

UR AI Horizons Transdisciplinary Institute

AI for Education White Paper

Preface

The AI for Education Working Group was given the charge to explore the implications of GenAI for education, spanning from applications of GenAI to enhance learning and teaching in various contexts to what it would take to prepare everyone for a future where AI is increasingly used in everyday life as well as the workplace. To make our task more manageable, early on we decided to focus on the following complementary themes - while recognizing that there are overlap and synergies among them:

1. Innovating teaching and learning with GenAI Leveraging GenAI to create tools/agents and learning experiences that can support, or even transform, the learning of ANY content.	2. Developing AI literacy Supporting effective learning about AI and its implications so as to ensure safe and ethical as well as effective uses of AI by everyone.
3. Rethinking workforce preparation in the age of GenAI Identifying how current programs preparing for specific occupations will need to change, once GenAI can perform what used to be core functions of that occupation.	4. Improving educators' productivity and well-being Exploring how GenAI might impact workplace practices as well as professional identities for educators in various roles, and what should be done to prepare educators for these changes.

For each of these themes, we held a two-hour in-person meeting to share and discuss:

1. Team members' related projects/initiatives, which could provide a foundation and/or inspiration for future work.
2. Key research questions that could be pursued.
3. New ideas for possible transdisciplinary projects - and their potential funding sources.

Agendas and detailed notes of these sessions can be found in these documents:

- 1. [Developing AI Literacy](#) (10/04/24)
- 2. [Innovating Teaching & Learning with GenAI](#) (9/19/24)
- 3. [Rethinking Workforce Preparation in the Age of GenAI](#) (10/11/24)

- 4. [Improving Educators' Productivity and Wellbeing with GenAI](#) (10/17/24)

This white paper summarizes the insights gained from these meetings along with the results of a preliminary literature review, as well as elaborations and reflections by the co-chairs of this Working Group. For each of these themes, we will start with a brief description of the theme and related current literature, then share a few selected examples of related UR recent projects (to provide some shared images as well as a sense of what we can build on), following them with an articulation of key framing questions to guide future research, and concluding with new ideas for possible collaborative projects generated so far by the Working Group.

As appendices, we have first included tables with information about an initial list of external and internal funding sources that we have identified as worth investigating to support work at the intersection of AI and education. A second appendix identifies the individuals that so far have participated in this Working Group and provides selected information about their backgrounds and interests (as a complement to the project-wide [Online Introductions](#)).

While reading on, there are a few considerations to keep in mind, as they have guided and informed much of our conversations:

- We want to keep in mind both “sinking the boat” and “missing the boat” risks when it comes to using GenAI in education - that is, when evaluating specific applications of AI we want to take into consideration both the opportunities they may offer, and the negative consequences they may cause along with ways to manage them.
- The benefits and risks of using GenAI in any educational applications will greatly depend on HOW specific GenAI tools are used - not just the tools themselves; our interest has been mostly on exploring uses of GenAI as an “assistant” to humans to enable them to do a better job, rather than a “replacement” for human functions.
- Using AI effectively and ethically will involve more than just learning how to use some tools or even developing an understanding of how AI works; rather, it is likely to lead to new practices and call for new mindsets.
- As our goal is to empower humans to make the most of AI, we want to assume a human-centered approach for applications of AI to education and try to maximize outcomes by leveraging what humans and AI can each do best.

1. Innovating Teaching and Learning with GenAI

Leveraging GenAI to innovate teaching and learning is the first thing that comes to mind when thinking about how GenAI may impact the field of education - and indeed the creation and use of AI tools and agents to support student learning across a variety of contents and instructional contexts is what has received the most attention so far within the literature about applications of AI and Education (often referred to as AI&ED for short). This has included examples and recommendations about how to best leverage AI in the design of more effective and inclusive learning experiences (e.g., Ali et al., 2024; Ayyildiz & Yilmaz, 2023; Beauchamp & Walkington, 2024; Chen et al., 2023; Henriksen et al., 2023) or assessments (e.g., Sparks, 2024; Tang et al., 2024), surveys about uses of AI in instruction by students and teachers (e.g., Digital Education Council, 2024; Imagine Learning, 2024), identifying potential obstacles to the use of AI in K-12 instruction (e.g., Woodruff et al., 2023; Xie et al., 2023), and most notably discussions about what may count as “cheating” when using AI for schoolwork and how it could be prevented (e.g., Adams et al., 2023; Forsyth et al., 2021).

Indeed, we believe that AI - and GenAI in particular - have tremendous potential to support learning in unique, and sometimes even transformative, ways. However, to fully realize this potential it is important to keep in mind that not all uses of AI to support learning are equally valuable. When considering applications of GenAI to support teaching and learning, it will be important to take into consideration more general frameworks about the integration of technology in instruction such as T-PACK (Mishra & Koehler, 2006), SAMR (Romrell et al., 2014) and PIC-RAT (Kimmons et al., 2020) that identify complementary ways in which tech tools can be used to support learning, along with their potential benefits and limitations. The PIC-RAT framework can be especially useful, as it identifies alternative uses of technology in instruction along two dimensions:

- *How technology is used:* whether it is to REPLACE (R) current tasks and practices with little change, AMPLIFY (A) current tasks and practices with new functionalities, or TRANSFORM (T) what students could previously do.
- *How students engage in the technology-supported learning activity:* whether they are PASSIVE (as when watching a video), INTERACTIVE (when they actively engage with the content and/or other students), or CREATIVE (when they are asked to create something new or tackle a problem they have not encountered before).

We should strive to design applications of GenAI to teaching and learning that take into consideration what we know about how people learn best from research in the learning sciences. In particular, we will want to build on the research-based principles from Self-Determination Theory to ensure that students want to engage in the GenAI-supported

learning activities we create – which will involve ensuring that students are offered some choices and control so they can feel some *autonomy*, providing opportunities for success that address their need to experience *competence*, and ensuring that they feel part of a learning community so they can satisfy their need for *belonging/relatedness*. We will also need to consider the value for students to actively engage in learning activities that allow them to construct new meaning and knowledge, often as the result of challenging some of their preconceptions, as well as working with others to benefit from different perspectives and complementary expertise – as suggested by constructivist theories of learning. It will also be important to leverage the potential of GenAI to personalize learning.

As it is the case for all educational innovations, if we want GenAI to be truly impactful in instruction, it will also be important to understand what may help or hinder the adoption of GenAI-powered solutions, informed by relevant theories about the diffusion of innovations. Two theories may be especially helpful in this regard. The first is Rogers’s classic Diffusion of Innovation theory, which categorizes people’s willingness to try new solutions as follows: innovators (the first to want to adopt new solutions), early adopters, early majority, late majority, and laggards (who will avoid the innovation as much as possible) (Halton, 2023). The second is the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), which suggest that the following factors will influence people’s willingness to adopt new solutions: performance expectancy (i.e., how beneficial the new solution is expected to be); effort expectancy (i.e., what they expect it will take to use it); social influence (i.e., potential impact of social expectations and pressures); and, facilitating conditions (i.e., the presence of what may help or hinder its use).

When it comes to supporting teachers’ adoptions of new teaching practices involving GenAI more specifically, it is also important to leverage what we know from research on teacher education in this regard. Since using GenAI will likely call for new practices and mindsets, some of which may challenge key elements of a teacher’s professional identity, principles from research on identity development may be important to consider. In particular, based on Gee’s work (Gee, 2001), Luehmann (2007) has argued for the value of providing teachers with opportunities for *participation* in the new proposed practices, along with *recognition* of this participation by self and others through reflections, sharing and feedback. In the case of GenAI-related innovations, one early form of participation should involve authentic “experiences as users of GenAI” to help them personally appreciate the power and limitations of GenAI - as this presents many parallels with the “experiences as learners” recommended in the teacher education literature (Borasi & Fonzi, 2002).

While research in this area is already underway, we believe that the UR can make significant contributions to it because of collaborations already in place between some of its computer science and education researchers, bringing to the table multiple disciplinary perspectives and

theoretical frameworks which are still rare - as illustrated by the projects reported in the box below.

“Innovating Teaching & Learning with GenAI” - Selected examples of recent UR projects
(* indicates members of the AI Horizons planning grant team)

GroupIt – Cultivating Scientific Mindsets in the Machine Learning Era (NSF RETTL - EAGER; award #2225227 (Team: *Bai-Hajim/GIDS, M.Daley-Warne, *Borasi-Warner/GIDS, *Luo-Hajim) - This project developed and field-tested an ML-powered learning environment to support data-driven high school students’ scientific inquiries. Key research questions informing this project are: (1) how can we develop accessible ML-supported scientific inquiry learning experiences for K-12 students and teachers with limited CS/ML knowledge? (2) how can ML support K-12 teachers and students to conduct data-driven scientific inquiry for STEM learning? (3) how can we support K-12 teachers in creating ML-supported scientific inquiry learning activities?

AI-Child Collaborative Reasoning Project (AIC2OR) (GIDS Seed Grant) (Team: *Bai-Hajim/GIDS; *Wang-Hajim/GIDS; He-Hajim/GIDS, Rosengren-BCS/Psy; Heck -Psy) -This project aims to develop a computational framework rooted in theory to create argumentation-driven conversational agents powered by large language models (LLMs) for fostering dialogic learning in children. Current key areas include socio-emotional development and relational reasoning in biology education.

Supporting parent-child interaction in ASL (Pump Primer II) (Team: *Bai-Hajim/GIDS; *Spann-Hajim/GIDS, *Li-Hajim/GIDS, Hall - URM, Kurumada-BSC) - This project aims to develop AI-mediated tools that assist hearing parents in using American Sign Language(ASL) to interact with their Deaf and Hard-of-Hearing (DHH) children. The project utilizes large language model (LLM) for real-time language translation and personalized assistance to mitigate communication barriers between hearing and DHH individuals - by reducing deep learning curve for ASL, high cognitive load as well as bridging different communication modalities.

Communication training with human-like conversation agent (Masum Hasan’s dissertation study - in progress) This project focuses on using generative AI to create virtual communication agents for training clinicians. These AI-driven avatars simulate complex conversations that doctors often face with patients, such as discussing difficult medical diagnoses or treatments. The system not only engages in a back-and-forth dialogue with clinicians but also analyzes their responses, body language, and facial expressions to provide feedback, helping clinicians improve their communication skills. The project leverages large language models (LLMs) to create general-purpose conversation agents that can simulate a wide range of scenarios, moving beyond the limitations of traditional single-purpose training systems. Future developments aim to fine-tune the AI for more nuanced human-like conversations and expand its capabilities, such as incorporating cultural contexts and emotion-based interactions.

Simon’s “Virtual TA” initiative (internal funding) (Team: *Lovett-Simon; *Keating-Simon; *Comstock + other Simon faculty and staff) - The Simon School of Business has adapted and is piloting in a few of their courses an LLM-powered Virtual TA that can be customized for each course to respond to

students' inquiries about assignments as well as specific content covered in the course, keeping track of and reporting anonymously the inquiries made so the instructor can also benefit from this information to improve the course design and delivery.

Framing questions for research:

Building on lessons learned from the projects listed above and an analysis of the existing literature, as well as conversations that took place in our meetings, we have identified an initial set of questions worth exploring in future research projects - as summarized in the box below, and articulated in more detail in what follows.

"Innovating Teaching & Learning with GenAI" - Initial Framing Questions:

1. *How could/should specific GenAI tools be leveraged to create more effective multimodal instructional materials?*
2. *What new kinds of learning experiences could/should GenAI make possible/accessible?*
3. *How can we create AI agents that best support learning of specific content/skills?*
4. *How do we need to rethink assessment if students can use GenAI tools?*
5. *How can we prepare teachers/instructors to make best instructional uses of GenAI?*

Framing questions' elaboration

1. How could/should specific GenAI tools be leveraged to create more effective multimodal instructional materials?

Research suggests that multi-modal instructional materials can be more effective for all students (Brisk, 2014), but would be especially valuable to provide greater access and success for English Language Learners (ELLs) (King, 2021; Long, 2005; Lee, 2021) and students with certain kinds of disabilities. While so far creating such materials was too time-consuming and difficult for individual teachers/instructors to do, GenAI capabilities for generating multi-modal materials now makes it more accessible - both through *general* GenAI tools such as ChatGPT or Copilot, and *specialized* tools such as Magic School and Diffit, which make the creation of instructional materials for teachers even easier, requiring very minimal prompting and making it possible to choose among several ready-made templates. However, we need to learn more about the benefits, challenges and drawbacks of this kind of AI-supported instructional materials for

students, as well as what it would take to empower teachers to create and/or use these materials well.

2. *What new kinds of learning experiences could/should GenAI make possible/accessible?*

While multimodal instructional materials can be very effective for conveying information, GenAI applications may also allow to design other kinds of learning experiences to learn specific concepts and/or skills in ways that could not even be conceived before - for example, enabling students to engage in realistic simulations to learn complex skills such as how to perform a certain type of surgery, providing the opportunity to ask questions about course requirements and content as and when needed by using “Virtual TAs”, or providing AI agents that can act as individual tutors. To get full benefits of this potential of GenAI for instruction it will be important, though, to pay attention to both setting worthwhile learning goals and leveraging what we know about how people learn best from research in the learning sciences - as articulated in the introduction to this theme. In particular, it will be valuable to explore the potential of GenAI to personalize learning - that is, adapting materials and tasks to the knowledge, learning preferences, and/or learning needs of individual learner - and what it would take to realize this potential in ways that are accessible to most teachers/instructors. Work in this area could especially benefit from collaborations between education and AI researchers, as educators are needed to envision the kinds of learning experiences we would like students to engage in, while AI developers are also essential to bring to the table what GenAI can and cannot do, as well as work at finding technical solutions and applications that push the boundary of what is currently possible.

3. *How can we create AI agents that best support learning of specific content/skills?*

While the previous questions have mostly to do with how educators and students can make the best use of existing GenAI tools, AI tool developers are also continuing to explore how they may create not just tools, but also more and more powerful AI agents that can interact with individual learners to support their learning. Research is needed in this area, and such research could benefit from focusing what may be needed and possible in specific domains. This will also need to include an identification of limitations of current LLMs and other GenAI technologies that will need to be resolved in order to make these AI agents truly useful. This is another area where collaborations between AI experts and education experts will be especially valuable.

4. *How do we need to rethink assessment if students can use GenAI tools?*

One of the first reactions to the launch of ChatGPT in the education community was the fear that now students could use it to “cheat” on assignments and exams - as GenAI-powered chatbots can indeed easily respond to simple questions, generate

credible essays in response to a prompt, and even solve math problems. At first, there was the hope of developing tools that could detect such uses of AI, but we have come to realize that there is no “silver bullet” solution to this problem (as even the most sophisticated software designed to detect AI uses have great limitations and get quickly obsolete with new fast developments of GenAI technology). Given the easy access to ChatGPT and other genAI tools by students (whether or not schools provide it), educators are now obliged to address this problem by rethinking how they assess student learning - which may actually be a good thing, as not all current assessment practices are ideal! While some teachers have reverted to in-class handwritten exams as their solution, the need to develop assessments where students cannot cheat with GenAI may actually motivate research on alternative types of assessments - especially since GenAI now provides new ways to evaluate and provide individual feedback on assignments that previously would have been too time consuming for teachers to grade (such as multiple versions of essays, or even multimedia projects).

5. How can we prepare teachers/instructors to make best instructional uses of GenAI?

While the previous questions have to do with uncovering the potential of GenAI to support learning, we are well aware that realizing this potential in instruction will require teachers/instructors willing and able to implement the new learning activities and assessments, as well as teaching practices, made possible by new GenAI tools. This will require not only learning about GenAI and some of its specific applications for instruction, but also shifting some long-held beliefs, mindsets and practices about learning, teaching and schooling, as well as becoming comfortable with integrating an ever-changing and rapidly changing set of tools to support instruction. This, in turn, calls for designing and offering appropriate professional learning opportunities for teachers/instructors, which leverage what we know from research in teacher education about what it takes to help teachers rethinking some of their beliefs as well as practices - including, among other things, “experiences as GenAI users” as well as other opportunities for *participation* and *recognition*, as discussed in the Introduction to this theme.

Initial Ideas for Possible Future Projects

The following ideas were generated and/or refined as a result of exchanges and collaborations developed from planning grant activities.

“Innovating Teaching & Learning with GenAI” - Initial Ideas for Possible Future Projects

(indicates members of the AI Horizons planning grant team)*

1. ***Studying teachers’ use of GenAI to create multimodal instructional materials and their impact on students’ learning.*** (Team: *Borasi-Warner; *Han-Warner; *Miller-Warner; *Rashid-Warner +) (Potential candidate for a 2025 NSF DRK12 grant proposal) As part of a 2023 ITEST proposal by LiDA that was declined, we proposed a set of professional learning experiences to prepare STEM teachers to make use of GenAI tools to create multi-modal instructional materials for their students. We think that this component has great potential on its own, especially if further elaborated to include research questions, and related data collection and analysis, aimed at a systematic study of the impact of these materials on different groups of students - especially ELLs and other students with special needs.
2. ***Create a “UR GenAI for Educational Innovations Lab”*** (Team: *Love-Warner, +) (would require some UR internal funding) - similar to an entrepreneurial incubator, such a structure could serve as a resource for faculty across the university interested in using GenAI to support learning in their courses.
3. ***Virtual TA enhancements and study*** (Team: *Lovett-Simon; *Comstock-Simon; *Borasi-Warner/GIDS; *He-Hajim/GIDS, +) (May be a candidate for NSF IUSE if focussing on applications to STEM UG courses, or possibly NSF RITEL if we can have a strong enough technology innovation component) The AI-powered Virtual TA already used at Simon could be adapted to other courses (especially undergraduate STEM courses in various schools) and its implementation rigorously studied to evaluate not only users’ satisfaction and impact on students’ achievement, but also how it may transform instructors’ teaching practices as well as students’ study practices and skills. We may also want to explore improvements in the AI technology used, to enable greater and easier personalization as well as the system’s continuous learning from input provided by the users. A first step is being taken with a UR IT Innovation mini-grant that was just awarded in January 2025.

2.Developing AI Literacy

With the rapid development of AI and its wide range of applications (Gil et al., 2014), there is a growing need for preparing 21st-century students with basic AI literacy (Evangelista et al., 2018).

As a driving force of the fourth industrial revolution, the advancement of AI leads to a huge skills gap for jobs of tomorrow. In the U.S. alone, AI-related jobs have increased by almost 80% between 2017 and 2018 (Squicciarini and Nachtigall, 2021). Meanwhile, AI inequality widely exists in workforce and education due to gender and race disparity - as only 22% of jobs in AI are held by women, and fewer than 6% of PhD students in AI programs are Hispanic or African (World Economic Forum, 2021, Zhang et al., 2021). If such AI inequality continues, the rapid societal AI adoption will widen the gap between rich and poor Americans as the latter have limited opportunity to develop AI skills (Gallup Optimism and Anxiety, 2018).

There are emerging efforts to introduce AI in K-12 education (Touretzky et al., 2019; Marques et al., 2020), with the main focus on extending Computer Science and Engineering curricula with AI knowledge (e.g., Kahn and Winters (2017), Sabuncuoglu (2020), and Druga (2018)). These efforts, however, require dedicated teachers with strong Computer Science content knowledge to be successful, which is lacking as more than 75% of K-12 schools in the US do not offer Computer Science (CS) curriculum (Wang et al., 2016). Recent efforts started incorporating AI learning experiences within science contexts (e.g., Zhang et al. (2019), Lin et al. (2020), Sakulkueakulsuk et al. (2018), Evangelista et al. (2018), and Zimmermann-Niefield et al. (2019)), which shed light on integrating AI and STEM education in K-12 classroom. The absence of CS curriculum in most K-12 schools often leads to students' limited programming skills - another major challenge for introducing AI literacy. This is because most emerging K-12 AI learning activities require prior programming skills, centered on block-based programming languages (e.g., code.org, MIT RAISE Playground, Machine learning for Kids). Prerequisite programming knowledge may inevitably increase AI inequality among young learners, especially those from historically underrepresented groups in STEM. For example, research finds that young children of low and median socioeconomic status (SES) tend to have a harder time understanding AI concepts than high SES peers due to lack of programming skills and experience interacting with AI technologies (Druga et al., 2019). Therefore, there is an increasing demand for introducing new learning activities and pedagogical methods to provide AI literacy highly accessible to learners with diverse computing and math backgrounds.

The related projects currently undertaken at the UR, as described in the box below, show the variety of directions that research in this area can take.

“Developing AI Literacy” - Selected Examples of Recent UR Projects

(indicates members of the AI Horizons planning grant team)*

Embodied Learning for K-12 AI Literacy (Bai’s CAREER) (NSF-CAREER, award #2238675) (Team: *Bai-Hajim/GIDS) - This project explores how to create embodied, analogical, and transformative AI learning experiences for children. Embodied cognition aids in simplifying complex computational concepts for children, enhancing their engagement and motivation. Analogical learning could bridge abstract AI concepts with learners' concrete prior knowledge. Moreover, embodied metaphors and analogies can offer a common ground that is accessible and inviting for children with diverse AI experiences. In this thread of research, we hope to provide transformative learning experiences for students to reflect on their daily interactions with AI and grow awareness of potential ethical issues as well as their inner workings. Some examples of learning environments created to achieve these goals include BeeTrap and OptiDot.

Empowering ELL students’ families to engage in AI-supported communications with school (VITAL-ELL families) (Final component of NYS VITAL program) (Team: *Miller-Warner, *Han-Warner, *Borasi-Warner/GIDS) - Creating pilot online resources to help families of English Language Learners learn to use AI tools that can help them better communicate with their children’s school in safe and effective ways.

AI-4-all course and other AI programs (unfunded university-wide committees) - Three university-wide committees have been recently launched to explore and develop plans for: (1) an AI-for-all course open to all UR undergraduate students (chaired by *Anand & Purtee); (2) courses and an MS in AI; (3) possible B.S. and Ph.D. in AI (chaired by *Kanan).

Developing STEM teachers for high-need schools to support the implementation of computer science standards (NSF-Noyce Scholarship, award #2344636) (Team: *Borasi-Warner; *Bai-Hajim; *Borys-Warner; Luehmann-Warner; Mason-RIT; *Xu-Warner). This Noyce Scholarship grant will support the preparation of STEM pre-service teachers able to implement the 2020 Computer Science and Digital Fluency standards in their courses. These pre-service teachers will take two additional courses and related practicum experiences designed to help them create opportunities to make their students appreciate the “impact of computing” – and AI in particular – in today’s world and develop the needed AI literacy. A key component of these courses will involve “learning how to learn on their own” about future technology developments, including within AI.

Framing questions for research:

Addressing the need to develop AI literacy for all will require research in a number of complementary fronts, as we have begun to identify through the “framing questions” identified in the box below and further elaborated in what follows.

“Developing AI Literacy” - Initial Framing Questions

1. *What does EVERYONE need to know about AI in order to function in today’s world?*
2. *Which approaches may be most appropriate to learn about AI? How could GenAI be leveraged to learn about AI?*
3. *How can we best prepare instructors who will be teaching about AI literacy?*

NOTE: Another relevant question - “What do people working in specific occupations need to know about AI?” - will be addressed under Theme 3.

Framing questions’ elaboration

1. What does EVERYONE need to know about AI in order to function in today’s world?

This question is especially important for K-12 schools (as they are preparing the next generation of informed citizens), although we should not forget that today’s public also needs to develop some AI literacy in order to function in a world where AI is increasingly being used in many everyday life applications. This raises the question first of all of what *everyone* needs to know about AI. This should include not only technical knowledge about how AI works, but equally (if not more) importantly what may be current limitations as well as potential risks of AI - so as to empower everyone to make safe and ethical, as well as effective, uses of AI in everyday life, and to understand broader potential implications of AI for the future of humanity. Addressing this question is made even more challenging by the reality that AI technology is advancing so rapidly - so an important component should also be how to empower everyone to “learn how to learn about AI” on their own, so as to be able to keep up with the on-going and rapid changes in this technology, as well as develop expectations and mindsets about the need of such on-going adjustments.

When developing any specific AI literacy program, it will be critical to first of all agree on the most appropriate goals, given the target population as well as specific constraints in terms of time and other elements. The existing literature for K-12 schools, as referred to in the Introduction to this theme, can provide a valuable starting point, but will need to be adapted to each specific context.

2. Which approaches may be most appropriate to learn about AI? How could GenAI be leveraged to learn about AI?

While this question may have some overlap with theme #1 (*Innovating teaching and learning with GenAI*) as well as #3 (*Rethinking workforce preparation in the age of GenAI*), the focus here will be more specifically about how we could use GenAI, as well as other instructional approaches and techniques, to support the achievement of specific learning goals about AI, among those identified in question #1. Prior work by Bai demonstrated effectiveness of embodied learning experiences in supporting young learners with limited math and computing skills to engage in critical thinking and sensemaking for AI concepts and technologies. Findings with K-12 students from marginalized communities in STEM also highlight the importance of situating learning experiences with students' daily experiences, or the so called "embedded learning". This could lead to fruitful research directions of new technologies and pedagogical strategies to gradually transfer knowledge obtained through embodied learning to everyday experiences with AI (e.g., real-world recommendation systems, GenAI technologies).

3. How can we best prepare instructors to teach AI literacy?

The previous considerations make clear that teaching AI effectively presents some unique challenges. First of all, AI instructors will need to continue to update their knowledge about the possibilities and potential impact of AI to keep up with the rapid changes in this technology. They also will need to have carefully thought about what should be the learning goals most appropriate for specific audience (as for example the learning needs and goals of younger children in school and those of older adults, who also need to develop AI literacy to function in today's society, will be quite different) and know about effective methods to teach specific AI concepts, while also taking into consideration the potential obstacles their students may be experiencing (for example, dealing with what is an acceptable use of AI and what is not). These challenges can be even greater when the people responsible to develop AI literacy programs are not necessarily AI experts - as it is likely to be the case in New York State K-12 schools, as the new Computer Science and Digital Fluency Standards expect *all* teachers across subjects to be responsible for at least some of these standards. This, in turn, calls for designing and offering quality professional learning opportunities for AI instructors at all levels, taking into consideration these specific challenges as well as the considerations articulated earlier in the Introduction to Theme 1.

Initial ideas for future collaborative projects

The following ideas were generated and/or refined as a result of exchanges and collaborations developed from planning grant activities.

“Promoting AI Literacy” - Initial ideas for future collaborative projects

(indicates members of the AI Horizons planning grant team)*

- 1. Creating opportunities to develop GenAI literacy in museums*** *(Proposal submitted to NSF AISL program) (Team: *Borasi-Warner, *Jesse-MAG, *Han-Warner, *Bai-Hajim, *He-Hajim, *Miller-Warner):* This proposal - which was developed by the team as a result of the planning grant, and submitted to NSF in January 2025 - involves creating an AI Tour agent as well as a GenAI-powered maker-space for the MAG, along with educational programming about GenAI, as a way for the public to personally experience use of GenAI and learning about it as part of their MAG visits. We especially targeted newcomer families who are English Language Learners, given GenAI capabilities for in-the-moment translations.
- 2. NSF Noyce Master Teaching Fellowship focused on the implementation of the 2020 NYS Computer Science standards*** *(could be submitted for the 2025 NSF Noyce MTF call) (Team: *Borasi-Warner/GIDS; *Borys-Warner; *Miller-Warner; Bai-Hajim/GIDS+).* While the 2020 NYS Computer Science and Digital Fluency Standards do not explicitly mention AI or any other specific technology, becoming aware of the potential and implications of AI could be considered a key element of the “Impact of Computing” standards, and learning to use AI tools effectively, safely and ethically, could be considered a key element of the “Digital Fluency” standards. As most K-12 schools do not feel prepared to meet the state’s current mandate that the Computer Science standards should be implemented at all grades and subjects by 2025, there is a clear need to support them by preparing a cadre of teacher leaders that could lead these initiatives. Part of this project should focus on how to best prepare this cadre to promote AI literacy, as well as to support their colleagues to do the same.

3.Rethinking Workforce Preparation in the Age of GenAI

Even before the launch of ChatGPT, there have been many reports predicting that AI would cause many jobs to change in the near future - but the growing capabilities and ease of use of GenAI tools have made it even more evident that a new set of working practices and expectations will be required in most *professional jobs* - starting now! Research studies, as undertaken with the support of NSF “Future of Work at the Human-technology Frontier” program (NSF, 2020) and by the “Work of the Future” group at MIT (<https://workofthefuture-taskforce.mit.edu/>) provide multiple illustrations and considerations about how AI in particular will affect the future of work for most occupations. If this is the case, it becomes imperative to question how we should prepare the workforce that is going to enter into specific fields - which includes most of our current students at the University of Rochester!

As GenAI is also providing new tools and strategies for researchers working in specific fields, it will be important to also consider the preparation of researchers in any field. GenAI may enable researchers to conduct studies that could not even be conceivable before - because they were too time-consuming, costly, and/or dangerous; at the same time, using GenAI in research may involve new risks in terms of accuracy and trustworthiness of results, as well as raise new questions about authorship, verifiability, and replicability. These questions are currently debated in each field, with no clear consensus; each field is also experimenting with possible and viable ways to use GenAI tools and applications in specific research projects. Despite all these uncertainties, future researchers need to become aware of both the potential and risks of using GenAI in their field, and develop the needed knowledge, skills and mindsets to be able to make the best use of these tools when appropriate. How to do so will present significant challenges, given the novelty and rapid advancements in GenAI technologies.

A worthwhile lens to inform research in this area is Christensen and colleagues’ theories about “disruptive technologies/innovations” (Bower & Christensen, 1995; Christensen, 1997; Christensen et al., 2018; Christensen & Raynor, 2003). Disruptive innovations are innovations (most often made possible by technology break-throughs) that dramatically impact the way an industry operates, creating new markets, expectations, and values, while also replacing and/or transforming existing practices. This model suggests that when a new technology makes it possible to develop a significantly “cheaper” solution, even if of inferior quality to the traditional one, there will be people willing to adopt that solution – especially if it makes it affordable for some new groups and if it offers some new functionalities. As the technology improves over time, the new solution gets closer in quality to the original one, while also even more affordable and with better functionalities – until a “tipping point” is reached when essentially everyone will adopt the new solution, and the old one may become obsolete or

limited to special applications (Christensen & Raynor, 2003). The development of digital cameras is often presented as a prototypical example of a disruptive technology/innovation for the field of photography. We may question whether AI could play a similar role for specific occupations, and if so, what will be the implications for preparing future workers for that occupation. At the very least, we can expect that a different set of expectations and mindset will be needed, since disruptive technologies/innovations radically change working practices and ways to operate in an industry.

The considerations made in the Introduction to Theme 1 about the dynamics of adopting innovations, and theories about diffusions of innovation (such as Roger's [Halton, 2023] and the Unified Theory of Acceptance and Use of Technology [Venkatesh et al., 2003]) in particular, also apply in this case - and should be kept in mind when designing programs and learning experiences to prepare current and future workers for specific occupations.

At the UR, we are especially well positioned to undertake interdisciplinary research in this area, as in 2020 we recognized the importance of paying attention to "future of work" issues for both research and education, and launched the "Building UR Capacity for Future of Work Cross-disciplinary Research and Education" initiative with seed-funding support from the Warner School of Education, the Goergen Institute for Data Science (GIDS) and the Ain Center for Entrepreneurship. With the explicit goals of developing internal capacity at UR to conduct multiple externally-funded cross-disciplinary research and research-based interventions around work of the future and workforce development, and to inform UR decisions about better preparing and supporting its students and alumni (both undergraduate and graduate) to new workplace realities and expectations, interdisciplinary working groups were formed at the time to explore research opportunities within the arts, humanities, optics, the climate economy, healthcare delivery and higher education, respectively. Some of these working groups were able to produce competitive grant proposals, one of which was awarded by NSF *Future of Work at the Human-Technology Frontier* program, while others (even though the grant was not awarded) led to valuable pilot studies and related publications; we showcased some of these projects in the box below. Equally important, the UR Capacity Building initiative developed some interdisciplinary collaboration and skills that we can now build on. In addition to this initiative, more recently the Simon School of Business has engaged in a rethinking of their MBA program in light of the increasing use of GenAI in the workplace and the Medical Center, in collaboration with GIDS, has launched a new M.S. program to prepare for uses of AI in healthcare (*also showcased in the box below*). When taken together, these initiatives provide a great foundation for further work more specifically focused on deriving implications for workforce development of a future of work where uses of GenAI will be ubiquitous and transformative.

“Rethinking Workforce Preparation in the Age of GenAI” - Selected examples of recent UR projects

(indicates members of the AI Horizons planning grant team)*

Toward an Ecosystem of Artificial-intelligence-powered Music Production (TEAMuP) (NSF “Future of Work at the Human-Technology Frontier”, awards #2222129) (Team: *Borasi-Warner/GIDS; *Roberts-Eastman; *Duan-Hajim/GIDS; *Hetherington-SMD/GIDS; Pardo, *Miller-Warner; *Borys-Warner; *Han-Warner; *Rashid-Warner; Brown-Eastman; Koerner-Eastman; Guerrero + Pardo from Northwestern) Among other things, this project explores what mindset and skills future musicians will need in order to make good use of AI tools in their music creation, and what implications this will have for the preparation of future musicians. The design of this project, now entering its third year, greatly benefited from the UR Capacity building initiative as well as a planning grant exploring the “artist-technologists” occupation which was also funded by the NSF Future of Work program.

Higher education student affairs staff’s perception about AI and implications for their work (UR mini-grant) (Team: *Barrett-Warner, *Borasi-Warner/GIDS, *Plate-SMD) - Following a literature review on uses of AI in higher education student affairs, UR student affairs staff in different offices and positions were interviewed to gather their knowledge and perceptions of AI as well as potential implications for their work. This study revealed that the field of student affairs is lagging behind with respect to uses of AI, while also suggesting valuable opportunities to explore applications of GenAI to support staff’s work and improve services that are currently underperforming (such as identifying students at risk, providing customized and timely information to students, advising about programs of studies and courses to take - just to mention a few). ***(*also relevant for Theme 4*)***

Simon’s Redesign of the MBA Program (internally funded) Since AI is transforming industries like banking and marketing, automating tasks and enhancing productivity, the UR Simon School of Business has redesigned their MBA curriculum to better prepare its students to enter this reality. This effort has involved infusing AI literacy, with 16 core competencies, across the curriculum and providing hands-on experiences through AI workshops and prototyping applications, among other things. Faculty are incentivized to integrate AI into their courses through mini-grants, with support from instructional designers to prepare both students and instructors for AI-driven industries.

New MS in Data Science and AI for Healthcare (internally funded) - This is a new program for healthcare professionals interested in developing knowledge and skills in AI so as to be able to develop effective applications of AI to healthcare.

Dual-track Role-based Learning for Cybersecurity Analysts and Engineers for Effective Defense Operation with Data Analytics. (AI4Cybersecurity) (NSF SaTC-EDU award #2228001 & #2228002) (Team: Yang (RIT-PI), Pelletier (RIT), *Miller-Warner, *Borasi-Warner/GIDS, *Borys-Warner) - Recognizing that recent developments in AI raise new questions and needs for effective cyber defense, a team of cybersecurity experts and educators are developing professional learning programs for cybersecurity practitioners to explore and learn how to incorporate LLMs for incident analysis through innovative learning experiences. These experiences include immersive scenarios and hands-on experiences, with an emphasis on role-playing between analysts and engineers in a team setting.

Framing questions for research:

Rethinking programs that prepare for specific occupations to respond to the changes caused by AI will require addressing a few complementary aspects, as we tried to capture in the “framing questions” identified in the box below and further elaborated in what follows.

“Rethinking Workforce Preparation in the Age of GenAI” - Initial Framing Questions

1. *What do students preparing for specific occupations need to learn about AI?*
2. *What new skills and mindsets may need to be developed, and what may become obsolete, once GenAI takes over certain existing functions in specific occupations?*
3. *How do programs need to change because of these new learning goals AND what students can do given GenAI tools/ agents?*
4. *How can we prepare instructors and other decision-makers for these new realities?*

Framing questions’ elaboration:

NOTE: Several of these questions will require distinct explorations and responses depending on the target occupation/field.

1. *What do students preparing for specific occupations need to learn about AI?*

This is a challenging question, as addressing it fully will require first of all some prediction about what kinds of AI applications and tools will be available to workers in the target occupation once they graduate - which is likely to change rapidly as a result of the speed of AI advances. This calls for occupation-specific studies to better understand how AI is currently used, as well as how it may possibly be used in the future - and these studies will require the collaboration of domain specialists (who understand well what is involved in that occupation, and what are core tasks within it) and AI experts (who know what AI currently can do, as well as what may be able to do in the near future). At the same time, especially given the rapid changes in technology, it will also be important to identify a few general principles and ethical considerations that are likely to stay constant even when specific tools may quickly become obsolete. It will also be critical to give students the expectation - as well as concrete strategies - to learn on their own about new AI tools, so they can keep up with the inevitable changes that will occur once they are in the workplace.

2. *What new skills may need to be developed, and which current contents and skills may become obsolete, once GenAI takes over certain existing functions in specific occupations?*

Once AI tools take over certain functions in a specific occupation, workers in that field will likely need to learn a new set of skills to manage those tools as well as other implications of these changes - so it will be important to identify what those new skills will be for each occupation. In addition, we can expect that a segment of workers in each field may also need to learn to work effectively (and differently) in interdisciplinary teams including tech experts; this, in turn, calls for preparing these future workers to effectively communicate with AI experts (who in most cases are not knowledgeable about the workers' own field) so as to establish productive collaborations - and we do not yet know much about what it takes to do so.

While addressing these new learning will require the addition of new units or even full courses in programs preparing future professionals in a specific field, it will also be important to examine whether there are contents and skills in current programs that are no longer needed because of the expected uses of AI in the workplace. While it will be hard to argue for any content to be taken out, this will likely be necessary to give room to new topics.

3. *How do programs need to change because of these new learning goals AND what students can do given GenAI tools/ agents?*

While answering questions #1-2 will help address this question in terms of setting new learning goals for programs preparing professions in specific fields, we also want to take into consideration insights gained from work around *Innovating teaching and learning with GenAI (Theme #1)* to leverage new types of learning experiences and supports that may be provided by applications of GenAI to instruction.

4. *How do future researchers need to be prepared for using GenAI in their field?*

GenAI is also providing new tools and strategies that may empower researchers in specific fields to conduct research studies that could not even be conceivable before - because they were too time-consuming, costly, and/or dangerous. At the same time, using GenAI in research may involve new risks in terms of accuracy and trustworthiness of results, as well as raise new questions about authorship, verifiability, and replicability. These questions are currently debated in each field, with no clear consensus; each field is also experimenting with possible and viable ways to use GenAI tools and applications in specific research projects. Despite all these uncertainties, future researchers need to become aware of both the potential and risks of using GenAI in their field, and develop the needed knowledge, skills and mindsets to be able to make the best use of these tools when appropriate. How to do so will present significant challenges, given the novelty and rapid advancements in GenAI technologies.

5. ***How can we prepare instructors and other decision-makers for these new realities?***

As the success of any program will depend in great part on the quality of its implementation, we will also need to consider what instructors in those programs will need to know about AI and its most current applications in their fields, as well as identify misconceptions and/or perceptions about AI that may impact their willingness to implement the proposed changes. Once again, principles and insights from research in teacher education - as discussed in the Introduction to Theme #1 – should be leveraged here.

Initial ideas for future collaborative projects

The following ideas were generated and/or refined as a result of exchanges and collaborations developed from planning grant activities.

“Rethinking Workforce Preparation in the Age of GenAI” - Ideas for possible future projects

(indicates members of the AI Horizons planning grant team)*

1. ***NSF training program on AI/GenAI for doctoral students across the university*** *(possible funding source: NSF training programs) (Possible team: ?*Bai, *Borasi, ?Cetin +):* We could build on lessons learned from the current NSF training grant on AR/VR to design a short series of courses and practicum experiences specifically designed to help doctoral students in various areas develop enough expertise in AI (or GenAI more specifically) to be able to design/customize new AI-powered solutions to solve problems in their field, as well as work more effectively with AI experts within interdisciplinary teams to build more complex solutions. *****Also relevant for Theme 2*****

4.Improving Educators' Productivity and Wellbeing with GenAI

One of the biggest challenges facing education today is the “burn-out” experienced by many educators as a result of their difficult working conditions, which have been further exacerbated by the social, behavioral and economic impacts of the COVID-19 pandemic (e.g., Kafka, 2021). Therefore, a priority for the field of education should be the wellbeing and retention of educators - a term we are using broadly to include not just those in charge of teaching, but also other professionals contributing to the educational mission of their institution, such as leaders and administrators, counselors, advisors and other student services staff. As with most occupations, we can expect that AI - and GenAI in particular - will likely change many of the current practices of educators working in a variety of roles, so it seems especially important to explore potential implications of uses of AI **by and for educators**, and how such uses may help or exacerbate the current situation.

However, little attention so far has been spent on this topic, as most of the focus has been on potential applications and implications of AI for teaching and learning. In their editorial for a special issue on AI and K-12 education, Mintz et al. (2023) make a valuable distinction among three types of applications of AI to education (often referred to in the literature as “AI&ED”): (a) *student-focused AI&ED*, involving a variety of ways in which AI could be used to support student learning and instruction, (b) *teacher-focused AI&ED*, where AI is used to support the work of teachers, and (c) *institution-focused AI&ED*, which “encompasses AI-enabled tools designed to assist educational institutions with tasks such as student recruitment, security, financial management, and other essential administrative functions” (Mintz et al., 2023, p. 328). This section of our white paper focuses on the *teacher-focused AI&ED* and *institution-focused AI&ED* categories, looking specifically at how GenAI may impact the work of educators, broadly defined.

Our review of the literature that focuses specifically on AI uses *by and for educators*, in both K-12 education and higher education, identified few publications on this topic. A few position papers (Foster et al., 2024; Fullan et al., 2024; Mintz et al., 2023) have been written promoting the value of K-12 teachers' uses of AI - which could be generalized to instructors across a variety of contexts – pointing out not only the benefits that uses of AI could provide to students in terms of learning opportunities, but also the benefits to the teachers themselves in terms of saving time and effort, thus making their jobs easier and more effective. Some position papers (Fullan et al., 2024; Karakose & Tülübaşı, 2024) have also broadened their consideration of uses of AI in K-12 education by school personnel other than teachers, as well as tasks not directly related to instruction. These papers identify potential benefits such as saving time in administrative tasks and better leveraging data; they also caution about risks, including possible

inaccuracies and biases, as well as potential job losses as a result of replacing some educators' functions and roles with AI. Using AI to analyze student data and in predictive analytics have also been mentioned (e.g., Woodruff et al., 2023). Wang (2021a, 2021b) focused more specifically on how AI could be used to support K-12 leaders' decision-making, by conducting a thorough conceptual analysis based on the literature on AI and K-12 leaders' decision making, respectively. Literature review publications (Bearman et al., 2023) have reported very few peer-reviewed publications focusing on student affairs staff; among the uses of AI recommended for student affair professionals were a few that involved routine tasks (such as scheduling appointments and creating customized communications) to save time, as well as tasks that would improve operations at the institutional level (such as identifying students at risk or benign able to extract relevant data stored in different databases) (Barrett et al., 2019; Bearman et al., 2023; Thottoli et al., 2023).

Empirical studies have been mostly limited to reports of survey data collected from various groups of educators - mostly K-12 teachers and K-12 leaders – about their uses and perceptions about AI. These included a 2023 teachers' survey by HolonIQ (HolonIQ, 2024), a 2023 teachers' survey reported in Diliberti et al. (2024), and a survey of K-12 leaders by Frontline Education (2024). In 2023, EDUCAUSE also launched their "EDUCAUSE AI Landscape Study", a survey intended to capture "the higher education community's current sentiments and experiences related to strategic planning and readiness, policies and procedures, workforce, and the future of AI in higher education" (EDUCAUSE, 2024). Findings have also been reported from interviews with 11 K-12 leaders (Diliberti et al., 2024) and two focus groups conducted with K-12 leaders soon after the launch of ChatGPT (Dunningan et al., 2023). All these empirical studies were essentially descriptive, reporting valuable information on the types of task AI was used for and by what percentage of the responders, perceived benefits and risks, and levels of acceptance - but lacking a theoretical framework to guide and interpret their data analysis. Most recently, results of interview studies conducted by members of our team with K-12 leaders (Borasi et al., 2024; Mason et al., 2024; Vaughan-Brogan & Miller, 2024; Miller et al., 20204) and higher education student affairs (Barrett et al, forthcoming; Barrett, 2024; Plate, 2024), respectively, have also been published, in some cases employing specific theoretical lenses; these theories, as well as selected findings, will be reported later as most relevant to specific framing questions.

As a result of this analysis, we suggest that this is an under-explored area that can present many valuable opportunities for research, and could benefit from interdisciplinary teams including experts in AI and education, as well as economists. We are well positioned to undertake this kind of research at UR, given a few research projects already underway in this area (as reported in the box below) and the interdisciplinary collaborations that have been established through these projects as well as this planning grant's activities.

Selected Current Projects

“Leveraging GenAI to Improve Educators’ Productivity and Wellbeing” – Selected examples of recent UR projects

(indicates members of the AI Horizons planning grant team; additional information are also linked for the item whose title has been underlined)*

Understanding and Supporting K-12 School Leaders’ AI-related Decision-making (RAPID-AI)

*(NSF-RAPID, award #2333764) (Team: *Miller-Warner, *Vaughan-Brogan-Warner, DeAngelis-Warner, Herington-MSD, Mason (RIT), *Borasi-Warner/GIDS, *Han-Warner) - K-12 leaders in the region were interviewed and surveyed about their experiences with and perceptions of AI uses in K-12 education, with the main goal of helping to inform future decisions about uses of AI in K-12 schools. Especially relevant to this theme, findings from this project have identified a few different types of uses of AI by and for K-12 educators, along their perceived benefits and risks by K-12 leaders. The project also created some online resources that could be used to support K-12 leaders’ professional learning about AI and its implications for K-12 education.*

Higher education student affairs staff’s perception about AI and implications for their work (UR mini-grant) (Team: *Barrett-Warner, *Borasi-Warner/GIDS, *Plate-SMD) - SEE THEME 3

Developing an LLM-powered tool to review transcripts for admission (GIDS internal funding) (Team: *He, Du, Anand, *Borasi) - This project is developing a prototype that can extract relevant transcript information from applications to UR Data Science graduate programs - as a first use case of creating new LLM-powered tools designed to support specific non-teaching tasks. While we were successful in creating a first prototype that can handle most transcripts, this experience also made us realize significant technology limitations that will need to be addressed - as our prototype still makes mistakes, cannot easily handle special cases requiring exceptions, may introduce some unintended biases, cannot learn from previous experiences, and most importantly encountered great challenges related to ensuring privacy of the data examined. Humans with expertise in specific document reviews have complementary capabilities that could help deal effectively with many of these limitations – which in turn calls for future solutions that combine what humans and machines can do best for optimal results, as well as improve on LLMs’ capabilities for continuous learning and customization.

Framing Questions for Research

Building on lessons learned from the projects listed above and an analysis of the existing literature, as well as conversations that took place in our meetings, we have identified an initial set of questions worth exploring in future research projects - as summarized in the box below, and articulated in more detail in what follows.

“Leveraging GenAI to Improve Educators’ Productivity and Wellbeing” – Initial framing questions

1. *In what ways could GenAI assist educators' work, and what would be the benefits and risks of specific types of uses?*
2. *What will it take to create new GenAI tools/applications to address specific pain points/needs?*
3. *How may GenAI impact the "future of work" for specific occupations within the field of education?*
4. *What factors are likely to affect the adoption of specific GenAI tools/uses by educators?*
5. *How can educators be prepared to use GenAI in effective, safe and ethical ways?*

Framing questions' elaboration:

1. In what ways could GenAI support educators' work, and what would be the benefits and risks of specific types of uses?

The RAPID-AI project identified at least four different types of uses of GenAI by K-12 educators, depending on whether they supported: (a) routine every-day tasks (such as responding to emails, writing memos or letters of recommendation), (b) decision-making (by supporting preliminary research, evaluating solution, suggesting alternatives, etc.); (c) instructional tasks (such as writing learning objectives or lesson plans), and (d) back-office/school operations (such as scheduling or budgeting). The K-12 leaders that participated in this study recognized the value of all these complementary uses of AI for saving educators' time and improving outputs due to new functionalities offered by specific GenAI tools; however, they also seemed to consider uses of AI in routine tasks as essentially non-controversial, while they showed greater concerns with respect to the other types of uses due to possible inaccuracies, privacy breaches, and biases; a different set of potential benefits and risks and, thus, levels of acceptance, were also associated to these different types of uses of AI. While some of the uses identified in the RAPID-AI study are specific to K-12 schools, they suggest the value of generalizing the four categories as follows:

- A. Using GenAI in routine everyday tasks;
- B. Using GenAI to support decision-making;
- C. Using GenAI to support professional tasks that are at the core of one's role/occupation;
- D. Using GenAI to improve business operations for the institution.

It will be worthwhile to explore how each of these types of uses may play out for specific professions within the field of education (e.g., counselors, higher education faculty, academic leaders, academic advisors, etc.), and their respective potential benefits, limitations and risks – especially when taking an approach that emphasizes the importance of always keeping the "human in the loop" and of using AI tools as "assistant" rather than "replacement" for human functions. These studies will require

collaborations between experts in each of these occupations (who will know the working practices and “pain points” that could most benefit from GenAI uses), on the one hand, and experts on AI (who will know about current GenAI capabilities and limitations, as well as where new functionalities and other future development are most likely to occur).

2. *What does it take to create new GenAI tools/applications to address specific pain points/needs of a specific group of educators?*

Appreciating the potential of GenAI to support certain tasks is one thing, but creating an application/tool that can actually realize this potential is another. While many valuable educational applications of GenAI may be achieved using a general tool such as ChatGPT with appropriate prompting, other applications - especially those involving complex operations/services at the institutional level - may call for the creation of more specialized AI-powered tools or even AI agents. Our experience developing a tool to support the review of transcripts as part of the admissions process (*see Current Projects box*) has made us aware that this process is more complex than one may think at first, and requires the collaboration of users/domain experts (who understand what are the pain points to be addressed, what aspects of the process the user wants to remain in control, the level of accuracy may be needed, etc.) and AI experts (who know the current capabilities and limitations of the technology, as well as the AI algorithms and existing tools that can be used to achieve specific goals). What it takes to make this collaboration productive is an interesting research question per-se, as it could provide valuable information about how to best prepare interdisciplinary teams working at future applications of GenAI in any domain.

We expect that these use cases could also be useful to help us understand what are limitations in current GenAI technology that need to be overcome in order to achieve applications that are truly transformational for specific occupations within the field of education. For example, our own experiences suggest that data privacy is a major concern in any educational application of GenAI; therefore, affordable solutions that ensure data privacy will be needed before we can work on applications of GenAI that involve student or research subject data. Another example based on our work is the value of developing GenAI tools that make it easy for the user to review and revise the AI-generated product, and then use this information to enable the tool to learn what is expected and improve future performance accordingly. Achieving personalization based on individual users is another important challenge to address.

3. *How may GenAI impact the “future of work” for specific occupations within the field of education?*

As discussed in the context of Theme #3, the “future of work” literature suggests that GenAI will have a significant impact on most professional jobs in the near future, given its growing capabilities to support, enhance and/or replace many functions currently performed by humans - and the field of education is not going to be immune to this trend. However, it is more difficult to predict *how* GenAI will affect specific occupations within the field of education - and especially whether it will turn out to be a “disruptive innovation” (Christensen, 20xx) or be somehow absorbed into current organizations and practices.

A common worry across fields is the potential loss of jobs due to the increased efficiency achieved when using GenAI tools. Our interviews with K-12 leaders and higher education student affairs staff suggest that this concern may not be very strongly felt by educators – at least not yet, and especially in the case of occupations such as instructors, advisors, and educational leaders, where human interaction and goal-informed decision-making are greatly valued. However, it would be valuable to engage a team of educators and economists to look at other indicators of what the future may bring with respect to the number and types of future jobs available for specific occupations within education. Regardless of its impact with respect to job losses, though, it seems clear that the *expectations* as well as *working practices* for most professional jobs in education will change, given the GenAI tools that are already available and their growing capabilities - which in turn may impact professional identities of people working in those jobs. It will be important to better understand these possible changes, so as to help current and future educators prepare for these new realities - a point we will address in more depth as part of question #4.

4. What factors are likely to affect the adoption of specific AI tools/uses by educators?

While it is important to explore the *potential* benefits and risks of educators’ uses of GenAI, as well as their implications for the field of education as a whole, the *actual impact* of GenAI on educators’ jobs will depend on how extensively specific uses of GenAI will be adopted. So it will also be important to study what factors may help or hinder this adoption, informed by relevant theories about the diffusion of innovations such as Rogers’s Diffusion of Innovation theory (Halton, 2023) and the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003) - as introduced previously in our discussion of Theme 1.

To explore this research question, it will be valuable first of all to gather information from representatives of each targeted profession about what they perceive as potential benefits/risks of specific types of uses - as those perceptions are likely to affect their openness/resistance to adoption. Our previous interviews with K-12 leaders and higher education student affairs staff (*see Current Projects box*) suggest that resistance will be

higher whenever the use of AI is perceived as threatening one's own professional identity - an hypothesis that will be interesting to explore with educators in other professions. This calls for conducting interview/survey studies across educational occupations, and also repeating those studies over time to capture changes due to technology advances and increased access to GenAI tools. It will be important to gather this information not only from potential *users*, but also potential *gate-keepers* - that is, people who will be making decisions/policies about what uses of GenAI are allowed within an institution and thus may enable or preclude access to the needed tools. It will also be important to gain a better understanding of what other factors may impact adoption of specific GenAI tools and uses – such as state and national policies, cost, and educators' own knowledge of and proficiency with AI.

5. *How can educators be prepared to use AI in effective, safe and ethical ways?*

Educators' understanding and appreciation for the potential of AI for education, along with their ability to put it to good use, are clearly major factors that will affect the use and impact of AI in education. This, in turn, calls for designing and offering quality professional learning opportunities for educators, so as to enable them to acquire the needed knowledge, skills and dispositions. However, this professional development will need to be very targeted, as we can expect that what an educator needs to know, be able to do, and come to appreciate about AI will be different depending on their roles and functions within the educational system - as for example a teacher/instructor's focus will likely be on how to leverage AI in teaching, while a school/academic leader will be more interested in using AI to support data analysis and decision-making. Given the many competing demands of their job, time is a very scarce resource for educators across the board, so it is important to be strategic about the goals and content of any training about AI, also taking into consideration what we may know about the target educators' current beliefs and/or perceptions about AI so as to design the most appropriate and effective professional learning experiences. Developing innovative ways to provide this professional learning will also be important, taking into consideration the different needs of specific audiences. For example, the online resources about AI for K-12 leaders created by the RAPID-AI team can provide a starting point and inspiration for developing similar resources for other groups of educators.

Initial Ideas for Future Collaborative Projects

The following ideas were generated and/or refined as a result of exchanges and collaborations developed from planning grant activities.

“Leveraging GenAI to Improve Educators’ Productivity and Wellbeing” - Initial Ideas for Future Collaborative Projects

1. Personalizing LLMs for educational applications through human-machine collaboration and continual learning with human feedback (possible RITEL OR ReDDDoT/HCI proposal)(*He-Hajim/GIDS; *Borasi-Warner/GIDS; others) - We would like to explore novel solution approaches for human-machine collaboration and continual learning with human feedback within specific use cases of using LLMs in education. We are still figuring out what may be the best use cases to focus on, while beginning to explore at least the following options: (1) extracting relevant information from academic transcripts for multiple programs (building on the prototype previously created); (2) enhancing and studying applications of Simon’s Virtual TA across programs and types of courses (with a focus on its impact on students’ learning experiences as well as instructors’ teaching practices); (3) developing a new tool to support course selection and program of study creation by academic advisors (whether faculty or staff).

2. Developing and studying an AI-powered tool to provide feedback to pre-service math teachers on their lessons (project submitted to NSF DRK12 program)

If funded, this proposed study will develop, test, and implement an AI-assisted feedback routine using *Vosaic* to support preservice teachers [PSTs] in elementary mathematics and science education to reflect on their implementations of high leverage instructional practices. The overarching goals of the project are two-fold. **First**, we will develop an AI-Assisted feedback routine that will: (1) provide feedback to PSTs on their classroom instruction in ways that minimize the time and content expertise necessary to provide such feedback; and (2) engage PSTs in reflective dialogues around the feedback to develop their evidence-based reasoning and inquiry stance. **Second**, we will develop and validate a suite of instruments needed to study the use of the AI assisted feedback routine and its impacts on PSTs.

APPENDICES

Potential funding sources

Potential EXTERNAL funding sources identified so far (to be added to and further explored):

Funding source (with link to their webpage & next deadline for application)	Comments/elaborations
NSF RITEL (11/4/25) Annotated RITEL RPF	<i>Supports early-stage interdisciplinary research in emerging technologies such as AI, robotics and immersive or augmenting technologies for teaching and learning that respond to pressing needs in real-world educational environments. Needs to advance BOTH technology and education.</i> <i>Funded UR faculty: NONE</i>
Improving Undergraduate STEM Education (IUSE - level 1: 1/18/25; level 2-3: July 19, 2025)	<i>Specific to undergraduate STEM education. Could involve teaching/learning interventions, or more institutional initiatives. Three levels of scope and funding available, with different deadlines.</i> <i>Funded UR faculty: NONE?</i>
NSF Training grants (Sept.8, 2025)	<i>Specific to research training of graduate students to prepare them for “convergent” research in key areas; would support stipends and tuition for some students, plus must provide training opportunities to other students</i> <i>Funded UR faculty: Cetin</i>
Advancing Informal STEM Learning (AISL - 1/8/25)	<i>Needs to focus on interventions taking place outside of K-12 education and higher education.</i> <i>Funded UR faculty: *Luehmann; Sami Daley</i>
NSF-Responsible Design, Development and Deployment of Technologies (ReDDDoT - no specific deadline yet for FY25)	<i>“invites proposals from multidisciplinary, multi-sector teams that examine and demonstrate the principles, methodologies, implementations, and impacts associated with responsible design, development, and deployment of technologies in practice ... to ensure that ethical, legal, and societal considerations and community values are embedded across technology lifecycles to generate products that promote the public’s wellbeing and mitigate harm.”</i> <i>Funded UR faculty: NONE?</i>
Discovery Research PreK-12 (DRK12 - 11/13/24) - has a learner-focused and teacher-focused component	<i>Choppin, Love, Carson are working on a proposal for Fall ‘24 for this funding line - on “Using AI with Preservice teachers (Elem. Science /Math) to understand their use of AI Tool for feedback on instructional practices”</i>

	<i>Funded UR faculty: *Luehmann; Choppin</i>
Secure and Trustworthy Cyberspace-Education (SaTC -EDU)	<i>Specific to cybersecurity education Funded team members: *Miller, *Borasi, *Borys</i>
Advancing Education for the Future AI Workforce (EducateAI - Dec.2023 DCL)	<i>Funded team members: NONE</i>
Innovative Technology Experiences for Students and Teachers (ITEST - 8/9/24)	<i>LiDA applied last year, and found the multiple components required by this program very difficult to meet Funded UR faculty: NONE?</i>
Computer Science for All (CS4All - 2/12/25)	<i>Funded UR faculty: *Bai</i>
CAREER	<i>Funded UR faculty: *Bai</i>
<i>Special calls/discontinued programs (included only as a reference of what may be possible)</i>	
RAPID - AI in K-12 Education (April 2023 DCL)	<i>We should be alert to similar opportunities that may come up in the future Funded UR faculty: *Miller; *Vaughan-Brogan; DeAngelis; *Herington</i>
Future of Work at the Human-Technology Frontier (<i>discontinued</i>)	<i>Funded UR faculty: *Borasi, *Duan;</i>
Science of Learning and Augmented Intelligence	The program supports research on learning and augmented intelligence through interactions with others or through the use of artificial intelligence in technology.

Potential INTERNAL funding sources identified so far (to be added to and further explored):

Funding source (with link to their webpage & future deadline for application)	Comments/elaborations
GIDS seed grants (<i>early summer</i>)	
URA (University Research Awards)	

Working group members' interests

In the table below we have listed in alphabetic order by last name all the individuals that have attended at least one of the in-person meetings and/or expressed their interest in this working group in another way, along with a few key information about their most relevant background and interests. More information about each of the individuals listed below can be found in the [AI Horizons Introductions](#).

NAME	Affiliation	Background/Expertise	"AI 4 Education" Interests
Ajay Anand	GIDS - faculty	Healthcare data science and AI program development	Ai program develop-ment + how Ai will change healthcare education
Zhen Bai	Hajim/GIDS - faculty	Developing innovative user interfaces for socio-emotional learning , science inquiry and communication	AI-related applications
Andrea Barrett	Warner- faculty	Higher education administration/ student affairs. Qualitative research + program evaluation.	AI implications for higher education, and especially non-teaching staff
Raffaella Borasi	Warner/GIDS - faculty	Design of innovative learning experiences; professional learning; STEM education; innovation/ entrepreneurship.	Envisioning & designing possible applications of AI to support students and educators + PD; AI implications for workforce development
Zenon Borys	Warner- faculty	Curriculum & pedagogy; STEM education; instructional design; PD; teachers' use of digital resources	AI role in society; what everyone needs to know about AI; teachers' uses of AI
Oliver Boxell	Warner- faculty	Counseling - human development - neuro-science	AI literacy in counseling and psychotherapy training; Ai implications for counselor education
Cynthia Carson	Warner- staff	STEM educator; online & digitally-rich teaching; online coaching; teacher education; coordinating large research projects	Using Ai in pre-service and in-service teacher education

Keirah Comstock	Simon – staff	Instructional design; digitally-rich instruction	Preparing instructors for AI integration; AI policies Virtual TAs; customizing GPT models
Haizheng Du	Hajim - staff		
Erfan Farhadi	Hajim – doc.student	AI literacy; background in cinema	AI literacy for educators; using AI for personalized learning
Kathleen Fear	SMD/Health Lab	Digital health; data science & AI in healthcare; creating tools	AI support for lifelong learning and to reduce administrative burden
Adma Gama	Warner – doc.student	Teaching & curriculum; ethics/philosophy; AR/VR; character education in the age of AI	Ethics of AI
Yu Jung Han	Warner – post-doc	AI and education; TESOL; qualitative research; interest-driven learning	Using AI to support language learning; Human-centered AI integration; ethical uses of AI
Masum Hasan	Hajim – doc.student	Computer science, with focus on AI and human-centered computing	Virtual avatars for communication training in healthcare; AI-assisted skill development
Hangfeng He	Hajim/GIDS - faculty	Foundations and applications of LLMs	Improving LLMs for education applications
Dan Keating	Simon - faculty	Instructional innovations using technology; teaching analytics, business and communications	AI & AI literacy in business education; AI program development for business; virtual TAs
Yifan Li	Hajim – doc.student	Assistive technologies for learning and communications	Using AI to facilitate communications for families of deaf/hard-of-hearing children
Kristen Love	Warner- faculty	Early childhood, elementary and special education	AI learning tools; AI in teacher education
Mitch Lovett	Simon - faculty	Marketing; AI program development an applications for business	AI in business education and program design
Dave Miller	Warner- faculty	Former ed-tech entrepreneur; education innovations and entrepreneurship; online teaching	AI educational innovations; entrepreneurial applications of AI
Meghan Plate	SMD- staff	Entrepreneurship; technology implementations in healthcare; higher education administration & innovation	AI applications to healthcare education
Mamunur Rashid	Warner – doc.student	Teaching & curriculum; AR/VR; photography and video editing	Human-AI interaction; creating multimodal instructional materials; AI impact on creativity
Rachel Roberts	Eastman - faculty	Music education, leadership & innovation	AI in music education; impact of AI on musicians' creativity
James Spann	Hajim – doc.student	Human-computer interaction + deep learning	AI tools for deaf/hard-of-hearing children & families
Carol St.George	Warner- faculty	Reading & literacy learning	AI literacy for reading teachers
Prattama Utomo	Warner – doc.student	Emergency medicine; health professions education	AI literacy for healthcare professionals; AI implications for medical education

Pat Vaughan-Brogan	Warner- faculty	K-12 leadership; leadership preparation	Leveraging AI in K-12 education and higher education/ leadership preparation
Hecong Wang	Hajim – student	LLM applications to interactive experiences	Using AI to support reasoning
Yvonne Xu	Warner – doc.student	Higher education student affairs; BS in computer science	AI impact on student affairs, students’ engagement; Ai literacy for educators
Jialin Yan	Warner – doc.student	Education policy & ethics	Ethical uses of AI; teaching to use IA safely; applications of AI to K-12 and higher education
Yamin Zheng	Warner – doc.student	Teaching & curriculum; data science; AR/VR; teacher education	Using AI in teaching, especially to enhance cultural competence; teacher preparation
Xiaofei Zhou	Hajim – doc.student	Computer science; learning technologies & educational technology	Use AI to empower different types of learning and the implications

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