***STRATEGIC INITIATIVE D. Developing capacity in applying selected promising technologies***

**BRIEF DESCRIPTION** - *FROM THE 2019 LiDA STRATEGIC PLAN*:
As new promising applications to education of specific technologies emerge, supporting those applications will require some basic understanding of the technology involved and its potential implications. Given our limited staff and rapid advances in technology, we will need to continue to strategically evaluate which technologies we want to focus on, and what it would take to develop sufficient internal capacity to support their use. At the moment, we have identified the greatest opportunity (and need for developing internal capacity) in Artificial Intelligence (AI) and Data Science – although we expect that new priorities will continue to emerge overtime.

*(NOTE: hereafter, * indicates LiDA staff, and ** indicates other LiDA Community members, including LiDA affiliated faculty)*

**Our vision**

This strategic initiative arose from the recognition, at the time of our strategic plan in 2019, that access to "big data" and advances in Artificial Intelligence (AI) technologies and applications were rapidly changing the world around us - in our daily lives as well as the workplace – and thus how students should be prepared for the future. We also recognized that new applications of AI and data science might suggest innovative ways to support and enhance learning that we may not even be able to envision today. Since the launch of ChatGPT in November 2022, the potential implications of Generative Artificial Intelligence (GenAI) to disrupt and potentially transform both WHAT we teach and HOW we teach it, at all levels of schooling and educational settings, have become even more evident,

As such, positioning the LiDA Center as a key player in this new field emerged as a top priority during our 2019 strategic planning process. Yet we also realized that achieving this goal would present some unique challenges for our Center – since, while our LiDA staff had developed considerable expertise in online and digitally-rich teaching and learning over the past decade, we did not have any expert in computer science and/or data science on staff. This led us to identify as a first critical step the need to develop capacity to do this kind of work - through a combination of our staff's commitment to learn about these fields, training some doctoral students to develop a dual expertise, and partnering with experts.

As we started moving in this direction, we were pleasantly surprised to discover that our expertise in education and innovation, combined with our prior experiences working at the intersection of different fields, made us immediately valuable as members of interdisciplinary teams operating in this field - despite our limited knowledge of the technologies involved. This led us to seek - and secure - grant funding earlier than initially expected.

**Efforts towards building capacity to date**

We approached the challenge of building capacity for work at the intersection of AI/Data Science and education in three complementary ways, as reported in this section.

***Developing LiDA staff's expertise in selected technologies***: Some of our staff members have been investing significant effort in learning more about these new fields - even though

this often required them to go beyond their "comfort zone"!  In Spring 2020, *Borasi and *Borys completed a semester-long course on "Artificial Intelligence Explorations and Their Practical Uses in Schools" offered by the International Society for Technology in Education (ISTE).  Since then, *Borasi, *Borys, *Miller and *Han have attended many webinars and presentations about potentially relevant applications of the targeted technologies - as made available through UR events, conferences, or on the Internet.  A very productive vehicle to learn about new technology fields and applications has been engaging in collaborative interdisciplinary projects that "forced" LiDA staff to learn "enough" about other fields to be able to communicate and collaborate with experts in those fields in the team - as described in more details later.  Most impactful, though, was the decision made in 2023 to make a major investment in hiring a post-doctoral associate that would devote a significant part of their time to keeping up with developments of GenAI applications to education, and help the rest of the team staying up to date.  Among other things, as part of this role, since 2023 *Han has facilitated a ChatGPT Study Group for LiDA staff, open also to interested LiDA affiliated faculty and LiDA doctoral students.

***Developing and leveraging doctoral students' dual expertise****:* We have also been proactively recruiting doctoral students interested in working at the intersection of education and AI/DS, and encouraged them to pursue the Advanced Certificate in Data Science offered by the UR College of Arts and Sciences - or at least take some courses in those areas.  Four of our current doctoral students (**Erqian Xu, **Qinqin Xiao, **Yunfan Gong, **Yamin Zheng) have enrolled in the Advanced Certificate in Data Science program, and two of them have already completed the program.  All four students, as well as **Adma Gama and **Md. Mamunur Rashid, have also been accepted in a special NSF-funded training program in AR/VR, and of those four (**Xu, **Xiao, **Gama, and **Zheng) were also awarded a prestigious NSF-funded one-year fellowship of $34,000 to support their work in this program.

***Partnering with experts:*** The following collaborations – which mostly occurred in the context of developing specific grant proposals – with colleagues who are experts in the targeted technology areas, both within the UR and beyond, have been most productive both for securing the needed expertise we did not have in house, and to continue to develop our own internal capacity to engage in this kind of interdisciplinary work:

- A collaboration involving **Dr. Zhen Bai, Assistant Professor in Computer Science, and *Borasi, *Miller and **Daley, around possible ***applications of machine learning to students' scientific inquiry*** has been going on since early 2019.  So far, this collaboration has centered on enhancing and developing educational applications for a novel computer-operated learning environment, *Smiley Clusters*, created by **Bai and her doctoral students to scaffold the use of selected machine learning algorithms to make sense of large set of scientific data and invite the generation and testing of hypotheses. To date, grant proposals to support this work were developed and submitted to the NSF Computer Science program in May 2019, IES in February 2021, and NSF RETTL program in October 2021, along with two submissions to the University Research Award program (2020 and 2021). While all these early proposals were declined, we finally received a 2-year $300K NSF EAGER grant in summer 2022 to support this work.  This work had a big impact on our team's learning about machine learning and its potential applications in education, which in turn has informed other work.

- *Borasi and **Daley were also involved in a university-wide effort to apply for an **NSF AI Institute on AI-Augmented Learning** - a very ambitious undertaking, as only 6-7 such Institutes have been funded each year for several million dollars each.   A first proposal for a planning grant was submitted in January 2020; while denied, the planning meetings we participated in were instrumental to develop connections with faculty from across the UR interested in AI-augmented learning and other applications of AI to education - which in turn led to the initiatives described under the next bullet.

- The connections developed during the AI Institute application process, combined with a call for proposals by the NSF Future of Work at the Human-Technology Frontier program, suggested the value of applying for an internal University Research Award [URA] to **develop capacity in the Future of Work area within the UR,** so as to be able to submit more competitive grant proposals in the future.  A team of 16 faculty and staff from several Centers and almost all academic units within the UR, led by *Borasi, participated in this effort and submitted a first application in February 2020 - when the program was cancelled because of the pandemic.  A subset of this team also decided to apply in March 2020 for a Future of Work planning grant focusing on the Artist-Technologist occupation - which was awarded and is described in the next section among the "funded projects".  A revised and enhanced [URA application](#) was submitted when the program was reinstated in early 2021, involving an even larger 25-people team; while a URA was not awarded, we were still able to launch a slightly modified version of this project in Fall 2021 with funding contributed by the several units involved in the project – as also reported in more detail the next section.  Over the next three years, this work involved three more full research proposal to NSF "Future of Work" program (one focusing on machinists in collaboration with RIT experts in 2021, one on musicians in 2022, and one on admissions staff in collaboration with a new UR colleague in computer science, He, in 2023), of which one was awarded – as described in the next section. Working on each of these proposals was a big learning experience per-se, as LiDA team members needed to understand the technological innovations proposed – which mostly involved various applications of GenAI and LLMs - in order to meaningfully contribute to the design of each project.  Our collaboration in several of these projects with Jonathan Herington, an expert in AI ethics, also contributed to a much deeper understanding of the many ethical issues that need to be considered whenever working on applications of AI to education.

- The LiDA Center was approached in Spring 2020 by another RIT faculty member, Peizhao Hu, who was seeking education partners to apply for a special NSF call for proposals at the intersection of cybersecurity, AI and education.  While this initial proposal was not funded, the program officer encouraged submitting a revised proposal for a regular grant in **cybersecurity education**.  The team, comprising of Hu and Dana Dachman-Soled from the University of Maryland as experts in cybersecurity, and *Borasi and *Borys, as experts in mathematics education, met weekly during the 2020-21 academic year to develop a proposal for a new type of introductory course to cybersecurity at the undergraduate level.  An important part of this experience required *Borasi and *Borys to learn about cybersecurity methods such as Multi-Party Computation (MPC), in order to make meaningful contributions to the design of the proposed course.  This collaboration was unfortunately stopped by Hu's departure from Rochester.  However, it provided *Borasi and *Borys the

confidence to accept the invitation to participate in a different grant proposal on cybersecurity education initiated by RIT faculty Jay Yang and Justin Pelletier in late 2021, which was eventually awarded by NSF in summer 2023 – and will be described in the next section.

- In Fall 2020, Warner Dean Peyre and Engineering Dean Heinzelman facilitated a connection with Dr. Cesare Wright, the founder and president of the Kyno-Eye Center, because of his unique combination of expertise in engineering and film-making, and his experience designing innovative technology experiences for students as part of programs funded from Microsoft.  Since then, *Borasi, *Borys and *Miller have been engaging in Zoom conversations with Dr. Wright to explore possible collaborations, one of which has materialized in a partnership to develop computer science "experiences-as-learners" for K-12 teachers for one of the state grants described in the next section.

- In early 2023, as a result of these previous collaborations, *Borasi was asked to participate in the preparation of another planning grant proposal for an NSF Institute, this time around AR/VR.  This effort contributed new insights about the future of AR/VR technologies and how they could contribute to education. While this first proposal was declined, in 2024 the same team asked once again for *Borasi's collaboration as they are planning to resubmit.

- In 2023, Chris Kanan, a senior UR faculty in computer science and expert in GenAI, invited *Borasi to participate first in a pre-proposal for yet another NSF AI Institute to be led by the UR, and when this pre-proposal was accepted, to be part of the leadership team for the full proposal for a 5-year $20M grant (submitted in early 2024, and still pending).  As a call for planning proposals for university-wide transdisciplinary institutes was issued by the UR Provost office around this same time, *Borasi and Kanan, together with other 6 PIs across the university, submitted a proposal that was one of ten awarded a $40,000 planning grant, starting in summer 2024.  Participation in these grant proposals by *Borasi resulted in a much deeper understanding of the potential and limitations of GenAI, as well as its future directions – as well as establishing stronger relationships with leaders in the development as well as applications of GenAI across UR.

It is worth noting that, although several of the grant proposals we submitted were not funded, each provided very rich opportunities for LiDA staff and RAs to learn about AI/data science and its possible applications to education, as well as to develop long-term relationships with colleagues in other fields that have already proven to be very beneficial as we continue to grow our expertise.

These invitations to join working groups and grant applications are per-se a concrete recognition of the increased capacity of LiDA staff to engage in work at the intersection of education and AI/DS.  Another form of recognition has come with the invitation to *Borasi to join the UR Goergen Institute for Data Science (GIDS) as an affiliated faculty in Fall 2020, and then to serve on the GIDS Director's Advisory in 2021 as well as on the committee designing a new Ph.D. in Data Science in 2022.

**Funded projects**

The collaborations and learning described in the previous section have led to a few funded projects the LiDA Center has already been able to secure to date.

***Computer Science strand of the Wayne-Finger-Lakes BOCES NYS Smart Start grant:*** The The LiDA Center, in collaboration with the Center for Professional Development and Education Reform and Dr. Cesare Wright (Kino-EyeCenter), designed a year-long fully-online professional development program for K-8 teachers participating in a 2021-2026 "Smart Start" grant awarded to the Wayne-Finger-Lakes BOCES to support the implementation of the 2020 NYS K-12 learning standards for Computer Science and Digital Fluency. This 5-year grant, aiming to develop capacity to implement the new NYS Computer Science and Digital Fluency Standards, was intended to serve each year a group of 50-60 K-8 teachers, although this number has been much smaller so far due to difficulties in recruiting teachers to professional development since the pandemic. All participating teachers engage in the equivalent of a 3-day Summer Institute plus two additional 2.5 hour Zoom sessions during the year; a sub-group of these teachers ("Tier 2") will also attend two additional Zoom session and participate in a mentored Professional Learning Communities (PLC) to support the implementation of what they learned into their classes. A total of xx teachers have participated in the program in the first 3 years.

***Future of Work planning grant exploring the Artist-Technologist occupation***: This 1.5-year $150,000 planning grant from the National Science Foundation [NSF] "Future of Work at the Human-Technology Frontier" program supported the exploratory work of an interdisciplinary team of 21 UR and RIT faculty and staff around artist-technologists' creative design at the human-technology frontier - with an initial focus on music (as the artistic domain) and Artificial Intelligence and Augmented/Virtual Reality (as main technologies) (see public abstract). The project core team included *Borasi (as PI), *Borys, *Miller and Warner doctoral student **Erqian Xu. In addition to the cross-disciplinary learning acquired as the result of presentations from various experts on the team, project activities contributed new insights about what and how individuals who are not expert in technology needs to learn about cutting-edge technologies in order to be able to leverage them for their work and to effectively collaborate with technologists who can complement their domain expertise – as summarized in a 3-minute video presented at the 2022 STEM for All Video Showcase, and also reported in the "Insights" section of the website we created with "Resources for Future Artist-Technologists".

***UR Future of Work Capacity Building project:*** With internal seed funding provided by the Warner School of Education, the Goergen Institute for Data Science and the Ain Center for Entrepreneurship, we were able to launch in Fall 2021 a pilot project to develop interdisciplinary teams with the capacity to conduct research on the implications of AI and Data Science for preparing future professionals in specific fields. Working Groups were established for Health Care, Humanities, Climate Economy and Higher Education Student Services, in addition to the original one on the Arts. The Humanities group, led by Jonathan Herington and in collaboration with LiDA staff, produced a grant proposal to NSF Innovations in Undergraduate Education (IUSE) program that proposed one of the first studies of ChatGPT applications in writing courses for engineers (unfortunately declined). The Climate Economy group decided against further pursuing work in their area, as they di not identified good enough opportunities. The HE Student Services group collaborated with the Ain Center to offer a day-long "Collision Challenge" event for UR students where teams tackled some specific challenges in UR student services and suggested possible solutions

that leveraged AI, initiated an interview study of UR student affairs staff about their experiences and perception of AI (which resulted in three publications), and collaborated with colleagues in computer science on a NSF Future of Work proposal on using LLMs to support the review of admissions documents that was declined but succeeded in securing some seed funding to develop a first prototype to use LLMs to review transcripts. Working on this last project has been especially interesting, as it enabled the LiDA personnel on the team (*Borasi and **Barrett) to experience first-hand the complexity involved in applications of GenAI that may at first seem simple!

### NSF Future of Work TEAMuP project
A $1.8M NSF "Future of Work at the Human-Technology Frontier" research grant entitled "Towards an Ecosystem (TEAMuP) was awarded in October 2022 to an interdisciplinary team comprising of

### EAGER grant on Machine Learning to support students' scientific inquiries
A 2-year $300K EAGER grant was awarded by NSF as part of its "Research on Emerging Technologies for Teaching and Learning" (RETTL) program to an interdisciplinary team consisting of computer science experts (**Zhen Bai and Jiebo Luo) and education experts (*Borasi and **Daley) to develop and pilot study a software that will enable high school students and teachers to leverage machine learning algorithms for clustering in scientific inquiries.

### Cybersecurity education grant with RIT
This collaborative research project, funded by a 3-year $500K grant from NSF "Secure and Trustworthy Cyberspace (SaTC) program starting June 2023, focuses on the design and study of a dual-track professional learning program for cybersecurity engineers and analysts to learn about AI/ML applications through role-playing. Let by RIT cybersecurity professor Jay Yang, the team comprises also of Justin Pelletier (cybersecurity instructor, RIT), and LiDA staff *Miller, *Borasi and *Borys.

### RAPID-AI grant
This 1-year $200K RAPID grant was awarded by NSF in September 2023 to support K-12 leaders' decision-making about uses of AI in their schools, by first uncovering their experiences and perceptions about AI, and then creating online resources that could help inform their future decisions. The team, led by *Miller as PI, included experts in K-12 leadership (**Pat Vaughan-Brogan), computing (Sharon Mason, from RIT), GenAI application to education (*Han), AI ethics (Hetherington), customer-discovery interviews (*Miller), survey design (**DeAngelis), and qualitative research and design of online resources (*Borasi). Key components of this project included: (a) semi-structured interviews conducted with a total of 42 K-12 school and district leaders in various positions across 17 districts in the region in Fall 2023; (b) a survey informed by these interviews, administered starting April 2024 to all the principals, superintendents, directors of technology and other district administrators in charge of curriculum/instruction across most counties within Western New York (which received 159 responses to date); and (c) the creation of online resources about AI for K-12 leaders (still in progress). Dissemination of preliminary results from this timely project have already produced two published practitioner articles, a research article currently under review, two accepted papers to be presented at professional conferences, as well as some interactive presentations to local K-12 leaders (including the Spring 2024 half-day retreat of the K-12 Digital Consortium, and a session of EDU-TECH directors organized by BOCES).