez-Zurita et al., 2024).

The role of genAI

GenAI-generated scenario-based exercises can advance the achievement of SDGs (e.g. SDG-3, SDG-8, SDG-10, SDG-11) by encouraging students to design interventions that address public health inequities. These tasks promote evaluation of local issues, community-driven solutions, and reflection on their societal impact (Coumans & Wark, 2024).

Interdisciplinary collaboration

Meaningful interdisciplinary collaboration is key to maximising the impact of SDG-aligned education and underpins adaptability, empathy, and social responsibility to address complex societal issues. Models like Learning-to-Develop through Research (LDR) can be adapted to help students integrate research into practice, developing innovative, sustainable solutions that align personal growth with cultural, structural, and ethical aspects of healthcare delivery (Stănciulescu, 2024).

Figure 12.5 presents a more complex genAI prompt designed to generate scenarios aligned with SDGs. While the LDR model is used, other frameworks can be substituted into the prompt. An example output is provided in [Supplemental Data 5](#).

Start by giving genAI this prompt:

Act as a clinical educator specialising in SDG-aligned curriculum design and socioculturally responsive teaching.

Based on the five educational principles outlined below, the aim will be to develop a comprehensive clinical case scenario and propose interventions to achieve a specific United Nations Sustainable Development Goal (SDG).

Key principles

1. **Integration of Learning and Development: Growth is continuous**

and closely tied to individual and group improvement.

2. **Psycho-Sociological Awareness: Identity, behaviour, and emotion are shaped by culture and society.**
3. **Social Change-Oriented Mindset: Actions are situated within, and influence, larger social systems.**
4. **Desirable Difficulties: Challenges in learning can improve long-term understanding and skills.**
5. **Dynamic and Plural Self: Learners' identities evolve across contexts and roles.**

Then, ask genAI:

Start by asking the user to specify the <patient demographic (e.g. children, adolescents, adults, elderly, individuals, social status, medical condition, city, state, country >, <target SDG> and <student population (e.g. course and year group), City, State, Country> to align the difficulty.

Because the prompt is complex, validate the genAI's assumptions:

If any detail is missing or unclear, ask follow-up clarification questions to ensure accuracy.

Next, ask the genAI:

Based on the validated input:

1. **Create a clinical case scenario that integrates the five key principles.**
2. **Propose two-three practical interventions aligned with the chosen SDG.**
3. **(Optional) Include reflective discussion questions to guide exploration of identity, social responsibility, and system-level implications.**

Ensure the tone and content align with the student population's level and cultural context.

After generating the case and interventions, briefly explain how each component reflects the educational principles and SDG chosen.

Figure 12.5. Designing scenario-based exercises to address SDGs

Preparing students for future challenges

As society transitions to the era of 'Society 5.0', emphasising productivity and innovation, tertiary education must develop students' digital competencies, critical thinking, creativity, and human-centric skills to

meet these demands (Shahidi Hamedani et al., 2024). Constructivist and humanistic approaches underpin the SCL framework, promoting engagement, autonomy, and growth (Mukhalalati & Taylor, 2019). Technologies such as genAI, big data, and virtual reality present new opportunities for developing these essential skills. Unlike healthcare informatics or traditional educational technologies, genAI is not purpose-built for curriculum delivery or healthcare instruction. Instead, it is a general-purpose language model whose educational value emerges through intentional and critical adaptation. Educators must guide the use of genAI to support reflection, inquiry, and dialogue aligned with student-centred values. As demonstrated through exemplar prompts, genAI can generate clinical scenarios, Socratic questions, and tailored coursework to foster critical and problem-solving skills. It also facilitates boundary-crossing learning by enabling interdisciplinary collaboration, reflective practices, and adaptability (Oonk et al., 2022), creating dynamic, inclusive, and personalised learning environments suited to current and future professional landscapes.

Frameworks for reflective and adaptive learning

Reflective and adaptive learning frameworks are crucial for developing the skills required in the dynamic and complex environments of Society 5.0. Integrating models like the Master Adaptive Learner (MAL) framework, and leveraging genAI to create scenarios that enhance students' critical thinking, educators can cultivate cognitive and

interpersonal skills essential for success (Cutrer et al., 2017). MAL employs a structured ‘plan-do-study-act’ cycle to help learners identify knowledge gaps, engage in targeted activities, reflect on the outcomes, and adapt ongoing strategies for continuous improvement. This aligns with coaching frameworks, like the GROW model, which support structured goal-setting and actionable learning pathways (Cutrer et al., 2017; Leach, 2020). Additionally, ISMART principles can ensure that learning objectives are precise, attainable, and aligned with individual and societal needs.

Figure 12.6 illustrates a prompt that demonstrates how facilitators can integrate the MAL and GROW models with ISMART principles within a reflective and adaptive framework. This structured approach guides students through self-reflection and goal-setting exercises to address their learning needs in the context of broader societal challenges. [Supplemental Data 6](#) shows an example of an output.

Start by giving the genAI this prompt:

Act as an experienced academic coach specialising in medical education. Your role will be to support a PBL facilitator in structuring an effective coaching conversation with a student using the Master Adaptive Learner (MAL) framework, the GROW model, and the ISMART goal-setting framework.

First, confirm genAI’s knowledge of the Master Adaptive Learner framework, GROW model, and ISMART framework:

1. **Please outline the goals of the Master Adaptive Learner framework.**
2. **Please outline the goals of the GROW model.**
3. **Please outline the goals of the ISMART framework.**

Then, ask genAI:

To be able to tailor the conversation, start by asking the PBL facilitator to specify the <student details (e.g. gender, age, cultural background, current situation)>, their <goals (e.g. long-term and short-term)> and their <current challenges>.

As an experienced academic coach specialising in medical education, your role is to support a PBL facilitator in delivering an effective, learner-centred coaching conversation. If the information provided about the student is incomplete or vague, please first ask clear, targeted follow-up questions (e.g. ‘Can you clarify the student’s most pressing challenge?’) before proceeding. This ensures the coaching plan is personalised, appropriate, and aligned with the student’s context and needs.

Then, ask genAI for guidance in structuring a conversation that leads the student through self-reflection and setting actionable goals:

Using the MAL framework as the core structure, and incorporating elements from the GROW and ISMART models:

- **Guide the facilitator in prompting reflective self-assessment.**
- **Help the student define clear, motivating, and time-bound goals.**
- **Ensure the student leaves the conversation with a set of actionable next steps.**

Provide **example phrasing or prompts** the facilitator can use at each stage of the conversation.

After presenting the structured conversation, explain how each part draws from the MAL, GROW, and ISMART frameworks.

Figure 12.6. Structuring reflective conversations and goal setting

GenAI in adaptive learning

GenAI emerges as a complementary tool for adaptive learning, facilitating scenario design that promotes argumentation, collaborative problem-solving, and reflective thinking (Guettala et al., 2024). GenAI can help create clinical scenarios that challenge students to explore differential diagnoses, engage in interdisciplinary collaboration, and address ambiguous real-world problems. In collaborative healthcare, argumentation and group decision making are crucial for identifying cognitive conflicts, mitigating biases, and improving problem

solving. Healthcare professionals often draw on personal experiences in teaching, which can enrich learning and introduce unconscious biases. Encouraging diverse perspectives helps uncover preconceptions and improves patient-centred care (Lu & Lajoie, 2008). Personal values influence decision making, with practitioners prioritising spirituality supporting more holistic, patient-centred approaches, while those emphasising critical thinking may promote evidence-based analysis (Moyo et al., 2019). These findings highlight the value of clinical case scenarios with inherent ambiguity in fostering debate around differential diagnoses, appropriate investigations, and context-based treatment. One specific genAI, ChatGPT, has demonstrated utility in supporting clinical workflows, achieving 71.7% accuracy in iterative clinical tasks and 78.8% accuracy in symptom-checking across 194 adult diseases (Chen et al., 2024; Rao et al., 2023). This suggests its potential to generate diagnostic challenges that encourage critical evaluation and prioritisation in clinical assessments. Figure 12.7 provides a general prompt to generate culturally and structurally relevant clinical scenarios to enhance collaborative problem-solving and critical thinking. An example output is provided in [Supplemental Data 7](#).

Start by giving genAI this prompt:

Act as a clinical case designer for medical education, specialising in PBL and diagnostic reasoning.

Your task is to create a rich, ambiguous clinical

case scenario that promotes argumentation about diagnosis and requires students to develop a differential diagnosis collaboratively.

Then, ask genAI:

Start by requesting the user to specify the central system on which this clinical scenario should focus (e.g. heart, lungs, neurological, gastrointestinal) and <student population (e.g. course and year group), City, State, Country> to align the difficulty.

Because the prompt is complex, validate the genAI's assumptions:

If information is unclear or missing, ask a targeted clarifying question.

Next, ask genAI:

Step 1: Create a clinical scenario for PBL that encourages argumentation around a patient diagnosis.

The scenario must include:

1. **Patient demographics based on typical condition presentation by ethnicity, age, and gender.**
2. **A typical clinical setting (e.g. ER, inpatient ward, general practice).**
3. **A broad chief complaint like (e.g. 'chest pain', 'stomach pain', 'dizziness')**
4. **Both normal and abnormal**

physical exam findings that could suggest multiple diagnoses.

5. **Variability, like symptom duration, history, lifestyle factors, systemic barriers, and access to care.**
6. **Offer four possible diagnoses, including the most probable one, but ensure that the scenario remains ambiguous to promote debate about differential diagnosis and the need for further investigations to reach an accurate diagnosis.**

Step 2: Please explain how each diagnosis relates to the findings to support facilitator preparation.

Figure 12.7. Generating ambiguous clinical scenarios for argumentation

Inclusivity in education

Inclusivity is central to creating equitable and supportive educational environments, particularly in high-pressure fields such as healthcare. Increasingly, students face pressures associated with stress, perfectionism, and systemic barriers, contributing to mental health issues (Thomas & Bigatti, 2020). Addressing these concerns

requires evidence-based strategies to build individual resilience, well-being, and equity.

Student challenges

Students' mental health is a global concern, with an estimated prevalence of depressive symptoms of 27.0%, with the highest prevalence of 40.9% in Africa (Tam et al., 2019). In healthcare students, reported depression rates vary considerably from 1.4% to 73.5%, with anxiety rates ranging from 7.7% to 65.5% (Mirza et al., 2021). Contributing factors include academic pressure, financial difficulties, and a family history of mental health issues. These stressors can evolve as students progress, with first-year students struggling with workload volume and lack of feedback, while advanced students face concerns about competence, pedagogical gaps, and unsupportive environments (Mirza et al., 2021).

Socioeconomic disparities worsen these challenges, with students from low-income or rural backgrounds reporting higher depression rates than urban or higher-income peers (Mirza et al., 2021). The culture of perfectionism is ubiquitous in medical training, often intensifying these pressures and disproportionately affecting women who face heightened societal expectations and systemic biases (Thomas & Bigatti, 2020).

Strategies to foster resilience, well-being, and equity

Addressing mental health and promoting equity in education requires inclusive environments. A comprehensive approach incorporates innovative technologies, resilience-building techniques, active engagement, and emotionally and culturally safe spaces. These strategies foster holistic well-being and empower individuals and communities to thrive (Osher & Pittman, 2024).

Emotional safety

Neuroeducation highlights the importance of emotionally and culturally safe environments for fostering a growth mindset – believing abilities can develop through effort and practice. Positive and trusting relationships enhance cognitive functions such as memory, attention, and problem-solving, allowing students to engage deeply with their learning. These conditions nurture resilience and holistic well-being, equipping students to navigate academic and personal challenges effectively (Coumans & Wark, 2024; Immordino-Yang et al., 2019).

Leveraging technology for equity

Technological innovations, like genAI, can support inclusivity and address systemic issues. By generating tailored feedback and challenging biases, these tools help

students overcome perfectionist tendencies, build resilience, and enhance mental well-being. Aligning technologies with the UN's SDGs enables institutions to tackle challenges of gender disparities, resource inequities, and other systemic challenges, and supports equity in educational opportunities (Carter et al., 2024; Murphy et al., 2021).

Encouraging active participation

Equity requires active engagement from all stakeholders. Promoting men's participation in gender equity efforts and addressing disparities in race, socioeconomic status, and gender is vital. Institutions must cultivate environments where all students feel valued and empowered to succeed (Thomas & Bigatti, 2020; Van Laar et al., 2024).

Strength-based coaching and feedback

Strength-based coaching, rooted in positive psychology, focuses on individuals' strengths to enhance resilience and self-confidence. It emphasises collaborative and reflective feedback that strengthens educator-learner relationships. Positive reinforcement and introspective practices equip students with adaptive skills, fostering motivation and resilience in overcoming challenges (Peláez Zuberbuhler et al., 2024; Telio et al., 2015).

Integrating strategies for inclusive

education

Holistic approaches that foster resilience, well-being, and equity integrate emotionally safe spaces, technological innovations, active engagement, and strength-based coaching. These strategies address the complex interplay of mental health challenges and systemic inequities by prioritising agency, groundedness, and inclusivity, and prepare students to thrive academically and to contribute meaningfully to society (Osher & Pittman, 2024).

Conclusion: A vision for future-ready education

Transforming education into a future-ready ecosystem requires innovation, inclusivity, and adaptability. As the 21st century presents increasingly complex global challenges, integrating genAI into SCL and PBL becomes pivotal. GenAI can support the integration of theoretical knowledge with practical applications, encouraging critical thinking, self-directed learning, and collaborative knowledge creation. (Thampinathan, 2022). Coaching frameworks such as the MAL and GROW model, combined with the ISMART framework, equip students with the reflective and adaptive skills needed to thrive in dynamic environments. If coupled with ethical considerations in using genAI, these approaches create a balanced framework for nurturing academic excellence, personal growth, and professional adaptability (Cutrer et al., 2018; Kasneci et al., 2023; Leach, 2020).

Education must also rise to the task of addressing pressing global challenges, including healthcare disparities, climate change, and social inequities. By aligning curricula with the SDGs and SL, institutions empower students to become meaningful, socially responsible professionals (Department of Economic and Social Affairs, 2024; Rodríguez-Zurita et al., 2024).

Transitioning to Society 5.0 education means prioritising digital literacy, creative problem-solving, and human-centric skills to prepare students to navigate the complexities of modern life, fostering a generation of adaptive, innovative, and socially conscious professionals ready to tackle the challenges of a rapidly evolving world (Shahidi Hamedani et al., 2024). It is hoped that this chapter has provided practical examples of how genAI can support the development of our future healthcare workforce.

References

- Almusaed, A., Almssad, A., Yitmen, I., & Homod, R. Z. (2023). Enhancing Student Engagement: Harnessing ‘AIED’'s Power in Hybrid Education—A Review Analysis. *Education Sciences*, 13(7). <https://doi.org/10.3390/educsci13070632>
- Alowais, S. A., Alghamdi, S.S., Alsuhebany, N., Alqahtani, T., Abdulrahman I. A., Almohareb, S. N., Aldairem, A., Alrashed, M., Bin Saleh, K., Badreldin, H. A., Al Yami, M. S., Al Harbi, S., & Albekairy, A. M. (2023). Revolutionizing healthcare: The role of artificial intelligence in clinical practice. *BMC Medical*

- Education*, 23(1), 689. <https://doi.org/10.1186/s12909-023-04698-z>
- Anggraeni, D. M., Prahani, B. K., Suprpto, N., Shofiyah, N., & Jatmiko, B. (2023). Systematic review of problem based learning research in fostering critical thinking skills. *Thinking Skills and Creativity*, 49. <https://doi.org/10.1016/j.tsc.2023.101334>
- Badenhorst, E., Mamede, S., Abrahams, A., Bugarith, K., Cilliers, F., Gordon, C., Gunston, G., Zweigenthal, V., & Schmid, H. G. (2021). What happens to misunderstandings of biomedical concepts across a medical curriculum? *Advances in Physiology Education*, 45(3), 526–537. <https://doi.org/10.1152/advan.00203.2020>
- Barrows, H. S., & Tamblyn, R. M. (1980). *Problem-based learning: An approach to medical education*. Springer Publishing. <https://books.google.com.au/books?id=9u-5DJuQq2UC>
- Bhardwaj, V., Zhang, S., Tan, Y. Q., & Pandey, V. (2025). Redefining learning: student-centered strategies for academic and personal growth. *Frontiers in Education*, 10. <https://doi.org/10.3389/feduc.2025.1518602>
- Bhargava, A., & Ramadas, V. (2022). Implications of neuroscience/neuroeducation in the field of education to enhance the learning outcomes of the students. *Journal of Positive School Psychology* 6502–6510.
- Brabrand, C., & Dahl, B. (2009). Using the SOLO taxonomy to analyze competence progression of university science curricula. *Higher Education*, 58(4), 531–549. <https://doi.org/10.1007/s10734-009-9210-4>
- Bremner, N. (2021). The multiple meanings of ‘student-centred’ or ‘learner-centred’ education, and the case for a more flexible approach to defining it. *Comparative*

- Education* 57(2), 159–186. <https://doi.org/10.1080/03050068.2020.1805863>
- Brown, M. E. L., Coker, O., Heybourne, A. & Finn, G. M. (2020). Exploring the hidden curriculum's impact on medical students: Professionalism, identity formation and the need for transparency. *Medical Science Educator* 30(3), 1107–1121. <https://doi.org/10.1007/s40670-020-01021-z>
- Bruner, J. S. (1961). The act of discovery. *Harvard Educational Review* 31, 21–32.
- Carlile, O., & Jordan, A. (2005). It works in practice but will it work in theory? The theoretical underpinnings of pedagogy. *Emerging Issues in the Practice of University Learning and Teaching*, 1, 11–26.
- Carter, J. C., Purcell, N., Stewart, C. H., Pearce, G. C., Balkin, M., & Allen, K. J. (2024). Still a 'boys' club': A qualitative analysis of how gender affects a career in anaesthesia in Australia and Aotearoa New Zealand. *Anaesthesia*, 79(7), 694–705. <https://doi.org/10.1111/anae.16281>
- Chang, B. S. (2023). Transformation of undergraduate medical education in 2023. *JAMA*, 330(16), 1521–1522. <https://doi.org/10.1001/jama.2023.16943>
- Chen, A., Chen, D. O., & Tian, L. (2024). Benchmarking the symptom-checking capabilities of ChatGPT for a broad range of diseases. *Journal of the American Medical Informatics Association*, 31(9), 2084–2088. <https://doi.org/10.1093/jamia/ocad245>
- Chen, A., Chen, W., & Liu, Y. (2024). Impact of democratizing artificial intelligence: Using ChatGPT in medical education and training. *Academic Medicine*, 99(6), 589. <https://doi.org/10.1097/ACM.0000000000005672>
- Coumans, J. V. F., & Wark, S. (2024). Impact of

- problem-based learning coaching and neuroeducation in the development of 21st century lifelong learners. *Mind, Brain, and Education*, 18(1), 35–42. <https://doi.org/10.1111/mbe.12406>
- Creely, E., Henriksen, D., & Henderson, M. (2020). Three modes of creativity. *The Journal of Creative Behavior*, 55(2), 306–318. <https://doi.org/10.1002/jocb.452>
- Cutrer, W. B., Atkinson, H. G., Friedman, E., Deiorio, N., Gruppen, L. D., Dekhtyar, M., & Pusic, M. (2018). Exploring the characteristics and context that allow Master Adaptive Learners to thrive. *Medical Teacher* 40(8), 791–796. <https://doi.org/10.1080/0142159X.2018.1484560>
- Cutrer, W. B., Miller, B., Pusic, M. V., Mejicano, G., Mangrulkar, R., Gruppen, L. D., Hawkins, R. E., Skochelak, S. E., Moore, D. E. Jr. (2017). Fostering the development of Master Adaptive Learners: A conceptual model to guide skill acquisition in medical education. *Academic Medicine* 92(1), 70–75. <https://doi.org/10.1097/ACM.000000000000132>
- Department of Economic and Social Affairs. (n.d.) *The 17 Goals*. United Nations. <https://sdgs.un.org/goal>
- Dewey, J. (1938). *Experience and Education*. Kappa Delta Pi.
- Divito, C. B., Katchikian, B. M., Gruenwald, J. E., & Burgoon, J. M. (2024). The tools of the future are the challenges of today: The use of ChatGPT in problem-based learning medical education. *Medical Teacher* 46(3), 320–322. <https://doi.org/10.1080/0142159X.2023.2290997>
- Dost, S., Hossain A., Shehab M., Abdelwahed, A., & Al-Nusair, L. (2020). Perceptions of medical students towards online teaching during the COVID-19 pandemic: A national cross-sectional survey of 2721 UK

- medical students. *BMJ Open*, 10(11), e042378. <https://doi.org/10.1136/bmjopen-2020-042378>
- Duffy, A., Keown-Stoneman, C., Goodday, S., Horrocks, J., Lowe, M., King, N., Pickett, W., McNevin, S. H., Cunningham, S., Rivera, D., Bisdounis, L., Bowie, C. R., Harkness, K., & Saunders, K. E. A. (2020). Predictors of mental health and academic outcomes in first-year university students: Identifying prevention and early-intervention targets. *BJPsych Open*, 6(3), e46. <https://doi.org/10.1192/bjo.2020.24>
- Ellikkal, A., & Rajamohan, S. (2024). AI-enabled personalized learning: Empowering management students for improving engagement and academic performance. *XJMB Journal of Management*, 22 (1), 28–44. <https://doi.org/10.1108/XJM-02-2024-002>
- Fluit, S., Cortés-García, L., & von Soest, T. (2024). Social marginalization: A scoping review of 50 years of research. *Humanities and Social Sciences Communications*, 11(1). <https://doi.org/10.1057/s41599-024-04210-y>
- Franz, A., Oberst, S., Peters, H., Berger, R., & Behrend, R. (2022). How do medical students learn conceptual knowledge? High-, moderate- and low-utility learning techniques and perceived learning difficulties. *BMC Medical Education*, 22(1), 250. <https://doi.org/10.1186/s12909-022-03283-0>
- Gattupalli, S. (2024). *The art and science of promptgramming*. <https://hdl.handle.net/20.500.14394/22900>
- Gordon, M., Daniel, M., Ajiboye, A., Uraiby, H., Xu, N. Y., Bartlett, R., Hanson, J., Haas, M., Spadafore, M., Grafton-Clarke, C., Gasiea, R. Y., Michie, C., Corral, J., Kwan, B., Dolmans, D., & Thammasitboon, S. (2024). A scoping review of artificial intelligence in medical

- education: BEME Guide No. 84. *Medical Teacher*, 46(4), 446–470. <https://doi.org/10.1080/0142159X.2024.2314198>
- Guettala, M., Bourekkache, S., Kazar, O., & Harous, S. (2024). Generative artificial intelligence in education: Advancing adaptive and personalized learning. *Acta Informatica Pragensia*, 13(3), 460–489. <https://doi.org/10.18267/j.aip.235>
- Gupta, N., Ali, K., Jiang, D., Fink, T., & Du, X. (2024). Beyond autonomy: Unpacking self-regulated and self-directed learning through the lens of learner agency—A scoping review. *BMC Medical Education*, 24(1), 1519. <https://doi.org/10.1186/s12909-024-06476-x>
- Hartling, L., Spooner, C., Tjosvold, L., & Oswald, A. (2010). Problem-based learning in pre-clinical medical education: 22 years of outcome research. *Medical Teacher*, 32(1), 28–35. <https://doi.org/10.3109/01421590903200789>
- Ho, Y. R., Chen, B. -Y., & Chien, M. – L. (2023). Thinking more wisely: Using the Socratic method to develop critical thinking skills amongst healthcare students. *BMC Medical Education*, 23(1), 173. <https://doi.org/10.1186/s12909-023-04134-2>
- Hswen, Y., & Nguyen, T. T. (2024). Generative artificial intelligence should not compromise traditional medical education. *Academic Medicine*, 99(6), 589–590. <https://doi.org/10.1097/ACM.0000000000005674>
- Hurlow, S. (2022). Revisiting the relationship between coaching and learning: The problems and possibilities. *Academy of Management Learning & Education* 21(1), 121–138. <https://doi.org/10.5465/amle.2019.0345>
- Immordino-Yang, M. H., Darling-Hammond, L., & Krone, C. R. (2019). Nurturing nature: How brain development is inherently social and emotional, and what this means

- for education. *Educational Psychologist* 54(3), 185–204. <https://doi.org/10.1080/00461520.2019.1633924>
- Jayasinghe, S. (2024). Promoting active learning with ChatGPT: A constructivist approach in Sri Lankan higher education. *Journal of Applied Learning & Teaching*, 7(2). <https://doi.org/10.37074/jalt.2024.7.2.26>
- Jin, J., & Bridges, S. M. (2014). Educational technologies in problem-based learning in health sciences education: A systematic review. *Journal of Medical Internet Research* 16(12), e251. <https://doi.org/10.2196/jmir.3240>
- Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T. ... Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, 103. <https://doi.org/10.1016/j.lindif.2023.102274>
- Kasula, B. Y. (2024). Advancements in AI-driven healthcare: A comprehensive review of diagnostics, treatment, and patient care integration. *International Journal of Machine Learning for Sustainable Development*, 6(1), 1–5.
- Kitsios, F., Kamariotou, M., Syngelakis, A. I., & Talias, M. A. (2023). Recent advances of artificial intelligence in healthcare: A systematic literature review. *Applied Sciences* 13(13). <https://doi.org/10.3390/app13137479>
- Koutsouris, G., Mountford-Zimdars, A., & Dingwall, K. (2021). The ‘ideal’ higher education student: Understanding the hidden curriculum to enable institutional change. *Research in Post-Compulsory*

- Education*, 26(2), 131–147. <https://doi.org/10.1080/13596748.2021.1909921>
- Krathwohl, D. R. (2010). A revision of Bloom's taxonomy: An overview. *Theory Into Practice*, 41(4), 212–218. https://doi.org/10.1207/s15430421tip4104_2
- Leach, S. (2020). Behavioural coaching: The GROW model. In J. Passmore (Ed.), *The coaches' handbook* (pp. 176–186). Routledge. <https://doi.org/10.4324/978100308988>
- Lerchenfeldt, S., & Nyland, R. (2016). learning technique utility and preferences among second-year medical students: A pilot study of general and pre-exam study habits. *MedEdPublish*, 5(96). <https://doi.org/10.15694/mep.2016.000096>
- Lu, J., & Lajoie, S. P. (2008). Supporting medical decision making with argumentation tools. *Contemporary Educational Psychology* 33(3), 425–442. <https://doi.org/10.1016/j.cedpsych.2008.05.005>
- Martin-Alguacil, N., Avedillo, L., Mota-Blanco, R., & Gallego-Agundez, M. (2024). Student-centered learning: Some issues and recommendations for its implementation in a traditional curriculum setting in health sciences. *Education Sciences*, 14(11). <https://doi.org/10.3390/educsci14111179>
- Mendl, M. (1999). Performing under pressure: Stress and cognitive function. *Applied Animal Behaviour Science* 65(3), 221–244. [https://doi.org/10.1016/s0168-1591\(99\)00088-x](https://doi.org/10.1016/s0168-1591(99)00088-x)
- Michel-Villarreal, R., Vilalta-Perdomo, E., Salinas-Navarro, D. E., Thierry-Aguilera, R., & Gerardou, F. S. (2023). Challenges and opportunities of generative AI for higher education as explained by ChatGPT. *Education Sciences*, 13(9). <https://doi.org/10.3390/educsci13090856>

- Mirza, A. A., Baig, M., Beyari, G. M., Halawani, M. A., & Mirza, A. A. (2021). Depression and anxiety among medical students: A brief overview. *Advances in Medical Education and Practice*, 12, 393–398. <https://doi.org/10.2147/AMEP.S302897>
- Moyo, M., Shulruf, B., Weller, J., & Goodyear-Smith, F. (2019). Effect of medical students' values on their clinical decision-making. *Journal of Primary Health Care*, 11(1), 64–74. <https://doi.org/10.1071/HC18055>
- Mukhalalati, B. A., & Taylor, A. (2019). Adult learning theories in context: A quick guide for healthcare professional educators. *Journal of Medical Education and Curricular Development*, 6. <https://doi.org/10.1177/2382120519840332>
- Murphy, M., Callander, J. K., Dohan, D., & Grandis, J. R. (2021). Networking practices and gender inequities in academic medicine: Women's and men's perspectives on the boys' club. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3957119>
- Oonk, C., Gulikers, J., den Brok, P., & Mulder, M. (2022). Stimulating boundary crossing learning in a multi-stakeholder learning environment for sustainable development. *International Journal of Sustainability in Higher Education* 23(8), 21–40. <https://doi.org/10.1108/ijsh-04-2021-0156>
- Osher, D., & Pittman, K. (2024). *Equity-centered thriving*. <https://kpcatalysts.com/wp-content/uploads/2025/03/Equity-Centered-Thriving-Osher-Pittman-Feb-2024.pdf>
- Overholser, J. C., & Beale, E. (2023). The art and science behind Socratic questioning and guided discovery: A research review. *Psychotherapy Research*, 33(7), 946–956. <https://doi.org/10.1080/10503307.2023.2183154>
- Passmore, J., & Lai, Y.-L. (2019). Coaching psychology:

- Exploring definitions and research contribution to practice? *International Coaching Psychology Review* 14(2), 69–83. <https://doi.org/10.53841/bsicpr.2019.14.2.69>
- Pavlović, J. (2021). *Coaching psychology: Constructivist approaches* (1st ed.). Taylor & Francis Group. <https://doi.org/10.4324/9781003016878>
- Peláez Zuberbuhler, J., Corbu, A., Christensen, M., & Salanova, M. (2024). The effectiveness of positive psychological coaching at work: A systematic review. *Coaching: An International Journal of Theory, Research and Practice*, 17(2), 163–188. <https://doi.org/10.1080/17521882.2023.2300822>
- Rao, A., Pang, M., Kim, J., Kamineni M., Lie, W., Prasad, A. K., Landman, A., Dreyer, K., & Succi, M. D. (2023). Assessing the utility of ChatGPT throughout the entire clinical workflow: Development and usability study. *Journal of Medical Internet Research* 25, e48659. <https://doi.org/10.2196/48659>
- Rodríguez-Zurita, D., Jaya-Montalvo, M., Moreira-Arboleda, J., Raya-Diez, E., & Carrión-Mero, P. (2024). Sustainable development through service learning and community engagement in higher education: A systematic literature review. *International Journal of Sustainability in Higher Education* <https://doi.org/10.1108/ijshe-10-2023-0461>
- Rogers, C. R. (1969). *Freedom to learn*. Charles E. Merrill Publishing Company.
- Sauder, M., Tritsch, T., Rajput, V., Schwartz, V., & Shoja, M. M. (2024). Exploring generative artificial intelligence-assisted medical education: Assessing case-based learning for medical students. *Cureus*, 16(1), e51961. <https://doi.org/10.7759/cureus.51961>
- Schneider, M., & Preckel, F. (2017). Variables associated

- with achievement in higher education: A systematic review of meta-analyses. *Psychological Bulletin* 143(6), 565–600. <https://doi.org/10.1037/bul0000098>
- Schön, D. A. (1992). *The reflective practitioner: How professionals think in action* (1st ed.). Routledge. <https://doi.org/10.4324/9781315237473>
- Seligman, M. (2011). *Flourish: A visionary new understanding of happiness and well-being*. Free Press.
- Shahidi Hamedani, S., Aslam, S., Mundher Oraibi, B. A., Wah, Y. B., & Shahidi Hamedani, S. (2024). Transitioning towards tomorrow's workforce: Education 5.0 in the landscape of society 5.0: A systematic literature review. *Education Sciences*, 14(10). <https://doi.org/10.3390/educsci14101041>
- Spencer, J. A., & Jordan, R. K. (1999). Learner centred approaches in medical education. *BMJ*, 318(7193), 1280–1283. <https://doi.org/10.1136/bmj.318.7193.1280>
- Stănciulescu, E. (2024). Beyond coping and adaptation: Toward a sociology of coaching. A necessary paradigm shift to address contemporary dramatic social change. *Social Science Information* 63(2), 213–249. <https://doi.org/10.1177/05390184241252770>
- Tam, W., Lo, K., & Pacheco, J. (2019). Prevalence of depressive symptoms among medical students: Overview of systematic reviews. *Medical Education in Review*, 53(4), 345–354. <https://doi.org/10.1111/medu.13770>
- Telio, S., Ajjawi, R., & Regehr, G. (2015). The 'educational alliance' as a framework for reconceptualizing feedback in medical education. *Academic Medicine* 90(5), 609–614. <https://doi.org/10.1097/ACM.0000000000000560>
- Thampinathan, S. (2022). The application of the constructivism learning theory to physician assistant

- students in primary care. *Education for Health* 35(1), 26–30. https://doi.org/10.4103/efh.Efh_333_20
- Thomas, M., & Bigatti, S. (2020). Perfectionism, impostor phenomenon, and mental health in medicine: a literature review. *International Journal of Medical Education* 11, 201–213. <https://doi.org/10.5116/ijme.5f54.c8f8>
- Van Laar, C., Van Rossum, A., Kosakowska-Berezecka, N., Bongiorno, R., & Block, K. (2024). MANDatory—why men need (and are needed for) gender equality progress. *Frontiers in Psychology*, 15, 1263313. <https://doi.org/10.3389/fpsyg.2024.1263313>
- Voss, P., Thomas, M. E., Cisneros-Franco, J. M., & de Villers-Sidani, E. (2017). Dynamic brains and the changing rules of neuroplasticity: Implications for learning and recovery. *Frontiers in Psychology*, 8, 274878. <https://doi.org/10.3389/fpsyg.2017.01657>
- Weimer, M. (2013). *Learner-centered teaching: Five key changes to practice* (2nd ed.). Jossey-Bass.
- Weurlander, M., Scheja, M., Hult, H., & Wernerson, A. (2014). The struggle to understand: Exploring medical students' experiences of learning and understanding during a basic science course. *Studies in Higher Education*, 41(3), 462–477. <https://doi.org/10.1080/03075079.2014.930122>
- Wood, D. F. (2003). Problem based learning. *BMJ*, 326(7384), 328–330. <https://doi.org/10.1136/bmj.326.7384.328>
- Wu, H., Zerner, T., Lee, D., Court-Kowalski, S., Devitt, P. & Palmer, E. (2024). GPT-4 versus human authors in clinically complex MCQ creation: A blinded analysis of item quality. <https://doi.org/10.21203/rs.3.rs-4831476/v1>
- Wu, Y., Zheng, Y., Feng, B., Yang, Y., Kang, K., & Zhao, A. (2024). Embracing ChatGPT for medical education:

Exploring its impact on doctors and medical students. *JMIR Medical Education*, 10, e52483. <https://doi.org/10.2196/52483>

Xu T., Weng H., Liu F., Yang L., Luo Y., Ding Z., & Wang Q. (2024). Current status of ChatGPT use in medical education: Potentials, challenges, and strategies. *Journal of Medical Internet Research* 26, e57896. <https://doi.org/10.2196/57896>

Xu, X., Chen, Y., & Miao, J. (2024). Opportunities, challenges, and future directions of large language models, including ChatGPT in medical education: A systematic scoping review. *Journal of Educational Evaluation for Health Professions*, 21, 6. <https://doi.org/10.3352/jeehp.2024.21.6>

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