

ORIGINAL CONTRIBUTION

What the experts see: A qualitative analysis of the behaviors of master adaptive learners in emergency medicine

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Abstract

Objectives: The Master Adaptive Learner (MAL) model postulates that learners develop adaptive expertise through cycles of self-regulated learning. Despite a robust theoretical basis, the actual observable behaviors of MALs are not well characterized. We sought to define behaviors that characterize MALs within emergency medicine (EM) training.

Methods: Using a constructivist grounded theory approach, we analyzed semistructured interviews with expert EM educators. These experts reflected on observable behaviors as well as factors in the clinical learning environment that may modulate these behaviors. We recruited using purposive sampling until thematic saturation.

Results: We identified four overall themes, of which three described groups of learner behaviors and a fourth described modifiers of these behaviors. Learner behaviors include: (1) critical interrogation of practice, (2) intellectual risk-taking, and (3) intentional curation of a learning network. Critical interrogation of practice encompasses several observable behaviors including learner-driven feedback conversations, independent synthesis of clinical information, appropriate deviation from algorithms based on their conceptual understanding of core principles, intentional use of case variation and hypothetical questioning, and continuous refinement of decisions. MALs also engage in intellectual risk-taking for their development by communicating clinical decision-making processes even at the risk of being wrong, openly addressing errors and gaps, and intentionally seeking out uncomfortable experiences. Intentional curation of a learning network is the deliberate development of a consortium of trusted individuals who serve as mentors and sounding boards. We also identified a fourth theme related to the expression of learner behaviors: learning environment modulates behaviors. Active promotion of psychological safety is necessary for learners to express these

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behaviors. This safety is mediated through trusting relationships and expert supervisors who serve as colearners and role models.

Conclusions: We present several behaviors that allow identification of MALs among EM trainees. These data expand our understanding of MALs and the critical influence of the learning environment. Identification of these behaviors may allow for more precise categorization of targeted curricular interventions and meaningful learning outcomes.

INTRODUCTION

Adaptive expertise in clinical practice is the ability to effectively transfer existing knowledge and skills to manage uncommon or never-before-seen patient conditions.¹ This contrasts to routine expertise, in which practitioners can consistently and efficiently perform complex yet common tasks.¹ Emergency physicians require adaptive expertise as they regularly face undifferentiated and atypical presentations of disease. Therefore, the skills required for adaptive expertise are among the most important learning outcomes of emergency medicine (EM) residency training.²

The Master Adaptive Learner (MAL) Conceptual Model for Skill Acquisition theorizes that MALs develop adaptive expertise through a self-regulated learning cycle.^{3,4} This four-phase model involves iterative and repeated cycles of planning–learning–assessing–adjusting.³ Subsequent refinements of the model have proposed specific learner traits (curiosity, motivation, resilience, and growth mindset) and relevant external factors (coaching and the learning environment) that may affect the development of MALs.⁴ Though based on a sound body of literature, none of these revisions included actual studies of MALs nor do they define specific observable behaviors that differentiate MALs.

Regan et al.⁵ investigated the initial *planning* phase of learning within a population of learners whom their residency program directors identified as MALs and elucidated a number of skills and strategies. In a related study, trainees not identified as MALs by their program directors demonstrated some behavioral overlap with MALs but with substantially different approaches to learning and with less success.⁶ These studies suggest that the accurate identification of MALs and their associated learning behaviors would provide an opportunity to design, assess, and implement effective learning interventions to develop adaptive expertise. However, while these studies provide some initial evidence in support of the MAL model, they often described inherent MAL traits and learned skills without corresponding *observable behaviors* and *actions*. Therefore, we do not know how to reliably decide which trainees are MALs through direct observation in the clinical learning environment. This lack of a behavioral definition of a MAL remains a major obstacle to accurately identifying MALs, conducting rigorous studies with them, or creating impactful curricular interventions. The purpose of this study was to identify and define essential, observable behaviors of MALs among resident trainees within EM.

METHODS

Study design and ethics

We used a constructivist approach to grounded theory to explore the MAL model.⁷ We conducted a thematic analysis of semistructured interviews to identify key observable behaviors felt to represent MALs in the clinical learning environment in EM.

External funding supported the conduct of the research; however, the funder had no input as to the study design, findings, or conclusions. The institutional review boards of the authors' institutions declared this study exempt. We obtained verbal consent for participation and recording from the participants. We offered a \$50 gift card as an incentive to participate.

Study setting and population

We used purposive sampling to recruit our study participants with an emphasis on the typical case.⁸ We identified a cohort of 94 potential participants in one of two ways. First, we obtained a roster of expert educators in EM provided by the principal investigator of another study using expert educator input (currently in progress) and funded through the American Medical Association's Reimagining Residency project. We augmented this roster by adding individuals known to the authors to have advanced training in education, research experience, or extensive practical experience in medical education within EM. From a single email solicitation in October 2022, we had 17 volunteers, all of whom we interviewed. Participants also completed a web-based demographic survey distributed via Qualtrics to understand the backgrounds of our group including educator and training environment characteristics. We anticipated our sampling approach would require a maximum of 25 interviews while remaining flexible on the exact number once we achieved thematic saturation.^{9,10}

Participant demographics

All participants (17/17) had a medical degree (MD or DO) with 12/17 having additional graduate degrees largely focusing on education. Almost all (16/17) worked at a university-based institution. Slightly more than half of our participants (9/17) came from institutions

supporting 48-month format EM residency programs. Women comprised 9/17 participants. Most (13/17) identified as White, one as Hispanic or Latino, two as Asian, and one as Black. They were geographically distributed throughout the United States and at different medical centers. They all had experience working with the spectrum of learners in EM from prehospital providers to students to residents/fellows and faculty. They also had extensive engagement across the spectrum of formal education leadership roles within EM. Participants had varying degrees of familiarity with the MAL model prior to this study. The vast majority were familiar with the model with a few being content experts. For a very few participants, this was novel information.

Study protocol

We iteratively developed an interview script within the author group informed by our literature review. A researcher experienced with qualitative methods but external to the project reviewed the script for clarity, content, and bias. Finally, we pilot-tested the script with volunteer educators who were not on the recruitment roster. We made minor revisions based on their feedback; these responses were not included in our data. Throughout the study, we reviewed and reflected on our initial transcripts and adjusted wording and ordering of questions when needed. The final interview guide is available in Appendix S1.

All interviews took place over a 3-month period in the fall of 2022. A single author (LRH) conducted the interviews over Zoom (Version 5.8) at a mutually agreed upon time with attention to best practices.¹¹ We audio-recorded the interviews, and a commercial vendor transcribed the recordings. After transcription, LRH reviewed transcripts for accuracy and removed any names and overt identifiers prior to coding to minimize bias. We destroyed the source files. LRH maintained field notes throughout the interview to reflect on the conduct and content of the interviews and to inform the analysis. The final number of participants was determined by thematic saturation.^{12,13}

Data analysis

Our coding process was informed by the literature with an emphasis on the development of a systematic process to increase reliability.¹⁴ We used a process described by Campbell et al.¹⁵ to inform our approach, although, in keeping with the constructivist paradigm, we intentionally chose not to define intercoder agreement to appreciate the contribution of individual perspectives. Instead, we reconciled differences through discussion and negotiated agreement.¹⁶ We used descriptive coding and proceeded using constant comparative analysis.¹⁷ All coding team members jointly reviewed two transcripts to create the initial codebook in Dedoose. To further create our shared mental model, each team member independently coded two additional transcriptions. The group then engaged in a process of negotiated consensus to determine the final code assignments. We distributed the remaining 13 transcripts among the authors for independent coding, with

all potential new codes and questions reviewed collaboratively by the author team. Over the course of coding, we met regularly to review new code definitions and to develop emerging themes using the MAL model as the conceptual framework.^{3,4} We maintained documentation of these reflections and discussions during coding. Interviews and coding continued until saturation.^{12,13} After our group review of the transcripts, we were confident that we were not identifying additional major codes, key themes, or concepts in the last several transcripts coded. Credibility activities such as triangulation, search for outliers, member checking, and reflexivity occurred throughout the research.¹⁸ We utilized SRQR criteria (Appendix S2) to build this manuscript.¹⁹

Member checking

We engaged our participants after our initial analysis with synthesized information through a web-based survey deployed through Qualtrics.²⁰ We inquired about their agreement with our identified themes including specific behaviors, and we invited them to provide qualitative feedback and additional examples of behaviors they felt complemented the themes. These responses (12/17 participated) informed the final version of the manuscript.

Research team and reflexivity

Our research team consisted of the four authors, all of whom have served as EM residency program directors with a cumulative 30 years of experience in that role. At the time of the study, three of the authors (LRH, MG, LR) were departmental associate/vice chairs for education and supervised multiple EM-related training programs. One was an active residency program director (LR), and one had transitioned to a noninstructional community practice (JB). All researchers were allopathic physicians. Three completed graduate degrees in education with a focus on the health professions (LRH, LR, JB). All involved have multiple publications as well as advanced training and experience in qualitative methods. Three authors had previously or currently held national leadership positions for organizations whose focus is on EM education (LRH, MG, LR).

We reflected on our own experiences to acknowledge and understand their potential effects on this project, including the results of our previous studies of MALs.^{5,6,18,21,22} We acknowledged some homogeneity of perspectives on EM trainees as we all have substantial experience with 4-year EM training programs at academic medical centers. LRH collected reflections and notes from all investigators throughout the process.

RESULTS

We identified 60 total codes from 658 min of transcripts (median length 38 min, range 27–52 min). From these, we identified four

major themes. The first three summarize discreet MAL behaviors, while the final theme related to the ability of MALs to express these behaviors:

1. Critical interrogation of practice.
2. Intellectual risk-taking.
3. Intentional curation of a learning network.
4. The learning environment modulates behaviors.

Theme 1: Critical interrogation of practice

Theme 1 encompasses several interlinked learner-initiated behaviors all oriented toward developing a greater understanding of their clinical practice and expanding their capabilities. Our participants observed MALs routinely engaging in learner-driven feedback conversations with their supervisors with the deliberate intent of promoting their own development. This concept appeared in nearly every transcript. Additional supporting quotes appear in [Table 1](#).

[I] was just working with an intern the other day who wanted to do his second paracentesis of his career and without me prompting, without me telling him anything, he had already found a pretty good instructional website and he was like, "Yeah, I remember how to do this. I don't really have any questions, but I want to watch somebody go through it again and watch what they do with their hands and how they set up the procedure."—F

Participants frequently appeared to identified MAL behaviors based on their comparison to trainees who they would not identify as MALs. For example, they juxtaposed this desirable feedback behavior with numerous accounts of non-MALs who have a much more passive engagement with the feedback process.

Some of our residents, they're very fixated ... on not being wrong ... even when they do get corrected ... They'll repeat what the learning point was ... And then they move on.—Q

Another identifying behavior for MALs is the independent synthesis of clinical information for diagnostic, therapeutic, and teaching purposes. This is not mere rote memorization or internalization of data but an active manipulation, transformation, and integration of the information into their existing knowledge base.

... he'll sometimes say, "This was the gap. This is what I want to do to fix it. I think this could be beneficial to other people too. So I'm going to try and write up a slide deck, or I'm going to circulate this one-pager, because I think this is helpful." So he's able, not only, to create something that's reasonable for himself. But

TABLE 1 Additional quotes further illustrating behaviors of MALs supporting the theme of critical interrogation of practice.

MALs engage in the following behaviors:

Learner-driven feedback conversations:

They've been very proactive in not just seeking feedback but seeking feedback and seeking feedback on very specific skills that they perceived that they were having trouble with. So, whether it was procedural skill or communication and difficult scenarios of breaking bad news or end of life care or if there was some specific thing that for whatever reason they felt like that they needed some extra coaching on, they were very proactive and very specific in requesting that information from me and from other attendings as well.—R

... they're more aggressive or assertive about getting that feedback when they need it, where they want it.—D

Independent synthesis of clinical information for diagnostic, therapeutic, and teaching purposes:

... the big one to me that I think about in years of education are the residents who, over the course of their training, evolve from this person who is just receiving information and teaching from you and regurgitating it back to you, to those who then start to kind of challenge you on your teaching a little bit.—I

... he'll sometimes say, "This was the gap. This is what I want to do to fix it. I think this could be beneficial to other people too. So I'm going to try and write up a slide deck, or I'm going to circulate this one-pager, because I think this is helpful." So he's able, not only, to create something that's reasonable for himself. But it's also shareable. And he starts thinking, How can I actually harness this and disseminate it so that other people might benefit from it, too?—Q

Appropriate identification of the limits of diagnostic and treatment algorithms and decide when and how to move outside an established pattern to provide optimal patient care:

These are the ones where that 2% is like, 'Oh, this isn't working so maybe this is the aortic dissection rather than just the whatever cardiac chest pain that we see a hundred of.'... what it is that they're doing, is more slowing down on the appropriate people, and then reevaluating all the different pieces of information, thinking about whether there's a different piece of information they need to get.—E

... the willingness to try something else when your current method is not giving you the desired effect and not holding on to "tried and true" things ... —M

TABLE 1 (Continued)*Intentional use of case variation and hypothetical questioning:*

So she was taking the opportunity for a straightforward patient that she could manage with her eyes closed at this point to make it more complex than it was to prepare herself for the next step ... she was trying to self-identify the gaps in her knowledge potentially, but also to then be able to, in her mind, formulate how she would apply that knowledge for a future patient that may never exist.—C

The questions that are iterations on the patient as opposed to just what should I do for this person directly in front of me. Or the questions that project out this patient's future course hypothetically if this gets worse, if this gets better, if this changes.—N

Retrospective case review to inform future practice:

[T]hey always have a case they want to talk about. The people who are like, "Let me talk to you about these cases, let me debrief these cases. What should I read about these cases?" I think end up fitting these phenotypes—N

Residents that will come back after a case and tell me, "Oh, you know that case we had? I followed up on it and then I read about this pathology and here were some things that we didn't know in the time that I'm now sort of sharing with you."—H

Abbreviation: MALs, master adaptive learners.

it's also shareable. And he starts thinking, "How can I actually harness this and disseminate it so that other people might benefit from it, too?"—Q

Participants also observed MALs appropriately deviating from clinical algorithms based on their conceptual understanding of core principles.

I see it a lot when people are bringing skills and management from their ICU rotations back to the ED and saying, "Well this is similar to the ARDS patient that I took care of in the unit. We've gotten past the initial resuscitation. How can I then apply some of these principles to this specific pathology?"—H.

The importance of this behavior is further emphasized by frequent observations by our participants that trainees whom they do not consider to manifest the MAL phenotype do not demonstrate this behavior.

One thing that really sticks with me is this sense of rigidity or overly algorithmic thinking that they [non-MAL] can't break out of and can't necessarily escape

from You will work with the resident that's like, "Oh, I saw this person with chest pain and I'm going to order a stress test." And you dig in: "Well, why?" "Oh, well, the last patient that we had that was like this, we did a stress test." And there's none of this reflective, "How is that different for this patient? How is that different in this situation? What are some of the other possibilities here?" That really starts to concern me about not just their practice now but their practice down the road.—F

[Non-MALs are] people who have absorbed illness scripts very quickly, and so ... they [have a] practice pattern that they've identified, from usually a role model, as good and they absorb that very quickly, but they don't always evolve from that.—N

MALs explore case variations and use hypothetical questioning to expand their understanding and application of underlying concepts by asking, "What if this or if this situation was different, what if that?" (M). They consistently critically examine their cases retrospectively to inform their future performance. This can occur independently as well as with supervisors and mentors within their network of trust sources.

[H]e'll, straight up, come up to me and say, "Remember that shift we had a week ago, and we had this patient? I followed up and this is what happened. I think we could have done this different."—Q

Theme 2: Intellectual risk-taking

MALs also engage in intellectual risk-taking to further their development (Table 2). This starts with openly communicating their clinical decision-making processes, even at the risk of publicly being wrong.

... they tend to be maybe a little bit more independent in their decision making. So they will come up and they will have a plan in place, and it'll be a statement and not a question.—I

These behaviors serve as a vivid counterpoint to those described for non-MALs who are seen as "looking to you to just provide them the answer" (I) with a tendency to defer to supervisors for information and solutions. By contrast, our educators observe MALs openly engaging with their errors and gaps as another mechanism to further their development as clinicians.

[MALs acknowledge that] "I don't have this knowledge, and it doesn't damage my identity as a physician or my internal milieu to admit to one of my supervisors that I have gaps in my knowledge."—P

In a similar vein, MALs actively and critically compare their own performance to external standards in a visible process of performance-driven gap identification.⁵ This is expanded by sharing their conclusions outwardly.

He will use rubrics and metrics and stuff. So he will find guidelines. He will look at society guidelines and what is recommended. And then he compares himself to this rubric. And then, in doing so, I think that's where he finds, "I need to read up more on this."—Q

Finally, we identify MALs intentionally seeking out uncomfortable experiences to further their own learning and development.

[The MAL says] "There's something on the track board that I'm not as comfortable with, I'm going to pick it up."—P

This behavior contrasts with educators accounts of non-MALs engaging in "cherry picking" (D, E), which has connotations of selecting an easy or straightforward patient while avoiding those perceived as complex or difficult. Our educators also describe them as, "the folks who sit back and just wait as opposed to jumping up and raising their hand or diving into things" (G).

Theme 3: Intentional curation of a learning network

Theme 3 refers to the trainee's deliberate cultivation of a consortium of trusted individuals who serve as mentors and sounding boards for their development. MALs are frequently felt to be adept at organizing their learning, often with facilitation of an expert community to screen, assess, and ultimately curate a group of learning resources that they find to be effective for themselves. "Because at the end of the day, there is so much information that there's no possible way that you can ever have all the answers. You need the village to make it happen" (J). These decisions are filtered through credibility and trust and ultimately result in building a resource network of human assets upon which they can draw.

... [T]hey ask questions of people they identify as experts. I think they try to use as many modalities as they can to try to fill those gaps.—G

Theme 4: The learning environment modulates behaviors

Finally, we identified a fourth theme related to MAL development: the learning environment modulates behaviors (Table 3). Specifically, active faculty promotion of learner comfort and confidence is necessary for learners to express these behaviors of acknowledging gaps and taking intellectual risks.

TABLE 2 Additional quotes further illustrating behaviors of MALs supporting the theme of intellectual risk-taking.

Communication of clinical decision-making processes even at the risk of being wrong:

... they actually say, "Here's my assessment. I don't think they have a PE. I would call him no risk. So I'm not even going to go down the PE route. But he is a four on ACS. I didn't think he needed to get admitted, but our protocol is to do that, so we should follow that versus we can admit him, but I think he'd be better to go home except you don't like that so I think we should admit because he got a big risk." ... So you hear more commitment and then you hear the why—J

... So they will come up and they will have a plan in place, and it'll be a statement and not a question.—I

Openly engaging with errors and verbalizing gaps to foster their development including intentionally seeking uncomfortable experiences:

... it's behaviors like being able to verbalize at the start of a shift, "This is something I've received feedback on that I'm weak at or I have self-assessed that I'm weak at this thing and so I'm going to try to focus on it for this shift."—H

... people who say, "I already know I'm weak at this." And without saying it, they want to tackle that and often they don't reach out for help but their self develop[ment] and I think an example of that is many people will say as a resident, "I hated X complaints. So I picked up as many of that complaint as I could."—N

Performance-driven gap identification to facilitate their development:

... those who have enough humility to ask others their opinions. And a lot of times that's not calling a consult, that's actually just talking to the people around them. But sometimes it's calling the consult too and getting a little bit of input that way.—R

They're self-assessing along the way, checking their medical knowledge against where they imagine that they are and self-correcting as they go.—F

Independence of thought and practice:

Adaptive learners staff patients because they either need some basic approval that their plan is safe and acceptable or they recognize that they don't know something and want my help, as opposed to someone who doesn't demonstrate this, who just comes to me for, well, what's the right answer?—B

Abbreviation: MALs, master adaptive learners.

TABLE 3 Additional quotes further illustrating behaviors of MALs supporting the theme of learning environment modulates behaviors.

Active promotion of psychological safety is necessary for learners to acknowledge gaps and take intellectual risk:

But, sometimes, it's hard to break through to them and say that it's okay to be wrong. It's okay to not know. Their performance anxiety is really high—Q

... they're really enthusiastic about it initially, and then you find faculty who support that idea and kind of push them and champion them, or you see them get smacked down, and then suddenly they don't bring those ideas anymore.—I

... creating a culture of judgment-free zones, if you will, of like, "Hey, growth mindset, we're all trying to get better. When we offer you opportunities for feedback or opportunities for growth, take them with the right mentality. We're not criticizing you.—F

This safety is mediated through trusting relationships and expert supervisors serve both as stewards of the CLE and as co-learners and role models:

They listen to feedback from people they respect and from people who are giving a crap. It has to come, they have to feel that it is coming from a place of investment as opposed to a dispassionate place of assessment.—N

I think to truly support master adaptive learners, there's got to be some degree of agreement with faculty of how they're going to support it and kind of have a common model, because when you have faculty whose practice patterns are so disparate from each other, it leads to a lot of confusion for the learners. And then, they don't necessarily know what's right. And if we aren't willing to ourselves kind of take that step back and say, "That's not how I would do it, but I'll let you go ahead and try that this time."—I

I think those opportunities ... to develop longitudinal relationships and create some of that trust that's necessary for coaching, for honest feedback conversations, informing some of that self-assessment.—F

I think when we as faculty are following up on cases and doing the same thing for them saying, "Hey, remember that thing we didn't know about? I read about it" or "I followed up on the patient and here's some learning that goes along with it." So that they see that it doesn't just stop in residency, that you have to keep doing it.—H

And one of the things with that is vulnerability and showing where you don't know the answer, and then showing them how you try to find the answer and kind of lead by example that way.—I

Abbreviation: MALs, master adaptive learners.

[I]t's a lot of just constant reassurance, hearing it from a lot of different places and people who are in a position of authority to hear, "It's okay to make mistakes. You are here to learn, you are here to grow. This is what we expect of you. We do not expect perfection from day one. That is not the reality." And I think doing that on a loop can help to foster that understanding maybe a little bit more quickly, but that scripting or expectation setting from the senior resident or from the attending can help to allow the resident to be in a more healthy mindset, to be willing to learn things as those opportunities arise.—C

This safety is also mediated through trusting relationships with supervisors who serve as stewards of the learning environment.

They listen to feedback from people they respect and from people who are giving a crap. It has to come, they have to feel that it is coming from a place of investment as opposed to a dispassionate place of assessment.—N

Additionally, these expert supervisors serve as colearners and role models and, in doing so, allow learners to thrive.

I think when we as faculty are following up on cases and doing the same thing for them saying, "Hey, remember that thing we didn't know about? I read about it," or "I followed up on the patient and here's some learning that goes along with it." So that they see that it doesn't just stop in residency, that you have to keep doing it.—H

Our participants frequently commented that learners fitting the MAL phenotype are "rare" (E) and struggled with how to proactively identify these learners as "It's not about the test taking, it's not about the actual performance measures"(D). They also mused that, while MALs may have these skills and habits at the onset of residency, they "... just weren't really displaying them, or maybe were kind of hiding their use of them" (I). They further speculate that this exercising MAL skills requires a "safe space" (D) because learners are often overwhelmed and just "... don't have space in their heads

for curiosity" (N). In addition, the learning environment itself serves as an impediment, at least initially during GME training.

... there's just still such a fear when you first start in residency of being wrong that's been cultivated by years of an education system that basically tells you that you have to be right. And I think it's really hard to be in this model and in this framework if you're constantly scared of being wrong.—H

DISCUSSION

Our findings expand and evolve our understanding of the MAL model from a behaviorist perspective by delineating observable practices and describing a behavioral phenotype for the MAL (Table 4). We also provide meaningful new insights about the omnipresent influence of the learning environment on the expression of these behaviors. Behaviors are *observable* actions. The MAL model has been inherently a presumption of skills and traits that are conceptual in nature and not grounded in empirical observation. Using our study findings, we can build a foundation to accurately identify MALs, provide developmentally supportive training experiences, and yield more nuanced insights into learning processes—all based on empirical observation.

Our three behavioral themes provide evidence for some of the skills initially hypothesized in the MAL model.^{3,4} For instance, the authors of the MAL model proposed that "the ability to ask thoughtful questions" is an essential aspect of the MAL learning cycle.³ Our education experts confirmed this and also provided concrete behaviors illustrating how MALs use effective questioning as a learning

strategy. This behavior, in turn, mirrors meaningful task variation, a key instructional method for cultivating adaptive expertise.^{2,23} Other studies of MALs echo this finding, with Kawamura et al.²⁴ showing that high-performing pediatric residents use deliberate experimentation and variation in their communication skill development strategies. These self-driven actions toward reflective practice allow the MALs to develop a deep and dynamic conceptual understanding of pathophysiology and management options.²⁵ In addition, we saw some observable behaviors emerging that have strong correlates to those identified in earlier studies of MALs and their self-reported learning habits.⁵ These included performance-driven gap identification through comparison with external sources, self-assessment of performance during patient care, and the importance of developing a network of trusted sources to support learning.^{5,22} Further research will need to elucidate the developmental timeline of these behaviors, as our participants highlighted that some of these behaviors may represent more advanced skills. It will also be necessary to further investigate the spectrum of behaviors for MALs. This will include eluding the spectrum of behaviors as a developmental process for manifesting the overall MAL phenotype.

All of our observed MAL behaviors flow from a learner's sense of *agency* to take intellectual risks. Fundamentally, agency refers to the extent to which individuals are able to exercise control in their lives and is also likely environment specific.^{26–28} Agency is also proposed as a key modulator of the core MAL traits of motivation, curiosity, growth mindset, and resilience.⁶ Success in the effort to develop MALs in GME will rely on constructing a supportive learning environment that fosters learners' agency, risk taking, and ownership of their development.^{2,27}

Our results—particularly the fourth theme—suggest an impending conflict between the assessment-oriented focus of

TABLE 4 Summary of MAL behaviors: observable behaviors of MALs in the EM clinical environment.

Behavior	The MAL ...
Learner-driven feedback conversations	Initiates, guides, and engages in the reflective process of obtaining performance feedback.
Independent personal synthesis of information	Integrates data from multiple sources to create a mental framework for diagnostic, therapeutic, or instructional purposes which is often shared with others.
Appropriate deviation from algorithms	Identifies the limits of diagnostic and treatment algorithms and decides when and how to move outside of an established pattern to provide optimal patient care.
Hypothetical questioning	Verbally explores (often with supervising physicians) the ways in which contrived variations in presenting characteristics, available resources, etc., would affect clinical decision making to broaden their understanding.
Case self-review	Engages in critical examination of recent cases to identify learning and performance gaps. This is often shared with their supervisors, particularly those from their network of trusted sources.
Commit to clinical decisions	Expresses their synthesis of information through independent decision-making and creation of a concrete clinical plan, even when they may have some degree of uncertainty about their conclusions.
Willingly engages with experiences outside their comfort zone	Proactively discusses, explores, and/or seeks out clinical exposure to perceived areas of deficit to build skills and fill gaps.
Performance driven gap identification	Critically compares their own performance to external standards. ⁵
Customized learning network	Cultivates a network of mentors to guide their learning and fill their personal needs.

Note: Many of these have applications to multiple phases (planning, learning, assessing, adjusting) of the MAL model.

Abbreviation: MALs, master adaptive learners.

competency-based medical education (CBME) and the growth-oriented focus of the MAL model. This tension is not new and has been previously described.²⁹⁻³³ We identified learner-initiated behaviors that allow trainees to take risks, form communities, and critically interpret their own practice. All of these require the learner to rely heavily on the learning environment to support their ability to take developmental risks. An assessment-oriented learning environment may stifle these positive developmental behaviors. Therefore, the learner who may actually be a MAL may not manifest these positive behaviors, and other learners may be deterred from even attempting to engage with these complex behaviors required to develop into a MAL. Our findings raise concern that CBME—as currently constructed—may forestall development or hinder MAL behaviors in the absence of a psychologically safe learning environment.²⁹⁻³³

Perhaps having anticipated this issue, the revised MAL model also acknowledges the importance of the learning environment in the development of MALs.⁴ The authors view the MAL as being able to “adapt to or cope with adverse or challenging learning environments.” They further postulate that the “MAL process may have an inoculating or protective effect.”⁴ This perspective sees MAL resilience as a trait that allows them to successfully navigate the learning environment. Our data suggest, however, that while MALs are often very successful in navigating the clinical learning environment, the expression of these behaviors may be more fragile and dependent on the environment than previously appreciated.^{5,22} This hypothesis is supported by recent findings that learners who do not currently demonstrate the MAL

phenotype (i.e., the majority of learners) also struggle to navigate the systems and pressures of the learning environment.⁶ Consistent with our prior investigations, our participants routinely emphasized that they view MALs as the exceptions rather than the norm among GME trainees.^{5,6,22} This begs the question of why this is the case, and the answer may be that the learning environment itself impairs the ability of learners to develop or manifest MAL behaviors and skills. Phrased otherwise, “[the] system is perfectly designed to get the results it gets.”³⁴

The key to navigating this developmental tension is the concept of psychological safety. A psychologically safe learning environment “free(s) learners from constantly being self-conscious about projecting an image of competence” and thereby promotes engagement with learning tasks.³⁵ This mindset reflects a “tacit calculus” to “assess the interpersonal risk associated with a given behavior” including engaging with learning through behaviors, such as asking questions.³⁵⁻³⁷ Supervisor responsiveness and peer social interactions also affect learner willingness to engage in self-regulated learning behaviors, such as self-disclosing performance gaps.³⁸⁻⁴¹ This process of “image management” determines student engagement with self-assessment during feedback conversations.⁴² Suggestions of this tension also arise in a recent work exploring the medical student learning experience during a transition from a traditionally graded clerkship to one focused on formative assessment. This change resulted in an increased orientation toward learning and fewer concerns about performance and assessment.⁴³ It is, therefore, of crucial importance that we recognize that individual agency and social structures are intrinsically

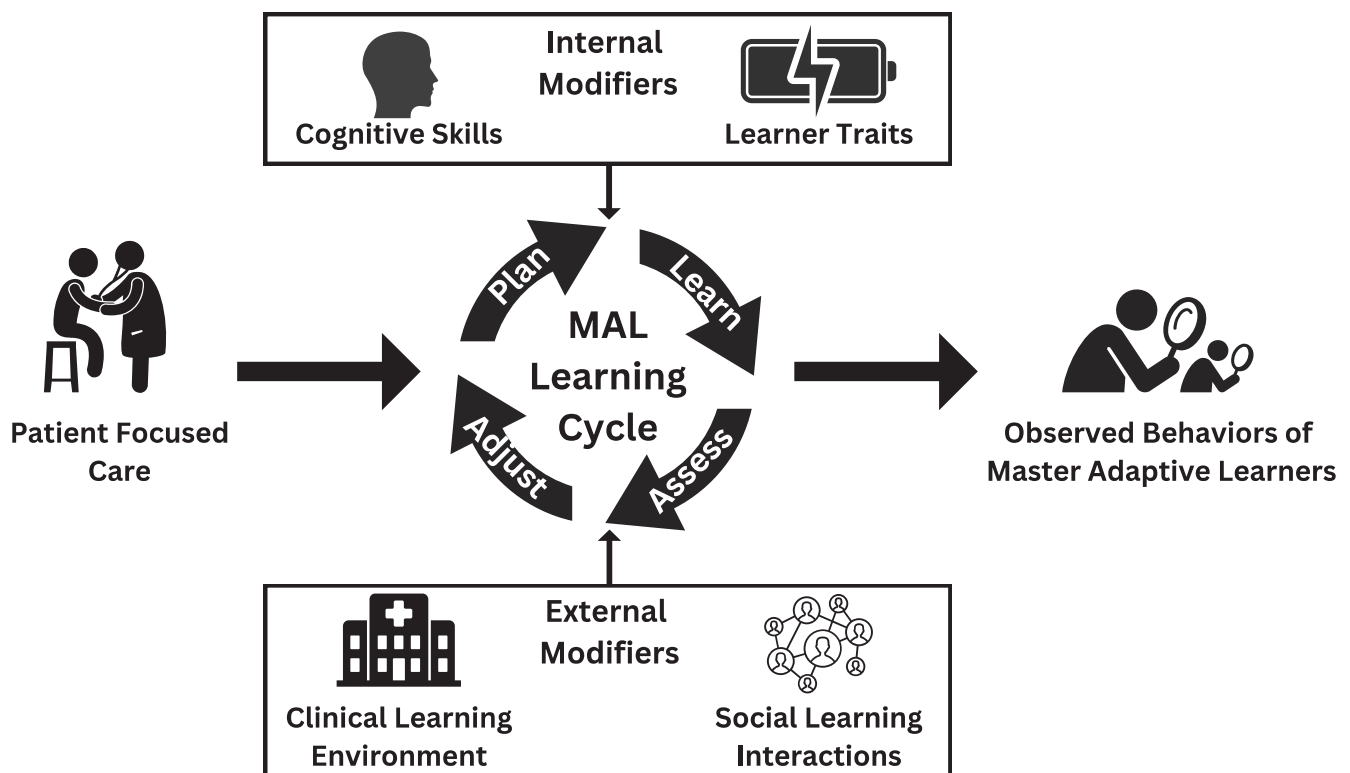


FIGURE 1 Patient encounters drive engagement with the MAL cycle of plan–learn–assess–adapt. Learner and environmental characteristics determine engagement with the cycle. Optimization of these elements promotes expression of MAL behaviors. MAL, master adaptive learner.

interconnected. Whether this can be mediated by the interventions such as the proposed coaching is still a matter of active investigation.⁴⁴ As a result, the MAL learner model may need to evolve to a system-centric rather than a learner-centric perspective.

Drawing on the collective results of extant MAL studies, we propose an evolution of the MAL model.^{5,6,22,24} In each study, the learning environment is a substantial mediator for the learner's intrinsic traits, cognitive skills, and observable behaviors. We believe we need to emphasize a sociocultural approach, such as that described by situated learning theory.⁴⁵ This construct originally described the apprenticeship model that has strong parallels to graduate medical education training. Additionally, it argues that learning occurs through engaging in authentic practice and that the learning itself cannot be separated from the context and community in which it occurs. From this broader perspective, learner cognitive skill development is necessary, but not sufficient, for them to express desirable MAL behaviors. This refined model recalibrates our focus by including not only the individual learner but also a balanced emphasis on the social learning interactions and clinical learning environment (Figure 1).

LIMITATIONS

Despite our explicit behavioral focus, a number of factors may contribute to an incomplete accounting of MAL behaviors. Our participants consistently highlighted that, with many behaviors invisible to educators. They also emphasized that the presence or absence of the MAL phenotype does not correlate with clinical performance. There is a risk that our participants conflated behaviors tied to high clinical performance—that is, toward clinical assessment measures—with true MAL behaviors. Finally, as with any behaviorist study, our reliance on observable behaviors precludes our ability to capture internalized cognitive processes or thoughts.

Our participating educators are primarily based at academic medical centers and disproportionately represent 48-month format programs. It is certainly possible that other relevant MAL behaviors may emerge in community-based environments. Our participants are roughly evenly split between men and women; however, they largely identify as White. This lack of racial diversity may also limit behavioral insights. Finally, we only captured the behaviors of EM trainees. Though a broader sample of learners would be more comprehensive, the underlying behaviors that we identified are not limited to an emergency department environment and should be generalizable.

CONCLUSIONS

We present several behaviors that allow identification of master adaptive learners within emergency medicine trainees. These data expand our understanding of master adaptive learner behaviors and may allow for more precise categorization of individuals for study of targeted curricular interventions. In addition, we highlight the critical importance of creating a safe and trusting learning environment

that allows learners to express master adaptive learner behaviors. This knowledge advances the master adaptive learner conceptual model by resituating the learning environment as a central element in promoting the master adaptive learner. Future work will focus on using these findings to methodically identify and categorize learners, testing interventions to promote desirable master adaptive learner behaviors, and optimizing the learning environment for all learners.

AUTHOR CONTRIBUTIONS

All authors contributed to study concept and design, analysis and interpretation of the data, and critical revision of the manuscript for important intellectual content. Laura R. Hopson acquired the funding. Laura R. Hopson acquired the data and drafted the manuscript.

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CONFLICT OF INTEREST STATEMENT

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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