ENSURING EQUITABLE AI ADOPTION IN EDUCATION: AN INITIAL FRAMEWORK AND PROPOSED NEXT STEPS

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Introduction
The MITRE Corporation and Oak Ridge Associated Universities (ORAU) have partnered on a project to research the topic of Artificial Intelligence (AI) in education.

Both not-for-profit companies bring extensive expertise from diverse perspectives to this important topic. To better understand the real-world needs of and implications for AI in education, the ORAU/MITRE team held focus groups and a webinar to identify issues pertinent to teachers and administrators in schools. Additionally, the team evaluated current academic research and media coverage about this topic, especially around equity issues.

This paper describes activities and findings related to AI in education and shines a light on ethical and equity issues to inform a new framework to guide teacher and administrators in their decision-making with regards to AI-based educational technologies. The paper first introduces the topic of AI in education, then provides a review of literature, findings from focus group and webinar activities, and concludes with a summary of findings, discussion, and next steps for the ORAU/MITRE team to consider.

AI presents opportunities to enhance or even transform various aspects of education by supporting stakeholders in the K-12 education community. However, there are examples of AI adoption that have produced unintended and unanticipated outcomes. Two such examples are the AI surveillance tool, Appearance Search, meant to increase school safety but negatively impacted student privacy (Heilweil, 2020), and the effort by the Massachusetts Institute of Technology (MIT) to use an algorithm to optimize the Boston school system’s bell time and bus routes to address equity issues which led to parent protests (Crockford & Ito, 2017; Ito, 2018). Without objective ways to establish confidence in equitable outcomes of AI in Education (AIEd), AI adoption may be considered too risky and result in many of its potential benefits not being realized.

This paper focuses on equitable AI; AI that can be individualized, adaptable, and fair to all students. Equity in education means giving each student “access to the resources they need to learn and thrive;”; equity is adaptable, individual-focused, and fair (Waterford, 2020). “Equity recognizes that each person has different circumstances and allocates the exact resources and opportunities needed to reach an equal outcome” (The George Washington University, 2020).

While similar, equity is not the same as equality. Equality means “giving everyone the same resources,” in other words, equality is generic and group-focused (Waterford, 2020). Thought Leaders (2021) defined equality as “treating every student the same,” and equity as “making sure every student has the support they need to be successful” (see Figure 1). For example, in the case of computer labs, an equality-oriented solution would offer the same number of computers and hours of operation across all labs, while an equity-based solution would provide extra machines and longer hours in certain neighborhoods where students may not have access to computers or internet at home (Just Health Action, 2010).

To successfully address equity in AIEd tools and technologies, issues of bias must be addressed. Bias is not uncommon in AI. Technologies and training data look at the world as it is, not as it should be, and this introduces cultural biases (Krishnamurthy, 2019; Resnick, 2019). In computer science and mathematics, GIGO (garbage in, garbage out) means the quality of output from a system or AI is determined by the quality of input data (TechTarget, n.d.). If the input data are biased, then those same biases will be translated into the algorithm and return faulty results. Training datasets, human error, deleted “irrelevant” data, sparse data, historical or social inequities, and other examples contribute to bias in AI (Manyika et al., 2019). The biases appear in many forms, including input bias, algorithmic bias, selection bias, sample bias, and societal bias, to name a few. Input bias, as described in GIGO, refers to the data that are put into the system. Input bias can be exacerbated and “baked in” to the algorithm through feedback loops that learn from the training data and inject that information back into the system to allow the algorithm to continue learning (Krishnamurthy, 2019). This feedback loop can lead to algorithmic bias, which is unfairness built into the algorithm that is being used to predict an outcome.

Algorithm bias is developed, in part, by selection and sample bias. These are similar concepts in that bias is perpetuated based on the variables that are selected (or ignored) or the sample population is over- or under-represented (Chaney et al., 2018; Ghoineim, 2019; Manyika et al., 2019). For example, a Microsoft AI-based chatbot that was released on Twitter began replying to people with “highly offensive and racist messages” because it had been trained on anonymous public data (Nouri, 2021). Facial recognition “benchmark” datasets were based predominantly on male and

Figure 1. Illustration depicting the similarities and differences between equality and equity illustration. Interaction Institute for Social Change, Artist: Angus Maguire
light-skinned individuals, or made from celebrity images—two sample sets that do not represent the global population (Boghani, 2016). Societal bias is based on societal and cultural norms, stereotypes, or assumptions that make their way into the algorithms without the developers recognizing their own biases and reflect social intolerance or institutional discrimination (Ghoneim, 2019; Krishnamurthy, 2019; Lexalytics, 2021; Nouri, 2021).

To capture the opportunities and challenges involved with integrating AI into education, especially those involving equitable outcomes for students and schools across districts, we gathered and synthesized perspectives from a broad range of education stakeholders, including teachers, principals, scholars, and district administrators. The findings in this paper are based on a series of focus groups, a webinar, and literature from magazine and journal articles, and government and news reports. By exploring steps that can be taken early in the exploration and evaluation of AI opportunities that engage stakeholders (e.g., participatory design) real-world problems and feasible solutions can be documented and explored. This paper provides initial input into a framework for schools and districts to evaluate their current or future AI tools for equitable outcomes.

Literature Review for AI in Education

A literature search via internet, scholarly databases, government websites, and news articles was conducted to discover relevant articles on AI use in education and the views of stakeholders. Literature from academic, government, and industry sources focused predominantly on:

- Rule-based applications and machine learning (ML)–based tools in classrooms and schools
- Bias in AIEd tools
- New markets and companies designing, developing, and distributing AIEd tools
- Impact of AIEd tools on students, parents, teachers, and other stakeholders

Studies on AI in Education

Current studies of AI in education focus on AI interactions with humans, approaches to development, and ethics content. One study by Cheriton School of Computer Science found that humor in an AI tool helps to increase effort and motivation for students, and that the greatest increase in effort was seen when the humor style of the AI tool matched the humor style of the student (Ceha et al., 2021). At Carnegie Mellon University, researchers are experimenting with sensors that record and evaluate the position of students’ body postures in class as a measure of engagement, using that to generate feedback to professors on their teaching style (Mattson, 2019). Proactive and reactive approaches that go beyond self-reports of student engagement have been studied. Proactive approaches include building in gamification, emotional design, and educational games, while reactive approaches focus on auto detecting engagement and making dynamic adjustments to motivate and encourage (D’Mello, 2021). Proactive approaches are in use today, but reactive approaches are the target of future AIEd tools and require far more research and development (Smakman et al., 2021).

Teachers’ attitudes towards social robots in education uncovered mixed perspectives. For instance, Kennedy et al. (2016) surveyed the general public and education professionals concerning social robots in schools noting a generally cautious attitude and concerns about social skills for the robots. Kim and Lee (2015) found that 140 elementary school teachers held negative attitudes towards robots in education. Reich-Stiebert and Eyssel (2016) reported that German school teachers held negative attitudes toward robots and were concerned about classroom disruptions, increased workloads, and impacts on interpersonal relationships. Serholt et al. (2014) discovered that teachers’ concerns were related to the fairness of access, robustness of the robot, and disruption of other classroom activities. Smakman et al. (2021) conducted an exploratory study of attitudes across multiple stakeholders identifying teachers as having the greatest concern about the trustworthiness of robots as well as data sharing. For teachers without access to social robots, they noted concerns that they may be distracting, may add to teacher workloads, may negatively impact interpersonal relationships, and may exacerbate social isolation, yet they do not consider robots as a replacement for their labor (Belpaeme & Tanaka, 2021). While there is promise for social robots in education, there are also technical and logistical challenges. One of the toughest technical challenges is artificial social interaction—a challenge in AI and robotics generally. Logistically, there are time-intensive resource demands to create content, and there is no guarantee that approaches will work across grade levels and groups, from pre-K to adult learners (Belpaeme et al., 2018).

AIEd development and adoption pros and cons were highlighted in a number of resources. Positive attributes of AIEd tools are that they save teachers’ time, increase global access to education (Balaganur, 2019), and provide basic competence (Schiff, 2021). However, AIEd falls prey to failing those it is intended to serve (Marachi & Quill, 2020) by using bad data, with sparse student information, and having problems such as assessing prior and ongoing learning, placing students in appropriate subjects levels, or individualizing instruction. The AI cannot account for environmental factors, such as student experiences, that may affect student achievement. For students with low achievement records, the algorithm might assign a bad instruction set, which may hinder a student’s growth (Balaganur, 2019). Marachi and Quill (2020) argue that AIEd tools are often defined based on the simplest things to measure. Michael J. Jordan, researcher in AI and ML, noted that AI systems are showing “human-level competence in low-level pattern recognition skills, but at the cognitive level they are merely imitating human intelligence” (Pretz, 2021). Finally, AIEd tools are also seen to possess unidentified feedback loops, such as in admissions decisions, that limit diversity (Lecher & Varner, 2021; Pangburn, 2019).
At use in a limited number of classrooms are robots with human-like features, such as faces, voices, and movement attributes. These “social robots” are more advanced AIEd tools that can be used to teach and enthuse students, performing some of the same functions as teachers in the classroom (Belpaeme et al., 2018). However, these social robots tend to work best with younger learners because older learners, especially those in junior high and up, want an interactive engagement with the social robot, a feat which is not yet achievable but is in the research and development stage.

Bias in AIEd Tools

Many authors mentioned bias in the data as a major concern. Most big datasets generated by ML-powered systems are biased (Baker, 2021; Buolamwini, 2018; Krishnamurthy, 2019; Williams et al., 2018). For example, Amazon’s AI tool to screen applicants, trained on employee data, was found to unfairly penalize women because men hold the majority of technical job roles in society today (Dastin, 2018). In 2011, Google’s search results for “girls,” no matter their race or ethnicity, would return results related to sexual gratification, while results for “doctor” returned with predominantly white male images. By 2016, Google had modified the algorithm, providing clear evidence of attention to bias in their search results (Noble, 2018). To address bias in AI tools, developers have been called upon to explicitly control for bias (Herold, 2017a) and demonstrate that they intentionally took steps to look for, and mitigate, bias in their designs (Walker, 2018). Despite this call to action, students in AI training programs receive little instruction on identifying bias or exploring how to uncover and repair the issues in algorithms. One study indicated that instruction on, and discussion of, ethics was only included in 12% of technical AI training programs and frequently focused only on privacy and bias in a general way (Garrett et al., 2020).

While bias is not intentionally built into technology tools, it can be subtly introduced through flaws and bias in the input data; bias that is present in current and historical media, books, and news articles (Rauf, 2019, 2020); algorithmic bias (Baker, 2021); and even bias in design decisions, to name a few.

New Markets and Companies Designing, Developing, and Distributing AIEd Tools

There are many new markets and new companies in the AIEd arena. Blumenstyk (2021) questioned the motives of private companies when it comes to a public service, writing that “boom times means ‘does it work’ is missing from development.” There are new end-user markets such as e-learning, language-learning apps, and informal learning/brain-training games. New platforms also exist for online K-12/university degrees, Learning Management Systems, and new technologies in education (e.g. virtual reality) (Grand View Research, 2021; Private Equity List, 2021). These new markets and platforms create room for new companies in the industry, such as Outschool, MasterClass, Course Hero, Varsity Tutors, and Skillshare (Paykamian, 2021), as well as new roles for companies and individuals.
Market Makers and Evidence Intermediaries are two new types of companies and individual jobs that have become more popular in the educational technology (EdTech) field (Grand View Research, 2021). Market Makers are companies, or individual brokers, that assess the market value of EdTech and focus on stimulating market growth (Bloomenthal, 2021; Grand View Research, 2021; Research and Markets, 2020; Warrior Trading, n.d.). Evidence Intermediaries, such as Guild, Knowledge Alliance, and Nepris, are companies that educate teachers, leaders, and procurement professionals about EdTech (American Youth Policy Forum, 2017; Fisher, 2018; McKenzie, 2018; McLaughlin, 2016; Tech & Learning, 2019; Williamson, 2021). Private capital is being invested into EdTech development from such companies and philanthropic entities as the Bill & Melinda Gates Foundation, the Chan-Zuckerberg Initiative, New Harbor Capital, Altich Capital Partners, TechAmmer, and 500 Startups (Herold, 2017b, 2019; New Harbor Capital, n.d.; Private Equity List, 2021; Wan, 2021).

With the amount of capital injected into the industry, there is concern that the focus of companies and developers will shift from customer service (meeting the goals of the customer, in this case educators) to sales to increase profits at the expense of tool performance and capability. Blumenstyk (2021) stated that while there is a lot of investment in the tools, unfortunately, there is not parallel investment in technology infrastructure or resources or training of educational staff. With growth of the EdTech industry (Grand View Research, 2021; Paykamian, 2021), attention to equity in the AIEd tools may fall by the wayside in the interest of rapid development to recuperate investment dollars (Herold, 2017b).

**Impact of AIEd Tools on Students, Parents, Teachers, and Other Stakeholders**

Apprehension about the impact of AIEd tools is both personal and socio-political in nature. The concerns focus on creativity, diversity, social interaction, self-concept, inferiority, transparency, and trust. From a personal viewpoint, AIEd tools are seen to detract from creativity and diversity due to mass standardization (Schiff, 2021), damaging students’ ability for social interaction (Rauf, 2020), and negatively affecting learners’ self-concepts (J. R. Young, 2020). From a socio-political perspective, the fears expressed include perpetuating inequality by “cheaper but inferior educational systems” (Rauf, 2020), lacking transparency (the ability for users to understand what the machine is doing), and the potential for private investments to dictate political agendas with their AIEd tools (Herold, 2017b). One final, broader concern is that the public may over trust an AIEd system and view it as “more fair” and ignore the subjective elements of education admissions, student recruitment, or student success (Pangburn, 2019). People are more apt to over trust technology if an expert or authority says it is trustworthy, or if an AI tool performs in a way that meets their expectations (Rotner et al., 2020).

**Focus Groups and Webinar**

The MITRE Corporation and Oak Ridge Associated Universities (ORAU) created a strategic partnership to advance the U.S. science, technology, and management agenda. The not-for-profit organizations are working together with ORAU’s network of schools and universities to gather information from educators on the use of AI technologies in education to help inform the future of AI research. ORAU and MITRE conducted two, two-hour focus groups at the end of May 2021. These focus groups included educators in a variety of roles within public education, including classroom teachers, school administrators, district administrators, and a state-level official. The information from these focus groups was analyzed and used to inform a webinar that was held on June 23, 2021. This webinar included five panelists with varying roles and backgrounds in education, including a superintendent, former educators, university professors, and data scientists. The goal of this webinar was to take a deeper dive and explore existing AIEd technologies and new concepts that could be leveraged to develop and prioritize AI adoption strategies at the local, state, and federal levels. The overall objective of these focus groups and webinar is to inform a framework for future research and adoption of equitable AI technologies in education.

**Key Demand Signals for AI Adoption in Education**

Throughout the course of the of the focus groups and discussion with the webinar panelists, clear demand signals for using AIEd began to emerge. A demand signal is a notification a supplier receives that goods are required (Bartholomew, 2006) or that a market audience is ready for new developments or in a “sweet spot” (Miller, 2020). In this context, a demand signal for AI in education indicates that there is a need for, or an issue within, education that AI can be utilized to address. In the case of AI in education, six clear demand signals for teacher tasks have emerged:
The first demand signal, time, is a precious commodity for everyone. This statement is doubly true for educators who must wear a hundred different hats at any given point during a typical school day. As one educator explained during the focus group, “Time is a huge constraint. Teachers don’t have ample planning time, so a tool that helps them meet content to each student would be helpful... Allow the teacher to be the guide but to use real-time data to make professional decisions.” This sentiment was echoed by others in the focus group with further examples given as to how AI tools could help make impactful decisions in the classroom, such as determining which portions of the content need to be covered in greater depth and which resources are the best to use for a given unit and why, along with providing the opportunity to cover more material.

No student learns or performs identically to another student. For the vast majority of those who took an education course in college, this is likely not a new statement. When lesson plans are created, it must be indicated how the plan will be individualized or differentiated for students at different levels of learning. Sometimes, this can be difficult depending on the lesson. According to a teacher in one of the focus groups, it would be beneficial for AI to help “create individualized curriculum materials that fit the needs of a diverse student population to help students grow both academically and personally.” Other participants in the same focus group concurred and one even noted that this would be especially beneficial for AI to help students at different levels of learning. Sometimes, this can be difficult depending on the lesson. According to a teacher in one of the focus groups, it would be beneficial for AI to help "create individualized curriculum materials that fit the needs of a diverse student population to help students grow both academically and personally." Other participants in the same focus group concurred and one even noted that this would be especially beneficial for AI to help students at different levels of learning.

The third demand signal, vertical alignment, is a need that was expressed through all levels of educator participants. In education, vertical alignment refers to the aligning of curriculum so that its content difficulty increases from low to high throughout a student’s educational journey. In discussing vertical alignment it was suggested that AI has the potential to help teachers avoid starting over each year at ‘square one’ with students. AI can be utilized to follow students through each grade level, ensuring that all curricula are aligned among teachers and grade levels. This way, the same subjects contain consistent content rather than skipping or rushing through it. AI could support easy creation of curriculum maps and other documents that ensure the curriculum is operating together in a coordinated, linear fashion rather than in silos (Luckin et al., n.d.). Also, this can help create more cross-curricular connections to keep students engaged.

Along with vertical alignment, another demand signal that emerged was the necessity for individual systems to communicate with each other (Marachi & Quill, 2020). Interoperability is having "multiple systems sharing a language or a framework for language that is designed to help them function together as a whole to improve usability and/or security" (Konopelko & Clark, 2020). One of the frustrations expressed by educators was the lack of interoperability between tools and systems within schools. One participant indicated that “there is currently no easy or straightforward way to streamline processes.” Rather, there are various tools that are individually used for a singular purpose. The frustration comes from the amount of time it takes to transition between tools for different uses, the static nature or lack of flexibility some tools have with regard to how they are and can be used (e.g., some grading tools do not support standards-based grading or rubrics). Not only do instructors want more interconnected, comprehensive, and flexible tools, students do as well. The focus group participants were exasperated because there is no uniformity in AlEd tool usage in schools. For example, one teacher in a school may use one specific tool, while another teacher in the same school uses a completely different tool for the same course. While AI may not be able to solve these problems, this frustration is apparent and should be considered by developers as something to address. Interoperability allows teachers and students to focus on the content rather than the system, thus freeing them “to work with students individually, address their social-emotional needs, and differentiate or personalize instruction” (Konopelko & Clark, 2020).

A fifth demand signal, an increased focus on ensuring academic integrity, was especially timely given the shift to virtual learning that occurred due to the COVID-19 pandemic. Many educators noted the difficulty of ensuring academic integrity among students during virtual learning. Even when homework is given and students are completing work outside the classroom, it is difficult to ensure integrity in the moment. Educators in the focus groups expressed the sentiment that technology has exacerbated the issue of academic integrity, but that AI could potentially be used to detect student cheating in the moment and respond to students by asking for evidence—or issuing background warnings when possible cheating is detected. There were 39 different comments made on this issue of academic integrity, and the sheer number of comments led to this demand signal emerging. One such comment alluded to having the “ability to detect if a cell phone or other electronic device is being used” when completing work. Other comments by the focus group participants included wanting a responsive, real-time AI tool and using a lockdown browser or lockdown software when completing work.
The final demand signal concerns student motivation and engagement. As most teachers can attest, some students may not engage with the content at all, while others may only engage enough to satisfy the minimum requirements for passing a class. A student who is engaged is primed to learn (D’Mello, 2021). For some educators, a method of tracking student engagement in real-time would be helpful to make on-the-spot instructional decisions during a class, while other educators desire ways to gauge student strengths and knowledge quickly before teaching a unit to adjust how much time is spent on the unit. D’Mello (2021) described two ways to address student engagement using AI tools, a proactive approach in which engagement by the student is built into the system and is a necessary part of tool usage, and a reactive approach in which the tool responds to student engagement “in the moment” as the tool is being used. D’Mello also pointed out that the preferences of youth change so rapidly that instruction needs to be innovated in a way to maintain engagement, which is an aspect that AI could help.

Key Barriers to AI Adoption in Education

The discussion among the panelists in the webinar held on June 23 resulted in the emergence of three important constructs for the optimal utilization of AI in education: literacy, applicability, and functionality. Literacy refers to the understanding and knowledge of technology users—in this case, educators and students—in the tools they are using to achieve the greatest benefit. Applicability refers to ensuring that the correct tool for a given purpose is selected and utilized to maximize the benefits of technological support. Functionality for any technological tool simply means that the tool performs as intended and provides the desired result. Interestingly, the key barriers to successful AI implementation that emerged during the focus groups with educators can fall mostly within the three constructs that emerged from the webinar.

In the focus groups, there was concern regarding several dimensions of tool literacy that could impact implementation of AI in education. First, people generally suffer a fear of the unknown. In education settings, schools and teachers create their own cultures that involve consistency and known quantities. Introducing a new tool to teachers usually creates some hesitancy due to fear of the unknown and because the tool is not part of the school’s established culture. Second, teachers are incredibly overworked. Some of the focus group participants indicated that there is simply too much curriculum to cover with not enough time left for much else, including the time to learn something new. Some teachers indicated that they simply do not have the time to become well-versed in using a new tool. Finally, educators need to be comfortable with using a tool to create buy-in among students and their parents. This is an issue because some instructors are more tech-savvy than others. Combined with the fear of the unknown, some teachers may not be willing or able to create the large-scale buy-in that is needed for the successful adoption of a new tool. Tool literacy is an even harder demand to meet for those that may already be struggling in a classroom due to language, technology fluency, and innate learning style barriers.

In the focus groups, teachers expressed their concern that AI tools may act as a replacement for human teachers, and they expressed confusion about the applicability of tools. AI performance and teacher performance need to be clearly delineated for some educators to be comfortable in applying AI tools to their schools and classrooms. Additionally, there was concern that the use of AI, while adaptive, may not be able to account for the full range of student ideas and experiences due to the wide variability in students. Finally, educators expressed concerns about the very nature of technology itself. With continued advances in technology and its ever-changing nature, some educators questioned whether AI tools could be successfully used in education if changes occur so rapidly that there is no longevity or scalability with a particular tool and its application to a particular task. The participants indicated that rapid development may result in short-term, limited relevance and become just another education tool that falls to the wayside.

Any type of technology tool must be able to continually and consistently function as intended to maintain viability. One of the biggest grievances among the educators in the focus groups was that, currently, many standalone educational tools do not work on all devices, and that some education software is device specific. Similarly, these tools do not generally work together. In order for a new AIEd tool to have full functionality for educators, it must have several capabilities:

1. **Device Agnostic**
   - Work across all devices in its intended use context

2. **Usable**
   - Remain user-friendly and simple to use

3. **Offline Functionality**
   - Full capability to work off-line or off a shared network when outside of a school

4. **Non-Distracting**
   - Intuitive capability to keep students from simply being distracted

While not necessarily a goal, educators in the focus groups expressed that there is not currently a single tool with the desired capabilities, nor is there one that meets all their functionality needs as an educator.

While most barriers to successful implementation of AI in education fall within the three constructs that emerged during the webinar (literacy, applicability, and functionality), there are two other barriers that fall outside this scope but are just as important when considering implementation. Perceptions are major barriers in the adoption of new technology. According to one of the educators in the focus group, there are many families who may shun certain
types of technologies and may see technology as an intrusion into their lives, leading to a reduction in privacy. Another barrier that must be addressed when implementing AI in education is the existence of current inequities and disparities in schools, among students, and between families. Inequity in resources and technology among schools and students is a constant issue in education that has yet to be fully addressed and mitigated. Consideration of current inequities, access issues, as well as those that may be amplified by the introduction of AI, must be addressed for an AI tool to be successful.

**AI Adoption in Education – Recommendations**

For AI adoption in education to occur, there needs to be a larger focus on tools, techniques, and procedures that can facilitate broad stakeholder engagement and participatory design and reduce barriers to adoption. Findings from the June 23 webinar and follow-on discussions indicate that solutions for reducing these barriers could include focusing on education and empowerment, clear communication, inclusive development teams, teacher engagement, and collective decision making.

Focusing on educating and empowering stakeholders (teachers, administrators, developers, researchers) is critical (Corry & Milman, 2019; von Davier, 2018). Topics of discussion for empowering stakeholders should include the interface between researchers and educational systems, the usefulness and corruptibility of technologies and mitigations (Schiff, 2021), and learning about algorithm bias and transparency (Marachi & Quill, 2020). Teachers need training on collecting and using data in the classroom (Corry & Milman, 2019). School systems need to learn how to evaluate AIEd technologies (Luckin et al., n.d.). Finally, getting the technologies in front of the teachers to allow them to “play” with them and learn how they can work with the tools they already have before procurement could reduce interconnectivity issues (Rauf, 2019).

In terms of clear communication, administrators need to be open about their procurement decisions and the rationale behind the adoption of selected tools (Schiff, 2021). Administrators and school superintendents should discuss the goals of any technologies being considered to get buy-in from the community (e.g., parents, teachers) prior to implementation (Ito, 2018). School systems should also interface with the vendors to uncover the research behind products as well as ask the question of how the system tracks and uses the data it collects (Simmers, 2021; von Davier, 2018). Lastly, ethics and equity should be open and ongoing components of goal setting and decision making (Herold, 2017b).

Research into AIEd technologies should be expanded to include a more diverse selection of stakeholders as part of the development team. Research teams should include teachers in their research design and engage them early and often to ensure that the classroom environment and its goals are included (Schiff, 2021). Additionally, university programs in computer science and AIEd technology development must consider societal impact statements (Hutson, 2021).

Developers need to engage with classroom teachers more frequently to ensure their products help teachers in real-world environments and that the material to be taught works well with the technology to increase the tool’s usefulness (Roschelle et al., 2020; Wang, 2021). AIEd companies should create explicit policies concerning the inclusion of ethics and equity in their tools (Roschelle et al., 2020). These companies should also generate future designs using an equity lens to ensure that all learners are being served (Perry & Turner Lee, 2019)—a point echoed by one of the webinar panelists. Additionally, the global AIEd field should shift the ITS-based tools toward an evolution that amplifies or augments human intelligence and expands the range of learning scenarios embedded within AIEd tools to increase equity for all learners (Baker, n.d.; Molenaar, 2021; Roschelle et al., 2021).

Finally, educators, administrators, and school systems should collectively discuss the goals of AIEd tools in their schools. School systems should develop a plan for AI use for education to help guide purchasing decisions. Likewise, they should establish an evaluation system for products to reduce monetary waste by procuring tools that do not fit the needs of their teachers or students (Ayoub, 2020; Seymour, 2021) including the demographics and learning needs of the populations they serve. Also, similar to the issues of clear communication mentioned above, vendors need to be transparent about the research that was used to develop their tools as well as share details of their data-acquisition policies and practices. This information must be included in the discussions and evaluations in order to make a sound decision that meets the needs of the school and the students.

**Future Ideas and Activities**

While the vision of AIEd technology is to empower educators (Schiff, 2021) by including, rather than replacing, teachers and developing new tools and analytics to improve the practice of teaching, AIEd technology also aspires to offer classroom analytics via dashboards (Dillenbourg, 2021), address the lack of teachers globally (Herold, 2017b), and deliver personalized education to students (Ayoub, 2020).

The potential benefits of AIEd tools include improving student assessments by using just-in-time assessments and allowing students to see how their learning is progressing in real time. Psychology and neuroscience can be leveraged to develop the tools and activities to encourage brain health and development (Luckin et al., n.d.). ITSs promise to assist teachers with classroom management and orchestration, and reengage and motivate students (Luckin et al., n.d.; Timms, 2016).
AIEd tool developers can also take their cues from other fields to improve education both inside and outside of the classroom. These projected uses include managing operations, facilities, and transportation; individualizing learning (Davis, 2020); and capturing attention, differentiating instruction, and identifying instructional opportunities (Timms, 2016).

While schools procure and deploy AIEd tools in the classroom and for school administration, stakeholders need a framework to guide decisions along the full lifecycle of AIEd technologies—from evaluation to procurement to deployment to retirement. Such a framework should address the issues raised in this report as well as those from literature, industry, and stakeholders. Ethics and equity issues are of great concern when it comes to AIEd. These issues have been highlighted in recent articles describing admissions biases in New York City’s use of AI for high schools admissions (Lecher & Varner, 2021); parent protests when Boston schools used AI to create a more equitable bus and start schedule (Crockford & Itô, 2017; Itô, 2018); equitable availability of transportation with Columbus, Ohio’s purchase of routing software to address its shortage of bus drivers (Widman Neese, 2021); data tracking and privacy from Mason, Ohio’s use of algorithms to identify students who may do self-harm (Roth, 2021); or biases against poorer students precipitating the United Kingdom’s decision to stop using a grading algorithm (Porter, 2020).

Based on the information shared in this report, a framework that helps stakeholders evaluate AIEd technologies requires development with input from all stakeholder groups: teachers, administrators, parents, students, researchers, and policy makers.

**Proposed Next Steps for ORAU/MITRE Partnership**

ORAU and MITRE should continue their partnership on equitable AI adoption in education. The proposed next steps focus on future research, public engagement, and public-private partnerships (PPPs). These next steps include:

- **Develop and host workshops** that introduce teachers to specific AIEd tools to increase familiarity and practice. Through ORAU’s K-12 programs, the ORAU/MITRE team should develop workshops on AIEd tools and topics. Making technologies available to teachers will encourage a discussion on how the tools work, how the tools may benefit the teachers and students (or not), and how the tools could be implemented in their classrooms. Making a connection with AIEd tools on a personal level will enhance the familiarity, comfort, and contributions to both research and development.

- **Explicitly address ethics and equity** in existing AIEd technologies. Through public-private partnerships and research-practitioner partnerships, the ORAU/MITRE team is focusing on developing a framework to evaluate equitable outcomes in AIEd technologies. Working with development teams that are diverse and focused on equity and implementing participatory design techniques will support a framework for procurement and implementation of AIEd relevant tools that avoid creating or amplifying existing disparities.

- **Develop “boots on the ground” case studies** of AIEd technologies that are successful as well as those that are not successful in the classroom environment. In line with white papers, case studies will illuminate different real-world issues that are faced by teachers when attempting to implement AIEd tools in their classrooms. One of the webinar expert panelists mentioned that there is the perspective that some research endeavors into K-12 tend to focus on affluent, suburban schools while not taking into account schools with large minority populations or those in urban centers within a district. To ensure inclusion, efforts should be made to focus on more urban and minority settings when conducting further research and case studies on the classroom use of AI. Such case studies will highlight both issues and mitigation.

- **Seek out private development companies to engage as R&D partners.** Public-private partnerships bring a depth of insight and funding to any R&D venture. Given the discrepancy between the focus group information and the literature findings, there is ample opportunity to develop such partnerships with a goal to develop an AI framework that meet the needs of teachers and students. Such partnerships can lend themselves to policy examination and development to assist school districts with their purchasing decisions by providing a useful guide or framework.

- **Secure funding to carry out field research and training** on the use of AIEd tools in the classroom environment. Such funding could come from government or private sector sources. Funding should be pursued through grants in association with ORAU’s university partners and school districts. Through such funding, pilot studies may be performed using developed or developing tools, especially those that our university partners are exploring. In the private sector, the ORAU/MITRE team should investigate funding from the big tech companies such as Facebook and Microsoft who are investing in educational technologies and seeking to influence the educational agenda of the future.

- **Work with ORAU’s University consortium members to increase AIEd research** that includes teachers from diverse backgrounds and in diverse settings, as part of research teams. It will be critical to ensure that teachers and school administrators are part of grant teams and have an active, critical role to play, not just in name only. Research at all levels and from all vantage points is necessary. As documented in the literature cited in this report, ethics and equity are key topics that have not been given adequate attention but are critical elements to building effective and useful AIEd technologies.

- **Attend and present at selected conferences** to learn about developments in educational technology tools. Conferences such as the ASU-GSV Summit, the EdTech World Forum, the International Conference on Educational Technology and Learning Innovation, the International Society for Technology in Education, the AAAI/ACM Conference on AI, Ethics, and Society, and the Artificial Intelligence in Education Conference offer opportunities, domestically and internationally, to investigate what is happening, to share what we learn, and to identify potential partners for future research and development.
Conclusion and Summary

This report has highlighted teacher perspectives on the pros and cons of AIEd tools, as well as educators’ needs and desires for future AIEd tools and implementation scenarios. The education field is ripe with data. School districts need to be aware of how these data are being used, stored, and monetized and that companies comply with student data use guidelines. AIEd tools are being developed predominantly to save teachers time and help students with their learning through ITSs, but that level of integration is only the tip of the iceberg in terms of potential. Even with ITSs and dashboards meant to help students and teachers, these tools are often purchased, implemented, and abandoned because they do not meet teachers’ needs, they do not integrate with their texts, or the learning curve is so great that it is easier to simply use what is known to work. According to the Jefferson Education Exchange, schools in the U.S. spend $13 billion every year on educational technology tools (The MITRE Corporation, 2019).

In addition to the large sums of money U.S. schools spend on AIEd tools, investors are also pouring money into the educational technology market. In 2018, the Chan-Zuckerberg Initiative and the Bill & Melinda Gates Foundation announced their partnership to address AI in education (Chan Zuckerberg Initiative, 2017; Herold, 2019). In 2020, educational technology companies invested $2.2 billion in venture and private-equity capital, this follows the 2019 investment of $1.7 billion (Private Equity List, 2021; Wan, 2021). New capital is also being invested in education-focused special purpose acquisition companies, which are formed strictly to raise capital, through an initial public offering, to acquire a company (Blumenstyk, 2021; Young & Anderson, 2020). While there is considerable opportunity for AIEd technologies given this much investment, there are also significant unanswered questions of ethics, equity, usability, and transparency for schools who will be using these tools.

Both the focus groups and the reviewed literature recognized what AIEd tools are currently being used for and what the needs and desires are for AIEd technologies. The literature focused most prominently on developer-side patterns of technology development, the lack of usefulness to teachers or in the classroom, the vision of future AIEd technologies, possible pitfalls, and ethical and equity issues. Our team identified seven specific recommendations for the ORAU/MITRE team to address going forward on the topics of focus groups, workshops, ethics and equity, case studies, funding, AIEd research, and conferences. Moving forward, the ORAU/MITRE team will develop an AI framework around equity in existing, and possibly future, AIEd tools.
REFERENCES


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Roth, A. (2021). Schools look to algorithms to flag students who may harm themselves. NPR. https://www.npr.org/2021/03/03/973198164/schools-look-to-algorithms-to-flag-students-who-may-harm-themselves


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