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GROUNDWORK

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Refining and Looking for Gaps: A Study of Adaptability in Preclinical Medical Students

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ABSTRACT

Adaptability is an essential element of professional healthcare practice, yet little is known about how medical students understand and engage with adaptability during their preclinical training. Insight into these early experiences can help uncover the fundamentals of later adaptive expertise. This study explored how preclinical medical students perceive their own adaptability in the context of their academic work. From December 2024 to January 2025, seventeen third-year medical students from three universities in Belgium, the Netherlands, and Portugal participated in semi-structured interviews. We conducted interviews in person or online and recorded, transcribed verbatim, and analyzed them using thematic analysis. A constructivist orientation informed the approach to data collection and interpretation. Coding was iterative and supported by regular team discussions and memo writing. Students described adaptability in two distinct but related ways. The first theme, *refining*, occurred in situations that were different but came with clear expectations, such as examinations, course structures, or explicit or inferred teacher requirements. In these situations, students described adaptability as adjusting established study strategies and seeking guidance from peers to meet goals they could define clearly. Their actions were cautious and deliberate, influenced by a desire to avoid failure and remain within a context that felt manageable. The second theme, *looking for gaps*, reflected experiences in situations that were unfamiliar or ambiguous, including early clinical encounters or unexpected challenges. In these situations, students realized their usual strategies were insufficient and described adaptability as stepping back, observing before acting, and asking targeted questions to understand how to proceed. Although these situations often prompted significant learning, students also reported discomfort, uncertainty, and vulnerability, which sometimes led to hesitation or avoidance. These findings highlight the importance of educational environments that acknowledge adaptability as part of learning and provide structured support to help students navigate less predictable situations. Such environments may encourage students to move beyond optimizing familiar strategies and toward the forms of adaptability that underpin the development of adaptive expertise.

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Introduction

Adaptability is a key element of being a healthcare professional. Previous research has investigated how adaptability manifests in clinical workplaces, but insight into what adaptability means to medical students is limited (Theys et al., 2025). A better understanding of this gap will help us more deliberately design medical education to help prepare students to develop adaptability. Adaptability is variously defined,

and in this study, we adopt Bartone et al. (2018, p. 537) definition: “the capacity to make appropriate responses to changed or changing situations; the ability to modify or adjust one’s behavior in meeting different circumstances or different people.” Holliman et al. (2018) showed in a survey study that, from their first days at university, students are immersed in dynamic learning environments where adaptability is essential. There is no reason to doubt that this also holds true for medical students. Beyond medical

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education, Martin et al. (2013) showed that students' adaptability predicts both academic and nonacademic outcomes, indicating that adaptability shapes how students navigate educational demands more broadly. Within health professions education, adaptability has been linked to how students and trainees respond to changing circumstances, including the hidden curriculum, online learning during the COVID-19 pandemic, intraprofessional collaboration in crisis situations, and preparation for future learning (Behmanesh et al., 2025; Biwer et al., 2021; Bus et al., 2022; Mylopoulos et al., 2016). Together, these studies show that adaptability plays a role in how learners manage uncertainty, change, and evolving expectations during medical education. This makes adaptability relevant not only as a response to immediate educational demands but also as part of students' longer-term development toward future professional practice.

Adaptability is seen as a capacity that underpins healthcare professionals' adaptive expertise (Pelgrim et al., 2022). Adaptive expertise describes professionals' capacity to perform efficiently in routine situations while also responding productively to novel, complex, or uncertain problems through flexible use of knowledge and, where needed, innovation (Bohle Carbonell et al., 2014; Bohle Carbonell & van Merriënboer, 2019; Hatano & Inagaki, 1984; Mylopoulos & Woods, 2017; Schwartz et al., 2005). While adaptive expertise refers to a specific form of professional expertise, adaptability refers more specifically to the capacity to modify one's behavior in response to changed or changing circumstances. Before students can develop the broader professional capacity to balance efficiency and innovation as captured by the concept of adaptive expertise, they must first learn to recognize change, respond to uncertainty, and adjust their actions in context. For medical students, these early experiences of adaptability may therefore be foundational for developing future adaptive expertise as healthcare professionals.

Educational theory has begun to address how learners might be supported in their development toward adaptive expertise. The Master Adaptive Learner model describes learners as engaging in a cyclical process of planning, learning, assessing, and adjusting, supported by self-regulation, reflection, and a learning environment that encourages both efficiency and innovation (Cutrer et al., 2017; Hopson et al., 2024; Pusic et al., 2018, 2022). This model has important consequences for medical education: if we want students to become professionals who can continue learning and adapting throughout practice, curricula should provide opportunities to recognize learning needs, respond to

uncertainty, test strategies, and receive support (Branzetti et al., 2022; Cutrer et al., 2018). However, such educational efforts require an understanding of the learner's starting point. Before we can design learning environments that foster adaptive expertise, we need to understand how students currently perceive adaptability in their educational context.

Mylopoulos and Regehr (2009) offer an important point of departure. Using adaptive expertise as a framework, they showed that medical students did not generally see innovation as part of their role as learners. This viewpoint suggests a possible mismatch between educational ambitions to foster adaptive expertise and students' own understanding of their task during training, a mismatch that could be addressed by focusing on students' adaptability experiences and development. It also raises the question of how adaptability appears from the students' own perspective before it is framed as professional innovation or adaptive expertise.

Previous research with medical students in clinical settings has emphasized the need to further explore how adaptability manifests before students enter clinical environments (Mylopoulos et al., 2025; Sellberg et al., 2022; Theys et al., 2025). The early phase of medical school is particularly relevant because students are positioned as learners, while already encountering changing expectations, unfamiliar learning tasks, early clinical experiences, and uncertainty about how to succeed. Studying adaptability in this phase can therefore help clarify how students begin to respond to change before they are fully immersed in clinical workplace learning. If we know what adaptability entails for early undergraduate medical students, we can better situate future educational efforts aimed at adaptive expertise, including efforts inspired by the Master Adaptive Learner framework. Therefore, our main research question was: How do preclinical medical students perceive adaptability in their academic practice?

Method

Design

This study employed a qualitative research design using semi-structured interviews to explore how preclinical medical students perceive adaptability. Our methods align with a constructivist paradigm, acknowledging the co-constructive nature of data collection and interpretation in analysis (Charmaz, 2006; Creswell, 2012).

Setting

We conducted this study at three universities, all offering a six-year undergraduate medical program. Participating universities were: Catholic University of Leuven (KUL), Maastricht University (UM), and Universidade Católica Portuguesa (UCP). Our goal was to recruit a diverse group of participants from different educational settings and backgrounds, allowing us to include examples from more than one curriculum without the intention to compare the sites. All sites followed a 3×3 Bachelor-Master structure, resulting in an MD degree. The 3-year Bachelor program represented a mainly preclinical phase in the medical education continuum. Both UCP and UM used a Problem-Based Learning (PBL) curriculum in which students mainly worked in small tutorial groups around real-life challenges, guided by tutors (Savery, 2015). At KUL, the Bachelor program consisted of traditional lectures accompanied by seminars and practicals. All three Bachelor programs had different forms of integrated curricula introducing students to clinical experiences before starting clinical rotations in the Master program. None of the Bachelor programs explicitly mentioned adaptability or adaptive expertise in the predefined outcomes of the program.

Participants, sampling, and recruitment

Participants were convenience-sampled in year 3 of the Bachelor program: MT pitched the research study in tutor groups in Maastricht as well as in auditoria in Leuven. In Portugal, SM set up a hybrid meeting to pitch the study to eligible students. Interested students provided their email address, and MT contacted them with additional information. At that time, willing students signed the informed consent, filled out a demographic questionnaire, and scheduled an interview. After the interview, we compensated participants with a 10-euro gift card. In total, we recruited 17 participants, none of whom reported previous enrollment at another medical school. We reached information power after 15 interviews but conducted the remaining two scheduled interviews to further enrich the data. Information power guided our decision to stop recruiting participants because the quality of the interview conversations and chosen analytic method allowed us to answer the research question with the data we had (Malterud et al., 2016; Varpio et al., 2017). Participants' demographic data is provided in Table 1.

Table 1. Participant data.

Gender (N)	
Male	11
Female	6
Prefer not to disclose	0
Site distribution (N)	
Maastricht	5
Leuven	8
Lisbon	4
Total	17

Data collection

Data collection ran from December 2024 until January 2025. The interview guide can be found in the [Supplemental Appendix](#). Questions were informed by research on adaptability, previous research on clinical medical students' adaptability, and adaptive expertise theory (Bartone et al., 2018; Bohle Carbonell et al., 2014; Bohle Carbonell & van Merriënboer, 2019; Hatano & Inagaki, 1984; Pelgrim et al., 2022; Theys et al., 2025). The aim was to prompt participants on adaptability and contextual factors surrounding their perceived adaptability. Similar to Betinol et al. (2023), we purposefully did not present participants with clear definitions, choosing instead to obliquely question them to leave ample room for interpretation and conversation. Throughout data collection, relevant topics based on previous interviews informed prompts in later interviews. We conducted a total of 17 interviews in Dutch or English, depending on participant preference, each lasting from 43 to 75 minutes. We conducted all interviews at UCP in person at the campus in Lisbon. We conducted interviews with participants from Leuven or Maastricht either on campus or online. Interviews were audio recorded and transcribed verbatim professionally by Amberscript Global B.V. (ISO 27001 & 9001 certified and GDPR compliant).

Data analysis

During data collection, a systematic and iterative thematic analysis helped us thoroughly examine and interpret participants' experiences (Ravitch & Carl, 2019). Following the analytical framework set out by Braun and Clarke (2006), we inductively coded all the transcripts, connected codes, and formed themes. MT and DV both coded three transcripts in a first round and subsequently met regularly to discuss the codebook, preliminary findings, and themes. MT and DV wrote multiple memos to keep track of the discussions and the coding process, and we used a logbook to track progress. SM did close reading for the UCP interviews, contributing to early code and theme

development, and joined several theme discussion meetings. Preliminary results were discussed with EB and PT and further refined by MT and DV. We used Atlas.ti version 25.0.1. to facilitate the technical process of coding (Atlas.ti Scientific Software Development GmbH, 2024). MT translated Dutch quotes to be included in the manuscript. Participant quotes in the text are indicated in italics and referenced by a unique code corresponding to the participant without revealing personal details (e.g., Y1F).

Reflexivity

The research team comprised four health professions education specialists, each bringing unique expertise. MT is a PhD candidate at the School of Health Professions Education in Maastricht, the Netherlands, with a foundation in educational sciences. EB is an assistant professor at Maastricht University, comes from a medical background, and has experience with international medical curricula. SM is an assistant professor at the Medical School of Universidade Católica Portuguesa and a member of the Department of Medical Education, with expertise in Developmental and Educational Psychology. DV is an associate professor at Maastricht University and has expertise in learning psychology and instructional design. PT is a professor specializing in work-based learning in health-care and also practices as a physician in obstetrics and gynecology. He is currently vice-dean of education at the Maastricht University campus but was not working in that role at the time of the interviews. All team members are experienced in qualitative research and collaborated closely to ensure adherence to research protocols. Four authors (MT, DV, EB, and PT) previously collaborated on a study regarding adaptive expertise and medical students. Results from that study led to the present research question. No data were re-used. To enhance rigor, the research team engaged in ongoing reflexive discussions throughout the study, critically examining how their diverse disciplinary backgrounds and prior work on adaptive expertise might shape data collection, analysis, and interpretation. The combination of educational sciences, medical practice, learning psychology, and work-based learning perspectives strengthened analytic depth through triangulation, while conscious attention to positionality helped ensure interpretations were grounded in participants' accounts rather than researchers' assumptions (McLaughlin, 2024).

Ethical approval and funding

We acquired ethical approval from Maastricht University file number FHML-REC/2024/022/Amendment/2024_15. Universidade Católica Portuguesa granted a unanimous favorable decision for this project with reference number 59. Catholic University Leuven did not require additional ethical approval but granted permission through a unanimous decision of the educational board of the faculty. None of the authors had a personal relationship with the participants. This project was supported by the Foundation “De Drie Lichten” in The Netherlands.

Results

We present two main themes that reflect how our participating preclinical medical students perceived and experienced adaptability. These themes represent two complementary yet distinct ways in which students experienced adaptability: (1) *Refining*, where participants adapted by fine-tuning existing strategies to meet clear external demands, and (2) *Looking for gaps*, where participants adapted in response to novel situations that felt unfamiliar or ambiguous. These themes represent both ends of a spectrum: at one end, the situation is within students' emotional comfort zone and triggers responses to refine what they know; at the other end, situations come with more negative emotions of uncertainty and self-doubt, triggering new actions. The distinction between these themes thus represents a difference in reaction to certain situations. We identify characteristics of situations that set adaptability in motion. For each theme, we describe characteristic responses, how these responses take shape as strategies or behavior, and how the need to adapt affects them. In this, we aim to show how adaptability can be seen along a spectrum of responses from refining knowledge and skills to looking for gaps in knowledge and skills.

Refining

First, our participants recognized adaptability as triggered by situations with external cues that they experienced as concrete and clearly defined. That is, triggers to adapt originated externally, but participants understood them well enough to adapt readily. Situations that participants described included changes in examinations, teacher expectations, and curriculum requirements. Even when goals were not fully spelled out, such as inferred expectations from teachers, they

still carried a recognizable form and direction. This external nature of the triggers, in combination with relatively clear outcomes, allowed students to adapt in a way that required adjustment rather than experimentation. In these situations, participants described having a clear idea of how to use their existing repertoire of knowledge and skills to reach their goals. One participant described this “knowing what to do differently” explicitly: “After the (first) lessons, I already know I’ll have to switch gears and learn in a different way.” (Z3L) The attainability and concreteness of these triggers gave participants confidence that they could influence outcomes through deliberate effort: “So then I realized: okay, if I do it this way, it usually works. And that worked again in the following semester.” (Z1T) Students engaged in a process of optimization: fine-tuning what they already knew and could do to perform well and meet expectations. Adaptability, according to participants, thus lay in the capacity to engage in that reflection and to be competent to resolve the new situation: “It makes you realize: ‘Okay, I’ve made an adjustment, and that is a good thing.’” (Z1T)

When explaining how they made these refinements, participants specifically focused on adjusting study methods and seeking peer advice. Participants frequently described adjusting study methods to align with specific assessments: “If it’s multiple choice, you study differently than when it’s open questions. With multiple choice, you focus more on the details.” (Z3L) For upcoming examinations, refining meant seeking advice from peers to understand what is expected. This participant spoke about asking more senior students specific questions about the course and the exam: “Asking senior students questions also helps me, such as how they liked the course and how they experienced it.” (Z4A)

Adaptability in this theme was constrained by participants’ desire to avoid risk and stay within familiar boundaries, reflected in their emphasis on the safety of what they already knew. One participant strongly asserted: “Since it works, why change it? Why would I be risking failing an exam just to try something new?” (Y2G), indicating the reactive nature of these adaptations. Being adaptable on this end of the spectrum meant being aware of what needed to change and knowing how to do so. Participants relayed that they were trying to avoid failure and accumulated study delay, resulting in conforming behavior rather than experimentation: “Actually, I don’t like situations where I’m not well prepared or have to adapt. And that doesn’t always feel like a safe environment.” (X2J) One participant explicitly mentioned avoiding risk:

“And then after that semester, I hadn’t taken any risks, really, so I was completely focused.” (Z1T) In sum, refining reflects a form of adaptability in which students deliberately adjust existing skills and approaches to succeed within predefined structures.

Looking for gaps

The second theme captures participants’ responses to situations that require adaptability and are characterized by a lack of clear structure or predictable outcomes. Participants mentioned the novelty of these situations (i.e., doing something for the first time), surprise (i.e., not knowing something was coming their way), and running into a metaphorical wall (i.e., not knowing what to do if all else failed). Situations in which this occurred often were novel in preclinical education, such as early clinical encounters. Participants described situations where they realized their usual repertoire of tools would not cover the job at hand. *Looking for gaps* reflects participants’ strategies for finding new ways of doing things in response to either failing known strategies or having no previous experience, covering both skills and knowledge. In contrast to refining, where external cues were well-understood and adaptability was within participants’ control, looking for gaps reflects the combination of reflection, realization that new approaches are required, and being able to then start looking for ways to deal with the situation without necessarily knowing the outcome.

Participants described this kind of adaptability as stepping into unfamiliar territory, trying new approaches without knowing exactly what will work or how it will be received. In looking for gaps, where uncertainty played a role, participants found it difficult to reflect on their actions as they were quite often in the middle of it, still figuring out what to do. They described actions like stepping back, observing, and asking questions: “I become very observant or that I pay much more attention to things, instead of doing things. Adapting, more in a way, so that I first observe and then act.” (X2J) Asking questions of peers helped participants find ways to tackle the situation at hand, as this participant described when approaching an upcoming exam about which they knew little: “I definitely asked quite a few different people before the exam: how did you approach that; how did you tackle it? I usually use that information to progress a little further.” (Z6K) Participants consciously used these strategies to find new answers to situations that went beyond the scope of their knowledge and skills. One student compared practicing with

a manikin and a real patient and the stress that comes with it: “So before an internship, you’re very focused on: next week it’s for real, then I’ll really be working with patients. If you make a mistake here on a dummy, or you’re not sterile, or you make a stupid mistake, that’s not a big deal. But then...” (Z3L)

Participants recognized that these uncertain, boundary-crossing experiences often led to the most profound learning. However, they also acknowledged that such situations were rare and often uncomfortable. For this reason, they did not take advantage of them or even avoided them. One student even said it literally: “Actually, I don’t like situations where I’m not well prepared or have to adapt. (...) And that doesn’t always feel like a safe environment.” (X2J) Their hesitation and avoidance was fueled by fear of judgment and lack of clarity about others’ expectations: “If you’re in a public situation, like you’re actually in a consultation and you realized, oh no, that went wrong. The patient noticed, the doctor noticed, the person who’s evaluated me noticed, my peer noticed. And it’s that weird embarrassment that you feel suddenly, which doesn’t usually happen when you’re alone studying and you realized, oh, I don’t know how to look for this. You feel vulnerable.” (Y3M)

Uncertainty was a common characteristic of situations demanding that participants look for gaps. Students described being unsure both of what is expected and how to succeed, which brought discomfort: “It’s not necessarily that I don’t want to come across as stupid, but for myself, I first want to know what we’re doing before I feel comfortable.” (X5B) Another participant described their feeling in an uncertain situation as follows: “It was like getting hit by a truck, I was like okay I need to change that. So it was for me it’s this weird realization and awareness of I don’t know, I need to change that.” (Y3M) They continued to describe the vulnerability associated with this feeling: “We’re all going to be vulnerable in a sense. But we need to try and get out of that and embrace it. It’s OK. Like, it happens. Everyone will ask questions or everyone will make mistakes. It’s medical school.” (Y3M)

Looking for gaps captures a more transformative form of adaptability, where learning occurs through experimentation. It reflects a form of adaptability where participants are pushed into unfamiliar territory and have to find new approaches without being sure of outcomes and expectations. The strategies they use to do so include taking a step back, observing-before-doing, and asking questions. Looking for gaps involves preparing oneself to be in a vulnerable position, possibly making mistakes, to learn and to adapt. This

theme therefore represents a more transformative form of adaptability, unfolding through uncertainty and acceptance of vulnerability.

Discussion

Building on our goal of understanding adaptability in medical students’ context, these results help articulate adaptability in preclinical medical education settings. Our findings reveal two complementary areas where preclinical medical students experience adaptability: refining within clearly understood expectations and looking for gaps in situations marked by uncertainty. While the first reflects a cautious, risk-averse approach aimed at optimizing familiar strategies to meet external demands, the second requires stepping into ambiguity and experimenting with new ways of acting and learning.

Our findings intersect with broader literature on transitions in medical education (Colbert-Getz et al., 2016; Dunham et al., 2017; Kilminster et al., 2011). Even though transitions were not explicitly part of the problem statement or focus of this study, these moments are characterized by uncertainty and ambiguity. Our results show clearly that in novel settings with unclear expectations, students rely on their adaptability to look for solutions. The multiple mentions of early clinical encounters in our results indicate that the transition toward clinical education triggers adaptability. Both themes carry examples from early clinical experience, showing that both *refining* and *looking for gaps* are relevant in a clinical environment. Previous research has shown the importance of these transition periods for development (Atherley et al., 2016, 2022). Future research could investigate how moments of institutional transition might serve as opportunities for intentionally fostering adaptability.

Our participants’ predominant orientation toward risk avoidance suggests a curriculum and learning culture that rewards predictable performance (Thompson et al., 2016). These patterns invite reflection on if and how adaptability is conceptualized and fostered in medical education curricula. Earlier work by Kapur (2015), Mylopoulos et al. (2018), Mylopoulos et al. (2025), and Steenhof et al. (2019) has shown the importance of productive failure to enhance self-regulatory skills and problem solving. Our finding of *looking for gaps* echoes this call but also highlights another important point in this space: participants reported hesitation to engage with uncertain/ill-structured/vague situations. Research on self-regulated learning can provide insight into how to support goal setting and gap identification to further invite students to engage with uncertain situations

(Biwer et al., 2021; Sandars & Cleary, 2011). Important questions raised by this insight include: why are students not taking advantage of these learning moments, and how can we support them in doing so? Efforts to answer these questions could be provided through design-based educational research or using methods like appreciative inquiry to gain insight into what already works well to refine current good practices (Sandars & Murdoch-Eaton, 2017). Based on our results, specific, reinforcing feedback in uncertain situations could help normalize uncertainty and realize an opportunity for adaptability. In classroom settings, cases could be designed with uncertainty in mind, scaffolding to support students to navigate this ambiguity, but without taking away the need for adaptability.

Our findings both align with and complicate Mylopoulos and Regehr (2009) claim that preclinical students do not see innovation as part of their task. While our participants indeed indicated that they felt less inclined to engage in situations without clear expectations, they did demonstrate forms of adaptability in taking action to handle uncertain conditions, suggesting that adaptability may precede but not yet entirely translate into the innovative component of adaptive expertise. This means that there might be more to the story of developing adaptive expertise; however, adaptability does play a role in students' exposure to change and their way of dealing with new things.

Remarkably, participants did not mention support from educators in their adaptability efforts. However, seeking peer support was an important part of gaining control over uncertain situations and part of their adaptability efforts. These findings should give a boost to efforts finding possibilities for educators to help support these processes. After all, the educators' main goal is to prepare students for later professional practice. An educational actor, such as a mentor, could provide the reassurance and guidance students need to look for gaps, making that step toward more transformative acts of adaptability (Sambunjak et al., 2010; Stenfors-Hayes et al., 2011). Perhaps peers could also support this, given their reported role in our participants' adaptability efforts. Literature on peer-assisted learning shows that through careful planning, peer-assisted learning helps to build motivation and a safe learning environment, potentially lowering the stakes for adaptability that is transformative in nature (Bulte et al., 2007; Ross & Cameron, 2007; Ten Cate & Durning, 2007). Future research could use insights from this study and align them with educators' efforts to support students' development through their teaching and initiatives such as peer-assisted learning.

Limitations

Although we drew our participants from three universities with varying curricula, this study was not designed for comparative analysis. Contextual influences, such as the degree of integration of clinical exposure on adaptability, may remain underexplored. In addition, although interviews allowed for in-depth exploration, they could not capture students' adaptability in real time or in action. Observational or longitudinal research could complement our findings by tracing how adaptability develops across time and context and by making visible the tacit aspects of learning and adaptation.

Conclusion

This study shows that preclinical medical students experience adaptability in two distinct yet interconnected ways: by refining what they already know and do to meet well-defined expectations and by seeking new ways of acting in uncertain situations. The former, characterized by cautious optimization within established structures, dominated students' narratives and reflected a broader tendency toward risk avoidance and conformity. In contrast, moments of genuine experimentation, emerging mainly in unfamiliar or ambiguous learning situations such as early clinical experiences, required *looking for gaps*. Students found this form of adaptability uncomfortable and often did not take advantage of situations that demanded it. Together, these findings encourage reflection on the environment medical education curricula provide for students and the experiences of adaptability they foster.

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Compliance with ethical standards

We acquired ethical approval from Maastricht University file number FHML-REC/2024/022/Amendment/2024_15. Universidade Católica Portuguesa granted a unanimous favorable decision for this project with reference number 59. Catholic University Leuven did not require additional ethical approval but granted permission through a unanimous decision of the educational board of the faculty.

Consent to participate

Participation was voluntary. Participants signed an informed consent form, agreeing to participate after being informed about the study design and goals and granting permission to use the data acquired from the interview.

Author contributions

CRedit: **M. Theys**: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Writing – original draft, Writing – review & editing; **E. E. Brouwer**: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Supervision, Writing – original draft, Writing – review & editing; **S. Menères**: Conceptualization, Formal analysis, Investigation, Methodology, Resources, Writing – original draft, Writing – review & editing; **P. W. Teunissen**: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Supervision, Writing – original draft, Writing – review & editing; **D. M. L. Verstegen**: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Supervision, Writing – original draft, Writing – review & editing.

Disclosure statement

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References

- Atherley, A., Hu, W. C.-Y., Dolmans, D., Teunissen, P. W., & Hegazi, I. (2022). Medical students' socialization tactics when entering a new clinical clerkship: A mixed methods study of proactivity. *Academic Medicine: Journal of the Association of American Medical Colleges*, 97(6), 884–893. <https://doi.org/10.1097/acm.0000000000004627>
- Atherley, A. E., Hambleton, I. R., Unwin, N., George, C., Lashley, P. M., & Taylor, C. G. (2016). Exploring the transition of undergraduate medical students into a clinical clerkship using organizational socialization theory. *Perspectives on Medical Education*, 5(2), 78–87. <https://doi.org/10.1007/s40037-015-0241-5>
- Atlas.ti Scientific Software Development GmbH. (2024). *Atlas.ti* In (Version 24.1.1.30813) [Qualitative data analysis software]. <https://atlasti.com>
- Bartone, P. T., Krueger, G. P., & Bartone, J. V. (2018). Individual differences in adaptability to isolated, confined, and extreme environments. *Aerospace Medicine and Human Performance*, 89(6), 536–546. <https://doi.org/10.3357/AMHP.4951.2018>
- Behmanesh, D., Jalilian, S., Heydarabadi, A. B., Ahmadi, M., & Khajeali, N. (2025). The impact of hidden curriculum factors on professional adaptability. *BMC Medical Education*, 25(1), 186. <https://doi.org/10.1186/s12909-024-06618-1>
- Betinol, E., Murphy, S., & Regehr, G. (2023). Exploring the development of adaptive expertise through the lens of threshold concepts. *Medical Education*, 57(2), 142–150. <https://doi.org/10.1111/medu.14887>
- Biwer, F., Wiradhany, W., Oude Egbrink, M., Hospers, H., Wasenitz, S., Jansen, W., & de Bruin, A. (2021). Changes and adaptations: How university students self-regulate their online learning during the COVID-19 pandemic. *Frontiers in Psychology*, 12, 642593. <https://doi.org/10.3389/fpsyg.2021.642593>
- Bohle Carbonell, K., Stalmeijer, R. E., Könings, K. D., Segers, M., & van Merriënboer, J. J. G. (2014). How experts deal with novel situations: A review of adaptive expertise. *Educational Research Review*, 12, 14–29. <https://doi.org/10.1016/j.edurev.2014.03.001>
- Bohle Carbonell, K., & van Merriënboer, J. J. (2019). Adaptive expertise. In J. M. S. Paul Ward, J. Gore, & E. Roth (Eds.), *The Oxford handbook of expertise* (p. 262). Oxford University Press.
- Branzetti, J., Commissaris, C., Croteau, C., Ehmann, M. R., Gisondi, M. A., Hopson, L. R., Lai, K. Y., & Regan, L. (2022). The best laid plans? A qualitative investigation of how resident physicians plan their learning. *Academic Medicine: Journal of the Association of American Medical Colleges*, 97(11), 1691–1698. <https://doi.org/10.1097/acm.0000000000004751>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp0630a>
- Bulte, C., Betts, A., Garner, K., & Durning, S. (2007). Student teaching: Views of student near-peer teachers and learners. *Medical Teacher*, 29(6), 583–590. <https://doi.org/10.1080/01421590701583824>
- Bus, C. L., van der Gulden, R., Bolk, M., de Graaf, J., van den Hurk, M., Scherpbier-de Haan, N. N. D., Fluit, C. R. M. G., Kuijer-Siebelink, W., & Looman, N. (2022). Adaptability and learning Intraprofessional collaboration of residents during the COVID-19 pandemic. *BMC Medical Education*, 22(1), 782. <https://doi.org/10.1186/s12909-022-03868-9>
- Charmaz, K. (2006). *Constructing grounded theory: A practical guide through qualitative analysis*. Sage.
- Colbert-Getz, J. M., Baumann, S., Shaffer, K., Lamb, S., Lindsley, J. E., Rainey, R., Randall, K., Roussel, D., Stevenson, A., Cianciolo, A. T., Maines, T., O'Brien, B., & Westerman, M. (2016). What's in a transition? An integrative perspective on transitions in medical education. *Teaching and Learning in Medicine*, 28(4), 347–352. <https://doi.org/10.1080/10401334.2016.1217226>
- Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Pearson Education, Inc.
- 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. S., 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.0000000000001323>
- Dunham, L., Dekhtyar, M., Gruener, G., CichoskiKelly, E., Deitz, J., Elliott, D., Stuber, M. L., & Skochelak, S. E. (2017). Medical student perceptions of the learning environment in medical school change as students transition to clinical training in undergraduate medical school. *Teaching and Learning in Medicine*, 29(4), 383–391. <https://doi.org/10.1080/10401334.2017.1297712>
- Hatano, G., & Inagaki, K. (1984). Two courses of expertise. 乳幼児発達臨床センター年報, 6, 27–36.
- Holliman, A. J., Martin, A. J., & Collie, R. J. (2018). Adaptability, engagement, and degree completion: A longitudinal investigation of university students*. *Educational Psychology*, 38(6), 785–799. <https://doi.org/10.1080/01443410.2018.1426835>
- Hopson, L. R., Branzetti, J., Gisondi, M. A., & Regan, L. (2024). What the experts see: A qualitative analysis of the behaviors of master adaptive learners in emergency medicine. *AEM Education and Training*, 8(1), e10943. <https://doi.org/10.1002/aet2.10943>
- Kapur, M. (2015). Learning from productive failure. *Learning: Research and Practice*, 1(1), 51–65. <https://doi.org/10.1080/23735082.2015.1002195>
- Kilminster, S., Zukas, M., Quinton, N., & Roberts, T. (2011). Preparedness is not enough: Understanding transitions as critically intensive learning periods. *Medical Education*, 45(10), 1006–1015. <https://doi.org/10.1111/j.1365-2923.2011.04048.x>
- Malterud, K., Siersma, V. D., & Guassora, A. D. (2016). Sample size in qualitative interview studies: Guided by information power. *Qualitative Health Research*, 26(13), 1753–1760. <https://doi.org/10.1177/1049732315617444>
- Martin, A. J., Nejad, H. G., Colmar, S., & Liem, G. A. D. (2013). Adaptability: How students' responses to uncertainty and novelty predict their academic and non-academic outcomes. *Journal of Educational Psychology*, 105(3), 728–746. <https://doi.org/10.1037/a0032794>
- Mclaughlin, S. (2024). When I say ... positionality. *Medical Education*, 58(10), 1149–1150. <https://doi.org/10.1111/medu.15427>
- Mylopoulos, M., Brydges, R., Woods, N. N., Manzone, J., & Schwartz, D. L. (2016). Preparation for future learning: A missing competency in health professions education? *Medical Education*, 50(1), 115–123. <https://doi.org/10.1111/medu.12893>
- Mylopoulos, M., & Regehr, G. (2009). How student models of expertise and innovation impact the development of adaptive expertise in medicine. *Medical Education*, 43(2), 127–132. <https://doi.org/10.1111/j.1365-2923.2008.03254.x>
- Mylopoulos, M., Steenhof, N., Kaushal, A., & Woods, N. N. (2018). Twelve tips for designing curricula that support the development of adaptive expertise. *Medical Teacher*, 40(8), 850–854. <https://doi.org/10.1080/0142159X.2018.1484082>
- Mylopoulos, M., Steenhof, N., Mickleborough, T., Atkinson, A., & Martimianakis, M. A. (2025). From struggle to strength: Embracing productive failure in clinical learning. *Medical Teacher*, 47(12), 1903–1910. <https://doi.org/10.1080/0142159X.2025.2550477>
- Mylopoulos, M., & Woods, N. N. (2017). When I say... adaptive expertise. *Medical Education*, 51(7), 685–686. <https://doi.org/10.1111/medu.13247>
- Pelgrim, E., Hissink, E., Bus, L., van der Schaaf, M., Nieuwenhuis, L., van Tartwijk, J., & Kuijer-Siebelink, W. (2022). Professionals' adaptive expertise and adaptive performance in educational and workplace settings: An overview of reviews. *Advances in Health Sciences Education: Theory and Practice*, 27(5), 1245–1263. <https://doi.org/10.1007/s10459-022-10190-y>
- Pusic, M. V., Hall, E., Billings, H., Branzetti, J., Hopson, L. R., Regan, L., Gisondi, M. A., & Cutrer, W. B. (2022). Educating for adaptive expertise: Case examples along the medical education continuum. *Advances in Health Sciences Education: Theory and Practice*, 27(5), 1383–1400. <https://doi.org/10.1007/s10459-022-10165-z>
- Pusic, M. V., Santen, S. A., Dekhtyar, M., Poncet, A. N., Roberts, N. K., Wilson-Delfosse, A. L., & Cutrer, W. B. (2018). Learning to balance efficiency and innovation for optimal adaptive expertise. *Medical Teacher*, 40(8), 820–827. <https://doi.org/10.1080/0142159X.2018.1485887>
- Ravitch, S. M., & Carl, N. M. (2019). *Qualitative research: Bridging the conceptual, theoretical, and methodological*. Sage Publications.
- Ross, M. T., & Cameron, H. S. (2007). Peer assisted learning: A planning and implementation framework: AMEE Guide no. 30. *Medical Teacher*, 29(6), 527–545. <https://doi.org/10.1080/01421590701665886>
- Sambunjak, D., Straus, S. E., & Marusic, A. (2010). A systematic review of qualitative research on the meaning and characteristics of mentoring in academic medicine. *Journal of General Internal Medicine*, 25(1), 72–78. <https://doi.org/10.1007/s11606-009-1165-8>
- Sanders, J., & Cleary, T. J. (2011). Self-regulation theory: Applications to medical education: AMEE Guide No. 58. *Medical Teacher*, 33(11), 875–886. <https://doi.org/10.3109/0142159X.2011.595434>
- Sanders, J., & Murdoch-Eaton, D. (2017). Appreciative inquiry in medical education. *Medical Teacher*, 39(2), 123–127. <https://doi.org/10.1080/0142159X.2017.1245852>
- Savery, J. R. (2015). Overview of problem-based learning: Definitions and distinctions. In A. Walker, H. Leary, C. Hmelo-Silver & P. Ertmer (Eds.), *Essential readings in problem-based learning: Exploring and extending the legacy of Howard S. Barrows* (Vol. 9, pp. 5–15). Purdue University Press.
- Schwartz, D. L., Bransford, J. D., & Sears, D. (2005). Efficiency and innovation in transfer. In J.P. Mestre (Ed.), *Transfer of learning from a modern multidisciplinary perspective* (Vol. 3, pp. 1–51). Information Age Publishing.
- Sellberg, M., Palmgren, P. J., & Möller, R. (2022). Balancing acting and adapting: A qualitative study of medical students' experiences of early clinical placement. *BMC Medical Education*, 22(1), 659. <https://doi.org/10.1186/s12909-022-03714-y>
- Steenhof, N., Woods, N. N., Van Gerven, P. W. M., & Mylopoulos, M. (2019). Productive failure as an instructional approach to promote future learning. *Advances in Health Sciences Education: Theory and*

- Practice*, 24(4), 739–749. <https://doi.org/10.1007/s10459-019-09895-4>
- Stenfors-Hayes, T., Hult, H., & Dahlgren, L. O. (2011). What does it mean to be a mentor in medical education? *Medical Teacher*, 33(8), e423–e428. <https://doi.org/10.3109/0142159X.2011.586746>
- Ten Cate, O., & Durning, S. (2007). Peer teaching in medical education: Twelve reasons to move from theory to practice. *Medical Teacher*, 29(6), 591–599. <https://doi.org/10.1080/01421590701606799>
- Theys, M., Verstegen, D. M. L., Teunissen, P. W., & Brouwer, E. E. (2025). A chameleon and a sponge: A qualitative study on adaptability in undergraduate clinical medical students. *Perspectives on Medical Education*, 15(1), 432–441.
- Thompson, G., McBride, R. B., Hosford, C. C., & Halaas, G. (2016). Resilience among medical students: The role of coping style and social support. *Teaching and Learning in Medicine*, 28(2), 174–182. <https://doi.org/10.1080/10401334.2016.1146611>
- Varpio, L., Ajjawi, R., Monrouxe, L. V., O'Brien, B. C., & Rees, C. E. (2017). Shedding the cobra effect: Problematising thematic emergence, triangulation, saturation and member checking. *Medical Education*, 51(1), 40–50. <https://doi.org/10.1111/medu.13124>