¹ Assistant Professor, King Saud bin Abdulaziz University for Health Sciences, King Abdullah International Medical Research Center (KAIMRC). Ministry of National Guard - Health Affairs, Saudi Arabia.

FROM ALGORITHMS TO ACCOUNTABILITY: HOW MEDICAL STUDENTS SELF-REGULATE LEARNING AT THE INTERSECTION OF LAW AND TECHNOLOGY

DOS ALGORITMOS À RESPONSABILIDADE: COMO ESTUDANTES DE MEDICINA AUTORREGULAM A APRENDIZAGEM NA INTERSEÇÃO ENTRE DIREITO E TECNOLOGIA

DE ALGORITMOS A RESPONSABILIDAD: CÓMO LOS ESTUDIANTES DE MEDICINA AUTORREGULAN EL APRENDIZAJE EN LA INTERSECCIÓN ENTRE EL DERECHO Y LA TECNOLOGÍA

Omar ALOBUD[1]
obudo@ksau-hs.edu.sa

Revista on line de Política e Gestão Educacional (RPGE), Araraquara, v. 29, n. esp. 4, e025105, 2025.

e-ISSN: 1519-9029

1

ABSTRACT: This study investigates how medical students develop self-regulated learning strategies when engaging in the legal and computational dimensions of medicine in an increasingly digital educational environment. Thirteen undergraduate students participated in semi-structured interviews, analyzed using Braun and Clarke's thematic approach. Three themes emerged: algorithmic planning and legal foresight, ethical debugging and adaptive reasoning, and reflective compliance and professional accountability. Students initially viewed the material as technical but gradually reframed it as a process of ethical self-governance. They learned to plan with moral foresight, test the validity of their reasoning, and evaluate decisions through the lens of accountability. The findings extend traditional SRL theory by showing how metacognitive regulation evolves into ethical reasoning when students engage with interdisciplinary content. Embedding self-regulation within technology–law curricula can foster reflective, responsible learners prepared to act with integrity in an era of data-driven medical practice.

KEYWORDS: Self-regulated learning. Medical education. Artificial intelligence. Digital health. Professional identity.

RESUMO: O estudo investiga como estudantes de medicina desenvolvem estratégias de aprendizagem autorregulada ao estudar dimensões legais e computacionais da prática médica em um contexto de crescente digitalização. Treze alunos participaram de entrevistas semiestruturadas, analisadas por meio da abordagem temática de Braun e Clarke. Três temas emergiram: planejamento algorítmico e previsão legal, depuração ética e raciocínio adaptativo, e conformidade reflexiva e responsabilidade profissional. Os estudantes inicialmente trataram o conteúdo como tarefa técnica, mas passaram a entendê-lo como um processo de autogoverno ético, aprendendo a planejar com responsabilidade moral, testar a validade de seus raciocínios e avaliar decisões segundo parâmetros de accountability. Os achados ampliam a teoria tradicional de aprendizagem autorregulada ao mostrar que a metacognição pode evoluir para um raciocínio ético diante de conteúdos interdisciplinares. Integrar a autorregulação às disciplinas de tecnologia e direito pode formar profissionais mais reflexivos, responsáveis e preparados para a prática médica orientada por dados.

PALAVRAS-CHAVE: Aprendizagem autorregulada. Educação médica. Inteligência artificial. Saúde digital. Identidade profissional.

RESUMEN: Este estudio investiga cómo los estudiantes de medicina desarrollan estrategias de aprendizaje autorregulado al se envolver en las dimensiones jurídicas y computacionales de la medicina en un entorno educativo cada vez más digital. Trece estudiantes de pregrado participaron en entrevistas semiestructuradas, analizadas mediante el enfoque temático de Braun y Clarke. Surgieron tres temas: planificación algorítmica y previsión jurídica; depuración ética y razonamiento adaptativo; y cumplimiento reflexivo y responsabilidad profesional. Inicialmente, los estudiantes percibieron el material como técnico, pero progresivamente lo reinterpretaron como un proceso de autogobernanza ética. Aprendieron a planificar con previsión moral, verificar la validez de su razonamiento y evaluar decisiones desde la perspectiva de la responsabilidad. Los hallazgos amplían la teoría tradicional del aprendizaje autorregulado al demostrar cómo la regulación metacognitiva evoluciona hacia el razonamiento ético cuando los estudiantes interactúan con contenidos interdisciplinares. Integrar la autorregulación en los currículos de tecnología y derecho puede fomentar aprendices reflexivos y responsables, preparados para actuar con integridad en una era de práctica médica guiada por datos.

PALABRAS CLAVE: Aprendizaje autorregulado. Educación médica. Inteligencia artificial. Salud digital. Identidad profesional.

INTRODUCTION

The landscape of medical education is changing in ways that challenge how future physicians think, act, and learn. As digital systems become embedded in clinical reasoning, medical students are now expected to understand not only biological mechanisms but also the legal and computational principles that govern digital medicine. This growing convergence of technology and law has made the ability to reason about ethical responsibility, data privacy, and algorithmic accountability an essential professional skill. For instance, issues surrounding artificial intelligence in diagnosis, automated consent forms, or the ownership of patient data illustrate that medical decisions increasingly carry legal and technological implications (Car et al., 2025; Marsilio et al., 2024).

Instead of learning solely how to diagnose illness, students must now learn how to interpret the regulations and digital processes that influence those diagnoses. This transformation has expanded the traditional purpose of medical education—from transmitting scientific knowledge to cultivating digital-legal awareness and professional judgment. As Hays (2013) observed, medical education must now integrate domains once considered peripheral, such as informatics and ethics, into its core identity. This shift places a greater demand on students to self-regulate their learning, since mastering such interdisciplinary content requires persistence, adaptability, and reflection across conceptual boundaries (Sandars & Cleary, 2011).

Building on this understanding, the notion of self-regulated learning (SRL) provides a useful lens through which to study how students manage complexity in digital and legal domains. Self-regulated learning refers to a learner's ability to plan, monitor, and evaluate their cognitive and emotional processes in pursuit of a goal (Zimmerman, 1986). Rather than passively following instructions, self-regulated learners consciously shape their study behaviors, use feedback effectively, and reflect on performance outcomes (Zimmerman & Moylan, 2009). This metacognitive cycle helps learners adapt to uncertainty—an ability particularly relevant when navigating ambiguous legal or computational problems. In this sense, SRL functions as a form of cognitive governance that allows students to control not only what they learn but also how they reason about it. Recent research emphasizes that SRL is deeply intertwined with learner agency and autonomy, suggesting that students who take ownership of their learning are better equipped to deal with novel or interdisciplinary challenges (Gupta et al., 2024). In medical contexts, SRL has been shown to enhance both knowledge retention and self-efficacy, helping learners maintain motivation in high-pressure environments (Artino et al., 2010; Durning et al., 2011). These findings imply that SRL is not simply an academic skill but a professional competence—one that supports responsible judgment in ethically and legally complex settings.

RPGE

Despite its significance, most research on SRL in medical education has focused on performance outcomes, study habits, or coping mechanisms, with little attention to how these skills transfer into domains where technology and law intersect. For example, studies have explored how self-regulation affects test preparation, clinical reasoning, or stress management (Foong et al., 2021; Lucieer et al., 2016), yet there remains a notable absence of inquiry into how students use SRL when learning to navigate digital regulations or legal obligations. Even comprehensive reviews highlight that SRL is often studied as an individual process isolated from social or systemic contexts (Cho et al., 2017; Jouhari et al., 2015).

In practice, however, medical students today operate in environments where their reasoning must comply with both ethical codes and computational logic. As Zheng and Sun (2024) note in their meta-analysis, SRL consistently predicts better learning outcomes across levels of medical training, yet its application to interdisciplinary or technology-mediated learning is still poorly understood. This knowledge gap suggests that SRL may play a deeper role than previously recognized—acting as a bridge between cognitive self-management and ethical-legal decision-making. Understanding how students regulate their thinking in such settings is thus crucial for designing curricula that prepare them not only to think critically, but also to act accountably in a digitized healthcare landscape.

Extending from this gap, self-regulated learning can be reinterpreted as a form of ethical and procedural self-governance. In traditional SRL models, students move through phases of forethought, performance, and reflection, each involving goal-setting, monitoring, and evaluation of progress (Zimmerman & Moylan, 2009; Panadero & Alonso-Tapia, 2014). Within a legal and computational context, these same phases acquire new meanings. During forethought, learners engage in legal foresight—anticipating the ethical and procedural consequences of their choices before acting. In the performance phase, monitoring becomes a process of ethical debugging, where students identify inconsistencies between their reasoning and legal principles or algorithmic logic. Reflection, in turn, transforms into a process of compliance awareness, prompting students to evaluate how their understanding aligns with professional accountability. As Koh and Townsend (2024) suggest, reflective writing can cultivate these higher-order regulatory skills, fostering both metacognition and moral awareness. Similarly, research on professional identity formation shows that reflection and self-regulation together shape how medical students internalize values such as responsibility, integrity, and respect for human autonomy (Wong & Trollope-Kumar, 2014; Wilson et al., 2013). When viewed through this lens, SRL serves not only as a cognitive tool for learning but also as a psychological mechanism that helps future physicians regulate their ethical and legal identities.

Building on these theoretical foundations, the present study explores how medical students develop self-regulation while engaging with topics that combine computer science, data

RPGE

4

ethics, and law. It investigates how learners plan, monitor, and adapt their reasoning in a medical informatics course that emphasizes legal accountability and algorithmic decision-making. While previous studies have shown that SRL contributes to academic success in medical education (Lee et al., 2019; Huang et al., 2024), little is known about how students apply these skills to situations that involve interpreting legal frameworks or evaluating digital responsibility.

By focusing on regular students rather than high performers, this study aims to capture authentic patterns of cognitive and emotional regulation that arise in everyday learning contexts. The goal is to understand how self-regulated learning supports the development of professional accountability and ethical reasoning when medicine intersects with technology and law. In doing so, this work extends SRL research into a new interdisciplinary space, where learning is no longer confined to cognitive mastery but expands toward moral and procedural awareness essential for modern medical practice.

The present study was designed to explore how medical students self-regulate their learning when engaging in the legal and computational dimensions of medicine. It seeks to uncover how learners plan their approach to complex, interdisciplinary material, monitor their understanding when faced with uncertainty, and adapt their strategies as they negotiate ethical and legal reasoning. The study focuses specifically on regular students—those who represent the everyday learning experience rather than exceptional academic performers—to provide a more grounded understanding of how self-regulated learning manifests in typical educational settings. As Foong et al. (2018) and Chou et al. (2019) highlight, the true insight into professional growth often lies not in the mastery of the highest achievers but in how average learners confront ambiguity, failure, and moral tension. By examining their experiences, this research aims to illuminate how cognitive, emotional, and ethical self-regulation interact in shaping responsible learning behavior. The central research question guiding this inquiry is: How do medical students self-regulate their learning when navigating the legal and computational dimensions of modern medicine?

METHODOLOGY

This study employed a qualitative design to explore how medical students regulate their learning when confronted with the overlapping demands of computer science, data ethics, and medical law. The aim was to capture the lived experiences of students as they made sense of abstract legal concepts within the context of technological practice. A qualitative approach was chosen because it allows a deeper understanding of how learners interpret, adapt, and construct meaning through reflection and dialogue. Rather than seeking

RPGE

to measure predefined variables, this study focused on how students describe their internal processes—how they plan, monitor, and evaluate their learning when faced with uncertainty and responsibility. The interpretive orientation provided the flexibility to follow participants' reasoning as it unfolded, capturing the complexity of self-regulation within a rapidly changing educational landscape.

The study was conducted in a second-year undergraduate course titled Medical and legal Informatics, which forms part of a broader curriculum designed to integrate ethical and computational thinking in medical education. The course introduces students to topics such as patient data privacy, algorithmic accountability, and the legal implications of artificial intelligence in healthcare. It emphasizes applied understanding through discussion of real and simulated cases that require students to evaluate both technical and legal perspectives. Within this setting, learning extends beyond memorizing laws or programming concepts; it requires students to engage in reflective reasoning about the ethical consequences of their decisions. Such an environment was ideal for examining how students activate self-regulation strategies in relation to legal foresight, critical reflection, and adaptive reasoning.

A total of thirteen medical students participated in the study, representing a mix of genders, backgrounds, and levels of comfort with technology. All were full-time students enrolled in the medical program, and none had prior formal training in law or computer science. The sample was purposively selected to include regular learners who were actively participating in the course rather than exceptional high achievers. This choice reflected the study's goal of understanding everyday self-regulation in typical educational circumstances rather than performance under ideal conditions. Participants were recruited through an open call at the end of the semester, and all provided informed consent after being briefed on the study's purpose and confidentiality protocols.

Data were collected through individual semi-structured interviews conducted over a three-week period at the conclusion of the course. Each interview lasted between forty-five and sixty minutes and followed a flexible guide that encouraged open reflection. Students were invited to describe how they approached learning tasks that involved both technical reasoning and legal interpretation. Questions probed how they planned their study process, managed confusion when technical or legal details overlapped, and adjusted their understanding after receiving feedback or encountering new ethical dilemmas. The conversational format allowed participants to share examples drawn from their experiences in lectures, group discussions, and case-based exercises. All interviews were conducted in a quiet room within the medical school and were audio-recorded with participants' permission. Field notes were written immediately afterward to capture tone, pauses, and contextual observations that added depth to the transcripts.

Data analysis followed Braun and Clarke's six-phase thematic framework, which allowed patterns of meaning to emerge inductively from the data. After transcription, the interviews were read multiple times to achieve familiarity, and initial codes were generated to represent key expressions of planning, monitoring, and adaptation. These codes were gradually refined into broader categories that described students' strategies for managing cognitive, emotional, and ethical challenges. Through an iterative process of comparison, discussion, and synthesis, three overarching themes were identified that captured how students developed self-regulation in legal-computational learning contexts. To enhance credibility, a second researcher independently reviewed the codes, and discrepancies were discussed until consensus was reached. Member checking was conducted with a subset of participants, who confirmed that the themes resonated with their experiences and accurately reflected their perspectives.

RESULTS

The analysis revealed that students' experiences of learning at the intersection of technology and law were shaped by an ongoing process of negotiation between logic, responsibility, and self-awareness. As they confronted unfamiliar legal principles and computational systems, they were forced to manage not only new information but also the tension between precision and uncertainty. Many described the process as "learning how to think twice"—once like a scientist and again like a lawyer. Through repeated reflection and self-correction, they developed strategies to plan their learning, test their reasoning, and evaluate their own ethical positions. This process unfolded through three interconnected themes that captured the evolving rhythm of their self-regulation: algorithmic planning and legal foresight, ethical debugging and adaptive reasoning, and reflective compliance and professional accountability.

The first theme, algorithmic planning and legal foresight, described how students began to organize their studies with the same logic they associated with coding or system design. They viewed the complexity of legal material as something that could be approached step by step, transforming overwhelming regulations into manageable sequences of ideas. One participant explained, "*When the legal terms confused me, I treated them like variables in a program—I defined each one, linked it to an example, and only moved on when the logic made sense.*" For many, this structured approach became a psychological anchor that helped them cope with ambiguity. Another student reflected that "*if I could map out the law like an algorithm, I could predict where mistakes might happen before they did.*" Over time, planning shifted from a way of organizing study time to a deeper form of foresight—an anticipatory awareness of the consequences embedded in both their reasoning and their future professional actions.

They no longer aimed only to pass the course but to understand how their decisions as doctors could hold legal weight.

The second theme, ethical debugging and adaptive reasoning, captured the moment when students began to question the correctness of their own logic rather than the material itself. As they discussed algorithmic bias or data privacy, many noticed inconsistencies between what they thought was fair and what the law required. This realization often triggered a cycle of self-correction that mirrored the debugging process in programming. One participant recalled, "*I would build an argument, realize it didn't match the ethical rule, then go back and change my assumption—it felt like fixing a bug in my thinking.*" Another said, "*Sometimes my first reaction was emotional, like 'this is unfair,' but then I had to stop and test whether my judgment fit within the legal framework.*" These reflections revealed how students used both logic and empathy to navigate uncertainty. They developed tolerance for ambiguity by treating mistakes as opportunities to refine their reasoning. Instead of feeling defeated by confusion, they learned to slow down, reassess, and rebuild their understanding—an approach that reflected a growing maturity in both thought and attitude.

The third theme, reflective compliance and professional accountability, illustrated how students transformed legal knowledge into a personal sense of moral responsibility. Reflection became more than an academic exercise; it evolved into a self-audit of one's own integrity. Several students described moments when they questioned whether their actions would withstand scrutiny beyond the classroom. One participant admitted, "*After our session on data sharing, I caught myself thinking—if I had to explain this decision in front of a patient or a court, would I still stand by it?*" Another remarked, "*At first, compliance sounded like following rules, but later I saw it's more about owning the decision.*" Through such reflections, students began to internalize the principles of accountability, recognizing that self-regulation extended beyond study habits to moral conduct. They linked their learning to the kind of doctors they aspired to become—individuals capable of making decisions grounded in both evidence and conscience.

These themes painted a picture of self-regulation as a living, evolving process—one that guided students from mechanical planning toward ethical self-awareness. The transition from viewing law as an external constraint to experiencing it as an internal compass marked a turning point in their learning journey. By planning like coders, reasoning like philosophers, and reflecting like professionals, the students demonstrated that the mastery of legal and computational knowledge in medicine was not only intellectual but deeply personal. Their stories revealed that genuine understanding emerged not from certainty, but from the willingness to question, revise, and take ownership of their thinking.

DISCUSSION

The findings of this study reveal that medical students learning at the intersection of technology and law regulate their learning in ways that go beyond conventional academic self-management. Building on the patterns identified in the results—algorithmic planning, ethical debugging, and reflective compliance—it becomes evident that self-regulated learning (SRL) in this interdisciplinary context is not merely a cognitive exercise but also a process of ethical and professional calibration. This aligns conceptually with Zimmerman's (1986) view of SRL as an active process of self-generated thoughts, feelings, and behaviors directed toward achieving personal goals, yet it expands that framework by embedding moral foresight into the cycle. Students in this study demonstrated a shift from planning to learn efficiently to planning to act responsibly, a transformation that connects cognitive regulation with ethical anticipation. This finding echoes the observation by Gupta et al. (2024) that self-regulated learners exercise agency not only in managing academic tasks but also in shaping the meaning of their learning experiences. While earlier studies such as Foong et al. (2021) emphasized SRL as a key to academic excellence in medical education, the present study suggests that its value lies equally in cultivating awareness of legal accountability and social responsibility. This redefinition underscores the evolving role of SRL in modern curricula where learning outcomes extend beyond intellectual mastery to encompass professional integrity.

Building from this broader understanding, the first pattern—students' use of algorithmic planning and legal foresight—illustrates how traditional SRL phases can be reinterpreted in digital and legal learning environments. In previous research, planning has been primarily viewed as a strategy to enhance learning efficiency and academic achievement (Panadero & Alonso-Tapia, 2014; Lucieer et al., 2016). In contrast, the students in this study planned not only to optimize performance but also to prevent ethical and procedural mistakes before they occurred. Their detailed mapping of legal concepts and anticipation of possible misjudgments resemble what Zheng and Sun (2024) describe as proactive self-regulation—a forward-looking process that predicts and minimizes potential failures. Yet in this study, foresight extended beyond cognitive preparedness to moral awareness, where planning became an internal compliance mechanism. This interpretation connects closely with Gupta et al. (2024) argument that SRL includes a dimension of self-determination that allows learners to govern their intellectual and ethical conduct simultaneously. The resemblance between the students' structured thinking and the logic of programming suggests a synthesis of cognitive and moral reasoning rarely captured in prior SRL literature. It shows that when medical students are exposed to interdisciplinary challenges, their planning strategies evolve from organizing knowledge to governing behavior—a shift that represents a deeper, more holistic form of learning regulation.

RPGE

The next theme, which centers on how students monitored and adapted their reasoning through what they described as "ethical debugging," extends the discussion from foresight to self-correction. This finding connects strongly with the performance phase of Zimmerman and Moylan (2009) cyclical model, in which learners continually observe and adjust their actions to maintain alignment with goals. However, in this study, monitoring was not limited to evaluating progress or efficiency—it became a form of moral reasoning. Students did not simply check for factual errors; they questioned whether their interpretations of law or data practices were ethically sound. This mirrors Pintrich's (2002) view that metacognitive knowledge involves monitoring one's beliefs as well as one's cognition, yet the participants went a step further by engaging in ethical reflection as a regulatory act. When one student described "fixing a bug in my logic" after realizing that her initial argument conflicted with legal principles, she demonstrated a self-awareness that blends cognitive accuracy with ethical coherence.

This process aligns with Sandars and Cleary (2010) argument that self-regulation in medicine is most effective when reflection becomes immediate and integral to reasoning, not just an afterthought. Furthermore, Koh and Townsend (2024) show that reflective writing can train students to identify inconsistencies in their moral judgments, thereby reinforcing the idea that self-monitoring serves as both a cognitive and ethical filter. The present study adds depth to these interpretations by showing that when learners confront interdisciplinary ambiguity—where laws meet algorithms—ethical reasoning becomes part of the regulation process itself, not a separate domain of learning.

Transitioning from adaptive reasoning to deeper self-awareness, the final theme of reflective compliance reveals how students transformed self-evaluation into an internalized sense of accountability. Whereas traditional SRL models conclude with reflection as a review of performance, the participants in this study used reflection to test their personal integrity and professional readiness. This mirrors the idea put forward by Wong and Trollope-Kumar (2014) that reflection acts as a bridge between learning and identity formation. Students began to ask not just "Did I understand this correctly?" but "Would I defend this decision in a professional context?" Such introspection reflects the progression from self-awareness to self-regulation in moral behavior, as described by Wilson et al. (2013), who noted that professional identity is shaped through cycles of reflection and responsibility.

The current findings build on this by illustrating that when law and technology are embedded in learning, reflection naturally extends to questions of ethical compliance and societal trust. Similar to Foong et al. (2018), who found that self-reflection deepens ownership of one's professional values, the students here demonstrated that accountability can be self--taught through critical reflection. Their narratives suggest that SRL in this interdisciplinary

RPGE

10

space operates as a moral compass, guiding students toward an integrated professional identity where learning, ethics, and responsibility are inseparable.

When these three dimensions—planning, monitoring, and reflection—are viewed together, they illustrate self-regulated learning as a process of ethical self-governance rather than merely a study skill. The students in this study did not treat law and computation as detached academic subjects but as interconnected systems that demanded both logical precision and moral restraint. This synthesis supports Gupta et al. (2024) argument that SRL involves agency and personal responsibility, where learners act as active regulators of their own learning environment. It also aligns with Pintrich (2002) concept of metacognitive control, in which learners continuously balance knowledge, motivation, and behavior to achieve meaningful outcomes. Yet the findings here expand these frameworks by showing that in legally charged, technology-rich learning spaces, self-regulation extends to ethical calibration—students manage not only what they know but who they become through learning. Like Huang et al. (2024), who emphasized the need for cultivating self-regulated learning ability in complex academic environments, the students' reflections in this study demonstrate that SRL can evolve into a mechanism for moral reasoning and professional accountability. This progression from cognitive control to ethical agency signifies that self-regulation in medical education is increasingly tied to character formation, especially when students must interpret the social and legal implications of their actions.

The broader implication of this reinterpretation is that teaching self-regulated learning in medical education should move beyond performance metrics to encompass legal, ethical, and technological awareness. When students learn to reflect on both the accuracy and integrity of their reasoning, they are developing competencies aligned with the Digital Health Competencies Framework, which calls for physicians who can manage responsibility in data-driven care (Car et al., 2025). Embedding SRL practices into interdisciplinary courses allows students to internalize accountability before they encounter real-world consequences. This supports Hays (2013) argument that integration in medical education must involve not only content but also the mindset and moral disposition of learners. Similarly, Sandars (2010) advocates for reflective approaches that teach students to pause, analyze, and regulate their actions as part of lifelong professional development. The present findings strengthen these perspectives by illustrating how SRL becomes a living system of ethical decision-making when applied to legal and computational topics. By approaching medical education through this integrative lens, educators can transform classrooms from spaces of information transfer into laboratories of ethical reasoning, where learners practice being both scientifically competent and socially responsible.

RPGE

While these insights offer a rich understanding of how students regulate their learning within legally and technologically complex domains, it is important to recognize the contextual limits of the study. The research was conducted with thirteen participants from a single institution, focusing on a specific course where legal and computational reasoning were explicitly integrated. As Foong et al. (2021) noted in similar qualitative inquiries, such context-specific studies privilege depth over breadth, allowing for detailed exploration but limiting generalizability.

Nevertheless, the strength of qualitative research lies in its ability to uncover the processes behind learning rather than to quantify them. The narratives presented here illuminate how ordinary students—not only high achievers—develop self-regulatory awareness through tension, confusion, and moral reflection. Future research could expand on these findings by combining qualitative interviews with quantitative measures such as self-regulation inventories or ethical reasoning scales. This mixed-method approach would allow educators to track how students' cognitive and ethical self-regulation evolve over time, complementing meta-analytic evidence like that of Zheng and Sun (2024), who emphasize SRL's consistent association with improved learning outcomes across medical training contexts. Moreover, longitudinal research could explore how the patterns of "ethical debugging" and "reflective compliance" observed here influence actual professional behavior during clinical rotations or early practice.

This study reimagines self-regulated learning as a moral and cognitive bridge between technology, law, and medical professionalism. By examining how students plan, monitor, and reflect across these domains, it reveals that SRL functions not only as a mechanism for managing study tasks but as a framework for ethical and procedural reasoning. The findings suggest that modern medical education must treat self-regulation as a foundational professional skill, on par with clinical competence or scientific reasoning. As Car et al. (2025) and Marsilio et al. (2024) emphasize, digital transformation in healthcare demands practitioners who can navigate complexity with both confidence and conscience. When SRL is embedded into interdisciplinary learning—where coding meets ethics and law meets logic—students begin to see responsibility as a habit of mind rather than an external rule. Ultimately, fostering this kind of reflective self-governance prepares future physicians to act with integrity in a world where medical practice is increasingly mediated by data, algorithms, and law.

CONCLUSION

In summary, this study demonstrates that self-regulated learning, when situated in a course that combines computer science and medical law, evolves into a process of ethical self-governance. Students did not merely manage their study routines; they learned to anticipate

the legal and moral implications of their reasoning, test their judgments, and reflect on their professional accountability. This redefinition of SRL shows that learning in modern medical education is no longer confined to cognitive mastery but extends to the development of conscience and foresight—qualities essential for practicing in an era of digital responsibility and data-driven care.

The findings suggest that integrating self-regulation training into interdisciplinary medical curricula can bridge the gap between knowing and doing, between reasoning and responsibility. Educators who create reflective, ethically charged learning environments can help future physicians internalize accountability as a core professional habit. By fostering this blend of cognitive flexibility and moral awareness, medical education can prepare graduates not only to solve problems intelligently but to act wisely and justly in the complex digital healthcare systems of tomorrow.

REFERENCES

Artino, A. R., La Rochelle, J. S., & Durning, S. J. (2010). Second-year medical students' motivational beliefs, emotions, and achievement. *Medical Education*, *44*(12), 1203–1212. https://doi.org/10.1111/j.1365-2923.2010.03712.x

Car, J., Ong, Q. C., & Erlikh Fox, T. (2025). The Digital Health Competencies in Medical Education Framework: An international consensus statement based on a Delphi study. *JAMA Network Open*, *8*(1), e2453131. https://doi.org/10.1001/jamanetworkopen.2024.53131

Cho, K. K., Marjadi, B., Langendyk, V., & Hu, W. (2017). The self-regulated learning of medical students in the clinical environment: A scoping review. *BMC Medical Education*, *17*(112). https://doi.org/10.1186/s12909-017-0956-6

Chou, C. L., Kalet, A., Costa, M. J., Cleland, J., & Winston, K. (2019). The dos, don'ts and don't knows of remediation in medical education. *Perspectives on Medical Education*, *8*(6), 322–338. https://doi.org/10.1007/s40037-019-00542-0

Durning, S. J., Cleary, T. J., Sandars, J., Hemmer, P., Kokotailo, P., & Artino, A. R. (2011). Viewing "strugglers" through a different lens: How a self-regulated learning perspective can help medical educators with assessment and remediation. *Academic Medicine*, *86*(4), 488–495. https://doi.org/10.1097/ACM.0b013e31820dc384

Foong, C. C., Ghouse, N. L. B., Lye, A. J., Holder, N. A. K. A., Pallath, V., Hong, W.-H., Sim, J. H., & Vadivelu, J. (2021). A qualitative study on self-regulated learning among high-performing medical students. *BMC Medical Education*, *21*(320). https://doi.org/10.1186/s12909-021-02712-w

Foong, C. C., Nazri, N. N. N., & Holder, N. A. K. A. (2018). I am becoming a doctor: Mine or someone else's will? A qualitative investigation. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(7), 3253–3267. https://doi.org/10.29333/ejmste/91084

Gupta, N., Ali, K., Jiang, D., Fink, T., & Du, X. (2024). Beyond autonomy: Unpacking self-regulated and self-directed learning through the lens of learner agency: A scoping review. *BMC Medical Education*, *24*, 1519. https://doi.org/10.1186/s12909-024-06476-x

Hays, R. (2013). Integration in medical education: What do we mean? *Education for Primary Care*, *24*(3), 151–152. https://doi.org/10.1080/14739879.2013.11494006

Huang, J., Huang, C., Qin, J., & Huang, K. (2024). Factors influencing self-regulated learning ability among medical undergraduates in China: A cross-sectional study. *BMC Medical Education*, *24*, 1235. https://doi.org/10.1186/s12909-024-06254-9

Jouhari, Z., Haghani, F., & Changiz, T. (2015). Factors affecting self-regulated learning in medical students: A qualitative study. *Medical Education Online*, *20*(1), 28694. https://doi.org/10.3402/meo.v20.28694

RPGE

Koh, S., & Townsend, J. (2024). Teaching self-regulated learning through reflective writing: Experiences of first-year medical students with the Master Adaptive Learner model. *Cureus*, *16*(10), e72664. https://doi.org/10.7759/cureus.72664

Lee, S. S., Samarasekera, D. D., Sim, J. H., Hong, W.-H., Foong, C. C., & Pallath, V. (2019). Exploring the cultivation of self-regulated learning strategies among pre-clinical medical students in two medical schools. *Medical Science Educator*, *29*, 1–10. https://doi.org/10.1007/s40670-018-00666-9

Lucieer, S. M., Jonker, L., Visscher, C., Rikers, R. M., & Themmen, A. P. N. (2016). Self-regulated learning and academic performance in medical education. *Medical Teacher*, *38*(6), 585–593. https://doi.org/10.3109/0142159X.2016.1142501

Marsilio, M., Calcaterra, V., Infante, G., Pisarra, M., & Zuccotti, G. (2024). The digital readiness of future physicians: Nurturing the post-pandemic medical education. *BMC Health Services Research*, *24*(1), 885. https://doi.org/10.1186/s12913-024-11365-6

Panadero, E., & Alonso-Tapia, J. (2014). How do students self-regulate? Review of Zimmerman's cyclical model of self-regulated learning. *Anales de Psicología*, *30*(2), 450–462. https://doi.org/10.6018/analesps.30.2.167221

Pintrich, P. R. (2002). The role of metacognitive knowledge in learning, teaching, and assessing. *Theory Into Practice*, *41*(4), 219–225. https://doi.org/10.1207/s15430421tip4104_3

Sandars, J. (2010). Pause 2 Learn: Developing self-regulated learning. *Medical Education*, *44*(11), 1122–1123. https://doi.org/10.1111/j.1365-2923.2010.03885.x

Sandars, 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

Wilson, I., Cowin, L. S., Johnson, M., & Young, H. (2013). Professional identity in medical students: Pedagogical challenges to medical education. *Teaching and Learning in Medicine*, *25*(4), 369–373. https://doi.org/10.1080/10401334.2013.827968

Wong, A., & Trollope-Kumar, K. (2014). Reflections: An inquiry into medical students' professional identity formation. *Medical Education*, *48*(5), 489–501. https://doi.org/10.1111/medu.12384

Zheng, B., & Sun, T. (2025). Self-regulated learning and learning outcomes in undergraduate and graduate medical education: A meta-analysis. *Evaluation & the Health Professions*, *48*(4), 430–450. https://doi.org/10.1177/01632787241288849

Zimmerman, B. J. (1986). Becoming a self-regulated learner: Which are the key subprocesses? *Contemporary Educational Psychology*, *11*(4), 307–313. https://doi.org/10.1016/0361-476X(86)90027-5

Zimmerman, B. J., & Moylan, A. R. (2009). Self-regulation: Where metacognition and motivation intersect. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), *Handbook of metacognition in education* (pp. 299–315). Routledge.

CRediT Author Statement

Processing and editing: Editora Ibero-Americana de Educação

Proofreading, formatting, normalization and translation

Revista on line de Política e Gestão Educacional (RPGE), Araraquara, v. 29, n. esp. 4, e025105, 2025.   e-ISSN: 1519-9029

10.22633/rpge.v29iesp4.20776

17