2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC

Host Sponsor UNC Charlotte

Paper ID #50736

Understanding AI Support Needs in High School Robotics Education (RTP)

Mr. Sanjeev M Kavale, Arizona State University

Sanjeev Kavale completed his PhD in Engineering Education Systems and Design (EESD) at Arizona State University (ASU). Prior to his Ph.D., he worked as an assistant professor in the School of Mechanical Engineering at KLE Technological University, India. His research interests are mindsets and their applicability in engineering, outcomes-based education, and problem / project-based learning.

Dr. Medha Dalal, Arizona State University

Medha Dalal, Ph.D., is an Associate Director of Scholarly Initiatives and Assistant Research Professor of Engineering Education Systems & Design within the Ira A. Fulton Schools of Engineering at Arizona State University. Her career as an engineering educator and researcher focuses on addressing complex engineering education challenges by building capacity for stakeholders at the grassroots, while also informing policy. Specifically, her research seeks to transform and democratize engineering education by exploring ways of thinking, identifying effective professional development approaches, and uncovering pedagogical techniques that enhance students' engineering curiosity, engagement, and learning.

Understanding AI Support Needs in High School Robotics Education (RTP)

Abstract

This research-to-practice paper examines how high school robotics teachers and AI tool developers conceptualize the use of AI in supporting teaching and learning. Robotics education at the high school level can support problem-solving and creativity, thereby contributing to students' interest in engineering. However, integrating robotics into classroom instruction presents instructional design challenges. As artificial intelligence becomes more visible in educational technologies, it is necessary to examine how key stakeholders interpret its role in robotics learning environments. The study was guided by the research question focused on stakeholders' views of AI's role in high school robotics education. Data were collected through three focus group discussions centered on an AI tool under development for integration with the XRP robot kit. Participants included fifteen high school robotics teachers across three groups and two AI tool developers who participated in all discussions. Transcripts were analyzed using inductive coding, followed by thematic clustering. Findings indicate that participants viewed AI as a tool for enhancing instructional design through support for curriculum development, project ideation, and access to credible learning resources. AI was also described as a real-time learning assistant that could aid debugging, scaffold problem solving, and respond to robotics-specific technical demands. Participants further noted AI's potential to reduce teacher workload through administrative support, automated assessment, and personalized feedback. At the same time, they stressed the need to develop students' critical AI literacy and responsible use practices. These findings offer early insights to inform the design of AI tools that are aligned with robotics instruction and classroom needs.

Introduction:

Artificial intelligence (AI) is rapidly becoming an inseparable part of daily life. Few fields remain untouched by AI and machine learning, and education is no exception. AI has significant potential to transform teaching and learning processes [1]. Numerous studies have examined both the benefits and challenges of integrating AI in education, and several reviews have synthesized its overall impact [2], [3], [4].

Although AI adoption initially gained prominence in engineering and technology education, its influence has now expanded across a wide range of university-level disciplines. However, beyond a handful of studies exploring its use in high school education [2], the integration of AI into high school STEM contexts remains limited. Within this domain, applications of AI in high school robotics education are even scarcer.

Robotics education at the K–12 level has gained significant momentum in recent years, supported by government policies and funding opportunities [5]. By providing hands-on STEM exposure, fostering critical thinking, and creating pathways to engineering careers, robotics serves as an early gateway for engaging with emerging technologies [6], [7]. With the rapid rise of AI, policymakers in the United States have also begun emphasizing its integration into schools. For instance, the current administration issued an executive order in 2025 to advance AI education for American youth, followed by federal guidance encouraging schools to use AI responsibly for tasks such as tutoring, personalized learning, and career advising [8]. Many U.S. states have begun issuing guidance related to the use of AI in K–12 education [9]. Globally, UNESCO has stressed the importance of human-centered and equitable approaches to AI in education [10], [11]. Together, these developments highlight the growing recognition of AI and robotics as essential components of modern STEM education. Integrating AI appropriately into robotics education offers unique opportunities such as assisting with real-time problem-solving, providing adaptive feedback, and supporting automation and critical thinking skills among students.

To address this gap, the e4usa+FIRST Phase II project initiated efforts to implement AI in high school robotics curricula. The e4usa+FIRST program has steadily advanced in creating classroom models and accessible resources to broaden participation in engineering [12]. Teachers have engaged with multiple blended models, including curricular, extracurricular, co-curricular, sequential curricular, and concurrent curricular models offering flexibility across diverse school contexts [12], [13]. One of the program's most significant outcomes has been its impact on access: enabling more schools, teachers, and students to participate in engineering and robotics education [14].

A notable advancement has been the development of the eXperiential Robotics Platform (XRP), an affordable, open-source classroom resource. Teachers are now able to purchase low-cost individual kits for their students. The kits are designed to perform basic tasks, require no specialised tools, and include easily 3D-printed replacement parts. Moreover, the platform offers online programming lessons through open-source software, lowering barriers for both teachers and learners.

While robotics education through this project has already made substantial progress, the emergence of AI offers new opportunities to further enhance it. Potential applications include providing timely support when teachers and students encounter hardware or software issues and assisting novice teachers and learners who may struggle to articulate technical problems. Since teachers are at the center of this initiative, understanding their requirements, together with the perspectives of developers, is essential to designing AI tools that are both relevant and practical for classroom use.

The current study addresses this need by exploring the requirements and expectations for AI tools in high school robotics education, as identified by both teachers and AI tool developers. Specifically, the research question guiding this study is:

> How do teachers and AI tool developers conceptualize the role of AI in supporting teaching and learning in high school robotics education?

This paper provides insights for teachers and administrators in high school education, as well as for developers working to implement AI in robotics education. It contributes to the ongoing conversation about how AI can support and expand opportunities in robotics learning at the high school level.

Methods:

This research study followed an inductive qualitative approach with thematic analysis. The subsequent paragraphs explain in detail the participant details, data collection methods, and data analysis procedures used.

Participants

The participants included 16 high school teachers involved in robotics education from multiple schools across the United States, along with two developers. Demographic information for the teachers and developers is presented in Table 1. Teachers represented two cohorts corresponding to the first and second years of the project. Teachers were recruited through a nationwide open call requiring an application. The same two developers participated in all three discussions. The two developers were White males who were members of the project team and educators with more than 25 years of experience teaching robotics. One developer was a retired university professor, and the other was a collaborator affiliated with a nonprofit organization.

Table 1: Participant demographic details

Teacher Sl. No	State	Years of Experience	Gender
1	AZ	20	Female
2	MD	29	Female
3	HI	17	Male
4	UT	13	Male
5	VA	24	Male
6	AZ	11	Female
7	MA	23	Male
8	MA	20+	Female
9	RI	11	Male
10	VA	10	Male
11	TN	13	Female
12	TN	30	Male
13	CA	7	Male
14	MD	22	Male
15	TN	20	Female

Data Collection

Data was collected through focus group discussions, which were part of the planned Community of Practice (CoP) sessions as a part of the project. The CoP sessions discuss various aspects of the project, including the implementation of robotics lessons, teacher feedback, and interactions among fellow teachers to build a community of robotics teachers. One such session with each cohort of teachers was utilized for the discussion on AI usage in robotics education. A total of three discussions were conducted with 6 teachers in the first discussion, belonging to cohort 1, 5 teachers and 4 teachers of cohort 2, divided into two groups in the second and third discussions. Initially, the developers began by sharing their perspectives on a potential AI tool to be integrated with XRP. Later, teachers and developers mutually discussed their opinions and perspectives about different aspects of the utilization of AI within robotics education. The discussions were conducted via Zoom meetings, which were recorded and eventually transcribed. The transcripts were cleaned and anonymized and later used for analysis.

Data analysis

The cleaned and anonymized data were analyzed using a generic inductive qualitative approach with thematic analysis. Statements from teachers and developers were coded to examine how AI was described in robotics education. The initial coding was conducted by the first author and subsequently reviewed by the second author to check for accuracy and consistency. The resulting codebook was then analyzed to identify emergent themes.

Results:

The qualitative analysis yielded 4 themes: AI-Supported Instructional Design and Delivery, Real-Time Learning and Performance Support, Differentiated Support for Teachers and Student and, Developing Critical AI Literacy and Ethical Use. Table 2 presents the emergent themes and their corresponding codes. The subsequent paragraphs discuss the themes in detail.

Table 2: Themes and codes

Theme	Code
AI-Supported Instructional Design and Delivery	Dynamic Curriculum Design Using AI
	AI-Generated Project Ideas
	AI for Research Skill Development
	Enhancing AI Accuracy through Preloaded Instructional Content
	AI Support Using Specialized Models
	AI Support for Identifying Foundational Knowledge Gaps
Real-Time Learning and Performance Support	AI-Based Performance Support
	Context-Aware AI Support for Robotics Programming
	AI-Guided Student Scaffolding
	Interactive AI Debugging via Screen Sharing
	AI Effectiveness with Informal Problem Descriptions
	Hardware-Driven AI Applications in Robotics
	Collaborative work with AI
Differentiated Support for Teachers and Student	AI-Enabled Administrative Support
	AI-Assisted Real-Time Grading with Rubrics
	Personalized Student Engagement
	Support for Non-Specialist STEM Teachers
	Infrastructure Constraints on Student AI Use
	Language Accessibility in AI Tools
	Using AI to Track Student Progress and Struggles
Developing Critical AI Literacy and Ethical Use	Evaluating AI-Generated Information
	Responsible AI Use in Student Learning
	Concerns about Student Difficulty in Using Correct Prompts
	Teaching AI Model Development

Theme 1: AI-Supported Instructional Design and Delivery

This theme describes how participants discussed the role of AI in supporting the design and delivery of robotics instruction. Teachers and developers focused on how AI could assist with curriculum planning, project design, and instructional preparation, specific to robotics content. Participants described instructional planning in robotics as involving evolving technical content and platform specific knowledge related to robotics hardware and software.

Developers described AI as a tool that could support curriculum development by drawing on current industry practices and academic sources. Rather than relying on static instructional materials, they envisioned AI systems that could help generate or adapt curricula based on approved and up-to-date sources. One developer described this expectation as follows:

> "… Imagine if we could use the tool to pull from industry content, like the chips, models, software, and tools that are developing all the time… academic research papers and social media… We could have an AI tool that allows us to develop custom curriculums… set the parameters and say, here's what I'm interested in teaching… a sort of dynamic curriculum generation."

Teachers similarly discussed AI as a support for instructional planning. Generating project ideas that emphasize specific programming concepts or robot behaviors can be useful. These descriptions focused on aligning projects with targeted learning goals rather than automating instruction. As one teacher explained:

> "… Can we have it develop what kind of project I might come up with that would emphasize these particular commands or this part of the programming… different projects that would emphasize these particular themes or types of code… trying to get a certain command about the distance you drive or the turn."

Participants also described AI as a tool that could identify foundational knowledge gaps within the curriculum. Developers noted that experienced instructors may assume prior knowledge when teaching. However, students who are novice learners may not be aware of missing prerequisites. The potential of AI tools to identify related concepts that support understanding of programming, particularly control logic and/or hardware behavior, was also discussed. Teachers also suggested using AI for information seeking rather than for content generation, such as locating credible sources for research or developing background knowledge.

Additionally, developers discussed the need for AI to provide contextually accurate responses. This was discussed within the context of the XRP robot kit, which a generic AI tool may not be able to help with. Participants discussed preloading AI systems with instructional materials and user guides so that the AI tool's responses are closely aligned with the XRP. Building on this, developers also discussed the provision of different AI models within a single system to support the distinct needs of teachers and students.

In summary, this theme explains developers' and teachers' perspectives on how AI tool can support instructional design and delivery in robotics education, specifically attending to context-relevant responses.

Theme 2: Real-Time Learning and Performance Support

This theme explains participants' perspectives on how AI can provide real-time support for learning by just-in-time assistance. Teachers and developers explained the use of AI tools for just-in-time assistance with coding, testing, and troubleshooting the robotic systems.

Developers highlighted the immediate technical assistance for programming and electronics-related tasks. They emphasized the usefulness of AI tools, which can act as an expert to detect syntax errors, debug code, and suggest corrective actions while students are actively working with the robotic kits. A developer expressed this perspective in the following quote.

> "…These tools can debug coding syntax and give you suggestions… like having a technical expert on your desk…"

Teachers echoed this perspective by sharing how the AI tools can support multiple students simultaneously while providing highly individualized feedback, which is challenging for a single teacher. AI tools were seen as a supplement to the instructor in providing quick guidance and feedback to students when troubleshooting robotic systems. Teachers also discussed how AI tools can provide only hints, not exact answers, thereby promoting critical thinking among students. Such guided scaffolding could help maintain students' interest and agency and support learners' independent progress. One teacher explained this expectation:

> "… Here's a hint, not the answer… there's an error on this line… if there was an AI overlay that would say why… why do we have a semicolon there or a comma… something that would integrate the why of the Python… here's a video that explains what the run feature is…"

Developers added to this perspective by sharing how AI tools can be effective at interpreting informal or imprecise language and translating it into meaningful technical guidance. This functionality of AI tools could be very useful for students without technical expertise.

Participants also discussed AI as a collaborative tool during project-based and exploratory activities. Teachers discussed using AI in creative or research-related tasks, such as exploring future applications of robotics or co-developing ideas. One teacher said:

> "… I integrate AI in side projects where students explore the future of robotics… writing a co essay kind of thing where you and the AI write together… using it in a researchy way, spot checking code… making sure they are not completely doing it with the AI, but working alongside it…"

These discussions not only place the AI tool as a just-in-time support system but also as a collaborator that can support exploration and reflection. Developers echoed this perspective by describing AI capabilities such as screen-based debugging and interpreting user actions within programming interfaces, such as reading code or visual programming blocks, to support real-time collaboration between users and AI systems.

In a nutshell, this theme explains participants' perspectives on the potential of AI tools as a real-time learning and support system in robotics education, offering technical assistance, guided scaffolding, and collaborative engagement experiences for students.

Theme 3: Differentiated support for Teachers and Students

This theme explains participants' perspectives on how AI tools can provide differentiated and unique support to teachers and students that extends beyond instructional assistance. Discussions within this theme highlighted the value of AI in addressing constraints on time, expertise, and access in high school robotics settings.

Teachers come across a significant administrative burden when it comes to project-based instruction, such as project planning, grading, and logistical and organizational tasks. Developers noted that AI tools can help teachers streamline routine administrative tasks, allowing them to focus more on supporting student learning. As one of the developers noted:

> "… There are lots of administrative functions, especially in project-based learning… are there ways we could streamline some of those tasks to make your lives easier…"

Participants also highlighted the significance of AI tools in supporting teachers who are novices to the field of robotics and programming. Developers and teachers both agreed on the challenges an inexperienced teacher faces, particularly during instruction within robotics education. AI was perceived as a resource that can aid teachers to get up to speed quickly by assisting with debugging and providing just-in-time guidance, as explained by the developer

> "…There are a lot of people teaching STEM who may not have experience with programming or robotics… it's hard to get help in the moment when questions come up… that's where some of these tools come in…"

Teachers described the potential of AI tools to track student activity data, such as repeated attempts, error patterns, and navigation paths, to identify learning struggles and inform instructional decisions. These forms of support were described as especially relevant in classrooms where students work at different paces or focus on different technical roles within teams.

At the same time, teachers also noted the practical challenges of integrating AI into the educational system. Teachers noted that these challenges may stem from school-issued devices such as locked Chromebooks, the school's policies on internet and AI use, and more. As a result, teachers shared the view that AI tools can be more beneficial to teachers in the immediate future, until policies are established for student use in classrooms. As one teacher explained:

> "… My students have Chromebooks that are incredibly locked down… the reality of students using tools like this anytime soon is limited… it feels more realistic as a tool for the teacher…"

Overall, this theme reflects participant descriptions of AI as a flexible support system that can be tailored to different roles and constraints within high school robotics education. Participants emphasized AI's potential to support teachers' capacity, reduce administrative load, and provide differentiated insight into student progress within existing infrastructural limitations, along with its potential for direct instructional support.

Theme 4: Developing Critical AI Literacy and Ethical Use

This theme somewhat deviates from earlier perspectives on how AI tools can benefit teachers and students. Teachers also expressed concerns about AI integration within the education system. They felt that as AI tools become more prevalent, students need guidance on accessing AI, evaluating AI outputs, using AI ethically, and understanding its limitations. AI literacy was framed as an instructional priority rather than as an assumed skill.

One key aspect discussed by the participants was the need for students to critically evaluate the AI-generated information. While these tools, for the most part, provide accurate information and useful guidance, there is a chance they can hallucinate and generate incorrect information. Participants emphasized the need for student learning on AI output evaluation:

> "…Sometimes the advice you get is really good… but sometimes these tools hallucinate… students could learn how to use the tool successfully by not assuming the answer is 100 percent right, but figuring out what's right and what's wrong…"

Teachers also discussed the ethical dimensions of AI use in classroom settings. They described the issues related to plagiarism and inappropriate reliance on AI tools. Instead of discouraging the use of AI tools, teachers stressed the need to explicitly teach students how to use AI responsibly and transparently.

> "Some of the students do need to start learning how to use AI… but we also have to teach them about the plagiarism side… students cheating using AI tools… we're going to have to teach them how to use it correctly…"

Participants alternatively emphasized the need for students to learn the concepts independently before attempting to use AI in their learning. In addition, teachers expressed interest in helping students understand how AI models are developed and applied, particularly within robotics contexts. While these ideas were described as aspirational, they reflected a broader desire to move students beyond surface-level AI use toward a deeper understanding of how such tools function.

In summary, this theme explained participants' perspectives on critical AI literacy as an essential, orthogonal aspect of how AI tools can benefit both students and teachers. These aspects can become crucial for the effective use of the AI tools being developed.

Discussion and Conclusion

This study examined how high school robotics teachers and AI tool developers perceive AI integration in robotics education. Across the findings, a consistent pattern emerged. Participants positioned AI as a support system rather than a replacement for instruction or expertise. AI's value was described in relation to the practical constraints that shape high school robotics classrooms, including limited instructional time, uneven teacher expertise, and the technical complexity of robotics platforms.

A central insight from this study is the importance of context specificity in AI-supported robotics education. Prior work has established the role of AI in supporting instructional design, assessment, and feedback across educational settings [15], [16], [17]. However, participants repeatedly emphasized that general-purpose AI tools are often insufficient for robotics contexts. Teachers and developers noted that the usefulness of AI outputs depends heavily on alignment with specific hardware, programming environments, and user interfaces. Without such contextual grounding, AI-generated responses were described as less accurate and less actionable. This finding aligns with emerging work highlighting the need for context-aware AI systems [18], [19], [20], [21], while also underscoring the limited availability of such tools within robotics education.

Participants also highlighted the relevance of just-in-time teaching and learning within robotics education. Providing guidance during task performance is a well-established instructional approach [22]. Yet teachers described significant challenges in sustaining such support in classrooms where students work simultaneously on complex and varied projects. In this study, AI tools were described as having the potential to extend just-in-time support by offering assistance during active project work, particularly when instructor availability is limited. Importantly, AI was framed as a means of supplementing instructional support during moments when timely intervention is difficult to provide consistently through traditional teaching practices.

Findings also underscore the importance of critical AI literacy in robotics education. Teachers expressed concerns regarding student overreliance on AI tools, difficulty formulating effective questions, and ethical issues such as plagiarism and attribution. These concerns suggest that effective AI integration requires explicit instruction in how AI tools function, how their outputs should be evaluated, and how they should be used responsibly.

Taken together, these findings suggest several implications for the design of AI tools in high school robotics education. AI tools should be developed as context-aware systems that are aligned with specific hardware platforms, programming environments, and classroom workflows, rather than as generic support tools. They should prioritize usability and immediacy to support learning during active project work, particularly in settings where teachers cannot provide continuous individual assistance. In addition, AI tools should be designed to complement teacher roles by supporting instruction and decision-making without replacing teachers' professional judgment about instructional choices and student learning.

Results indicate the necessity and the possibility of a deeper study. Future studies can include a more detailed needs analysis with teachers and students, who form another important end-user group of the AI tools. Studies particularly focusing on ethnographic approach while the students are utilizing the AI tools can provide deeper understanding on how these tools are being utilized and what are the subtle requirements of AI within robotics education.

This study has several limitations. Teachers represented a range of experience levels with AI, which shaped the perspectives shared during discussions. In addition, this study focused on perceived requirements rather than classroom implementation. Future work should examine how AI-supported tools are used by teachers and students during robotics instruction and how these tools influence teaching practices and learning experiences over time. The findings from this study informed the design of an AI-enabled extension to the XRP robotics platform, illustrating how stakeholder-identified requirements can guide tool development. Ongoing testing will examine how such integrations are used in practice and how they align with classroom needs.

In summary, this study contributes a stakeholder-grounded perspective on AI integration in high school robotics education. The findings indicate that effective AI tools must be context aware, support instruction and performance without displacing teacher roles, and be accompanied by explicit attention to responsible use and AI literacy. Together, these considerations highlight the importance of designing AI tools that respond to the realities of robotics classrooms rather than relying on generic approaches to AI in education.

Acknowledgement

This material is based upon work primarily supported by the National Science Foundation (NSF) under Award Number EEC-2435175. Any opinions, findings, and conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect those of the NSF.

References

[1] A. Harry and S. Sayudin, "Role of AI in Education," *Injurity*, vol. 2, no. 3, pp. 260–268, Mar. 2023, doi: 10.58631/injurity.v2i3.52.

[2] A. I. Akhmetova, D. M. Sovetkanova, L. K. Komekbayeva, A. E. Abdrakhmanov, D. Yessenuly, and O. S. Serikova, "A systematic review of artificial intelligence in high school STEM education research," *EURASIA J Math Sci Tech Ed*, vol. 21, no. 4, p. em2623, Apr. 2025, doi: 10.29333/ejmste/16222.

[3] X. Liu and B. Zhong, "A systematic review on how educators teach AI in K-12 education," *Educational Research Review*, vol. 45, p. 100642, Nov. 2024, doi: 10.1016/j.edurev.2024.100642.

[4] W. Xu and F. Ouyang, "The application of AI technologies in STEM education: a systematic review from 2011 to 2021," *IJ STEM Ed*, vol. 9, no. 1, p. 59, Sept. 2022, doi: 10.1186/s40594-022-00377-5.

[5] Y. Zhang, R. Luo, Y. Zhu, and Y. Yin, "Educational Robots Improve K-12 Students' Computational Thinking and STEM Attitudes: Systematic Review," *Journal of Educational Computing Research*, vol. 59, no. 7, pp. 1450–1481, Dec. 2021, doi: 10.1177/0735633121994070.

[6] F. B. V. Benitti, “Exploring the educational potential of robotics in schools: A systematic review,” *Computers & Education*, vol. 58, no. 3, pp. 978–988, Apr. 2012, doi: 10.1016/j.compedu.2011.10.006.

[7] A. Eguchi, “Robotics as a learning tool for educational transformation.,” in *Proceeding of 4th international workshop teaching robotics, teaching with robotics & 5th international conference robotics in education*, Padova (Italy), 2014, pp. 1–6.

[8] The White House, *Advancing artificial intelligence education for American youth*. 2025. Accessed: Dec. 20, 2025. [Online]. Available: https://www.whitehouse.gov/presidential-actions/2025/04/advancing-artificial-intelligence-education-for-american-youth/

[9] A. Prothero and J. Vilcarino, “How School Districts Are Crafting AI Policy on the Fly,” *EducationWeek*, Oct. 20, 2025. Accessed: Dec. 20, 2025. [Online]. Available: https://www.edweek.org/technology/how-school-districts-are-crafting-ai-policy-on-the-fly/2025/10

[10] *Guidance for generative AI in education and research*. UNESCO, 2023. doi: 10.54675/EWZM9535.

[11] UNESCO, “Recommendation on the Ethics of Artificial Intelligence,” SHS/BIO/REC-AIETHICS/2021, 2021. Accessed: Dec. 20, 2025. [Online]. Available: https://unesdoc.unesco.org/ark:/48223/pf0000380455

[12] M. Dalal, A. Iqbal, and A. R. Carberry, “Blended Implementation of Existing Precollege Engineering Programs: Teacher Perspectives of Program Impact,” *IEEE Trans. Educ.*, vol. 67, no. 3, pp. 364–376, June 2024, doi: 10.1109/TE.2023.3338610.

[13] M. Dalal, J. Wu, and A. Iqbal, “Overcoming challenges in robotics education: Examining teacher facilitators and barriers.,” in *Proceedings of the Research in Engineering Education Symposium*, Johor Bahru, Malaysia, Sep 29-Oct 3.

[14] J. Wu and M. Dalal, “High School Students’ Perspectives on Pre-college Engineering Education Courses (Fundamental),” in *2024 ASEE Annual Conference & Exposition Proceedings*, Portland, Oregon: ASEE Conferences, June 2024, p. 47527. doi: 10.18260/1-2--47527.

[15] W. Holmes, M. Bialik, and C. Fadel, *Artificial intelligence in education: promises and implications for teaching and learning*. Boston, MA: The Center for Curriculum Redesign, 2019.

[16] W. Holmes and R. Luckin, *Intelligence unleashed: an argument for AI in education*. London: Pearson : UCL Knowledge Lab, 2016.

[17] O. Zawacki-Richter, V. I. Marín, M. Bond, and F. Gouverneur, “Systematic review of research on artificial intelligence applications in higher education – where are the educators?,” *Int J Educ Technol High Educ*, vol. 16, no. 1, p. 39, Dec. 2019, doi: 10.1186/s41239-019-0171-0.

[18] R. Caruana, Y. Lou, J. Gehrke, P. Koch, M. Sturm, and N. Elhadad, “Intelligible Models for HealthCare: Predicting Pneumonia Risk and Hospital 30-day Readmission,” in *Proceedings of the 21th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, Sydney NSW Australia: ACM, Aug. 2015, pp. 1721–1730. doi: 10.1145/2783258.2788613.

[19] E. Horvitz, “Principles of mixed-initiative user interfaces,” in *Proceedings of the SIGCHI conference on Human factors in computing systems the CHI is the limit - CHI ’99*, Pittsburgh, Pennsylvania, United States: ACM Press, 1999, pp. 159–166. doi: 10.1145/302979.303030.

[20] A. K. Dey, “Understanding and Using Context,” *Personal and Ubiquitous Computing*, vol. 5, no. 1, pp. 4–7, Feb. 2001, doi: 10.1007/s007790170019.

[21] V. Aleven, I. Roll, B. M. McLAREN, and K. R. Koedinger, “Automated, Unobtrusive, Action-by-Action Assessment of Self-Regulation During Learning With an Intelligent

Tutoring System," *Educational Psychologist*, vol. 45, no. 4, pp. 224–233, Oct. 2010, doi: 10.1080/00461520.2010.517740.

[22] S. P. Simkins, *Just in Time Teaching: Across the Disciplines, and Across the Academy*. Milton: Taylor & Francis Group, 2009.