2018 - 2021 Report
Center for Cross-disciplinary Research on Equitable Advanced Technology for Education (CREATE Center)

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1. Introduction

This report provides an overview of the first four years of the activities and achievements of the Center for Cross-disciplinary Research on Equitable Advanced Technology for Education (CREATE Center).

CREATE Center has been established through the L. D. and Ruth G. Morgridge Endowed Chair Office and was approved by the NIU Board of Trustees in Fall 2018. The Morgridge Chair is charged with advancing teacher education research and demonstrating leadership in and through research and scholarship and serves as the Director of the Center. Over the last few decades, technology integration has been acknowledged as a critical challenge in teacher education by broad communities in both formal and informal education research and practices. The mission of the CREATE Center, therefore, has been aligned closely with the Chair’s charge. The Center has been focused on applied research on advanced technology for education. The Center has developed innovative cutting-edge technologies (e.g., humanoid robots, wireless mobile technology, and augmented reality, etc.) for assisting teachers and students and investigated how such technology can be implemented in schools to address critical challenges that teachers and, more broadly, public education face today.

Drawing upon seminal basic research in learning sciences and human computer interaction, the Center’s applied research connects education and technology while maintaining strong foci on diversity/equity and multidisciplinarity. The trend towards increasing learner diversity in schools is recognized as a serious challenge to teachers and school administrators both locally and nationally. The Center’s vision includes achieving equity and inclusion by investigating equitable designs of cutting-edge technology and introducing them to teachers and schools. Moreover, acknowledging that this complex challenge requires pooling of expertise from diverse disciplines, the Center director has strived to establish research collaborations among scholars in social and technical disciplines from different departments and colleges at NIU and other universities in the U.S. and abroad. Additionally, the Center has established partnerships with local schools to implement this applied research and with private industry to acquire technology and expertise. Notably, this emphasis on promotion of diversity and multidisciplinarity dovetails with two recent NIU strategic initiatives supporting transdisciplinary research and education, and diversity and equity for faculty, staff, and students.

In this report, we present the initiatives described in the Center’s mission statement. The report documents how research activities and output have grown, how local, national, and international research collaborations were established and supported, how partnerships with local schools have been developed, and how the Center’s national and international prominence has increased since the Center’s inception. The report provides a synthetic account of four years of seeking to establish the Center as a pivotal research center within the College of Education and within the Educational Technology community. We strive to make the CREATE Center an example and an inspiration in its commitment to robust research on technology integration in teacher education and the multifaceted application of educational technology to solve real-world educational problems.
2. CREATE Center Mission

The CREATE Center conducts leading research on the edge of the education-technology frontier. It develops innovative, transdisciplinary research programs that investigate cutting edge technology to address urgent challenges in education for teachers and learners. The Center is committed to facilitating multidisciplinary collaborative research, involving regional and international communities through partnerships, and nurturing a new generation of researchers to ensure sustainability and broad impact. The CREATE mission is as follows:

- Developing research programs that investigate the use of state-of-the-art technologies and design solutions that address critical challenges in teaching, learning, and workforce development.
- Involving diverse expertise from multiple disciplines across colleges and universities as well as practitioners in schools, industry, and government.
- Designing and studying innovative ways to support teaching and learning for marginalized groups of students in traditional and non-traditional education settings.
- Securing external funding to sustain productive research programs.
- Generating and disseminating new knowledge broadly to both academic and professional communities.
- Developing collaborative partnerships with schools and institutions to identify urgent needs and deliver research-based solutions to help improve teaching and learning.

3. Productivity in Research and Scholarship

3.1 Research Activities: Research Projects and Strands

The research activities of CREATE Center were performed through two channels (research projects and research strands). Research projects were led by the Center researchers (Dr. Yanghee Kim, the Morgridge Chair and Center Director and Dr. Michael Tscholl, research professor), in collaboration with researchers from multiple disciplines and local school partners. Research strands were led by the CREATE faculty affiliates at NIU whose research was supported by the Morgridge Office/CREATE Center as part of one of the core missions (supporting and enhancing affiliated scholarship). The Center leadership advised and/or assisted the strand teams in various phases of research performance according to the teams’ needs.

3.1.1 Elementary Education

**Research Project:** Inclusive Design for Engaging All Learners (IDEAL), Year 2018-2020
This project was funded by the National Science Foundation (NSF-IIS #1839194).

**Project team:**
Leader: Dr. Yanghee Kim (Morgridge Chair and Center Director)
Members: Dr. Sachit Butail (Asst Prof, Mechanical Engineering), Dr. Lichuan Liu (Assoc Prof, Electrical Engineering), Dr. Michael Tscholl (Research Assoc Prof,
CREATE Center), and Dr. Laura Johnson (Assoc Prof, ETRA: Educational Technology Research and Assessments).

School Partners: Central Elementary School, Rochelle (IL) and Cortland Elementary School Cortland (IL).

The activities developed in this project were implemented in collaboration with five kindergarten teachers from the two partner schools and provided a technologically enhanced education opportunity for approximately 100 children from four regular classes and one after-school program over three years.

Research goals and significance:
The goal of this project was designing a child-robot interaction involving a physically embodied humanoid robot to facilitate equitable collaboration among young children who come from diverse backgrounds. For three years, the project studied the designs of a set of robot-mediated learning activities in a small socio-technical group that consisted of a robot, a child from an English-speaking family, and a child from a Spanish-speaking family. The robot mediated two equitable interactions for children while inviting active participation in the interactions and prompting them with questions to enable learning of academic concepts. This robotic mediation involved children in making shared decisions on how to overcome obstacles and achieve goals close to the children’s personal interests. Through this experience, it was expected that children would develop positive learner identities and social and academic skills. Indeed, our research found that children gradually learned to take turns and come to agreements with each other, a sign of equitable collaboration, and that our design scenarios enabled children to co-create digital artifacts on a shared tablet. Children not only shared ownership of these artifacts but also developed a sense of belonging to the world they jointly created. This fun and equity-oriented pedagogy not only actively engaged children in difficult topics (e.g., tackling math problems), but also provided participating teachers with experiences with technology-enhanced supplemental materials applicable to their classrooms that also promoted equitable collaboration.

Research Project: Child-Robot Interaction Multimodal Data Analytics, Year 2019-2021

Project team:
Leader: Dr. Yanghee Kim & Dr. Jaejin Hwang (Asst Prof, Industrial Systems Engineering)
Members: Dr. Michael Tscholl (Research Assoc Prof, CREATE Center) and Dr. Lichuan Liu (Assoc Prof, Electrical Engineering).
External member: Dr. Xiaojun Qi (Prof, Computer Science at Utah State University)
School Partners: Central Elementary School, Rochelle (IL) and Cortland Elementary School Cortland (IL).

Research goal and significance:
The project goal was to investigate authentic assessments of children’s learning and development. As an extension of the previous project IDEAL, this project involved
pioneering work in multimodal learning analytics which performed in-depth analyses of the video and audio datasets collected from IDEAL. Young children’s language and literacy skills are still developing, and traditional paper/pencil tests can provide only very limited information on children’s learning. The project assessed children’s enhanced learning and positive affect while they interacted with a peer and a robot. The assessment was accomplished through the analyses of their natural, multimodal behaviors which included bodily movements, voice, speech, and facial expressions. Also, Dr. Hwang has been applying Inertial Measurement Unit (IMU) sensors and the Optical Motion Capture system which enables automated collection and analysis of bodily movements in real time. Dr. Liu developed an algorithm that automatically extracts acoustic features from children’s recorded voices to measure levels of engagement in the task. This innovative means of learning assessment could provide teachers with valid and reliable information about children’s learning progress, as well as alleviating their burden to assess young children’s learning and development. In STEM learning environments, this technology-enhanced assessment supports a natural multimodal way of interaction, engaging children not only cognitively but also socioemotionally and physically.

**Research Project:** Implementing Mixed Realities for Inclusive and Embodied Learning (IMRIEL), Year 2021-2024
This project was funded by the National Science Foundation (NSF- DRL #2049046).

**Project team:**
*Leader:* Dr. Yanghee Kim (Morgridge Chair)
*Member:* Dr. Jaejin Hwang (Asst Prof, Industrial Systems Engineering)
*External members:* Dr. Kyungbin Kwon, Dr. Thomas Brush, and Dr. M.M. Dalkilic (Professors, Indiana University)

**Research goal and significance:**
This new project, started in fall 2021, aims to provide an innovative mixed-reality environment that combines a humanoid robot and augmented reality (AR), where children in K-2 will engage in problem-solving tasks embedded in their play with the robot. Through this hands-on experience, children will understand abstract symbols and the concept of sequence, both of which are crosscutting and foundational to STEM and literacy learning. Also, grounded in embodied cognition and culturally responsive/sustainable pedagogy, this environment will equitably invite every child to AR-enhanced play with a robot playmate that is free from judgments and social biases, enabling children’s positive affect about working *with* and *on* such cutting-edge technologies. This developmental research, using advanced sensor technology, will also unobtrusively measure children’s multimodal behaviors to assess children’s learning and affect authentically. In Years 1 and 2, the project team will study the design of the environment in iterative cycles of design and development. In Years 2 and 3, we will implement teacher workshops to better understand teachers’ (or caregivers’) insights and needs for remotely supporting children to succeed in the environment. In Year 3, we will investigate the effectiveness of the mixed-reality
environment on children’s understanding and affect, which will be implemented in ordinary settings, both formal and informal.

**Research Strand: A Systemic Approach to Teacher Training (SATT) to Improve Academic Outcomes, Year 2018-2019**

**Project team:**
*Leaders:* Dr. Ximena D. Burgin (CREATE Center & RIPS: Research and Innovation Partnerships) & Dr. Mayra C. Daniel (Curriculum and Instruction)
*Mentor:* Dr. Yanghee Kim (Morgridge Chair)
*Partnerships:* Elementary teachers in Ecuador

**Research goals and significance**
The project addressed teacher empowerment in Ecuador, providing them with tools and strategies to engage in ongoing self-study, and implementing interventions to support students.

This project was important because in Ecuador teachers were not adapting lesson plans that consider the students' culture and linguistic diversity. To effectively educate culturally and linguistically diverse students, teachers need to understand the academic and emotional needs of students and lead changes in the classrooms while collaborating with other teachers to solve academic issues. The project was conducted in a K-12 institution in Ecuador from June 2 to June 23, 2019, with 20 elementary school teachers. Core findings included that the current educational system did not have the flexibility to adjust instruction based on linguistic or cultural needs; and that the educational system and its administrators did not support the teachers due to beliefs that classroom issues were to be solved by the teachers. Participants possessed limited knowledge about the importance of social and emotional learning. It was suggested that teachers and all other institutional actors receive professional development which will provide them with an effective framework for the integration of social-emotional learning into classrooms.

**Research Strand: Integrated STEM Curriculum, Year 2020-2021**

**Project team:**
*Leader:* Dr. Tom Smith (ETRA)
*Members:* Dr. Ying Xie (ETRA), Dr. Todd Reeves (ETRA), Dr. Wei-Chen Hung (ETRA)
*Mentor:* Dr. Michael Tscholl (CREATE Center)
*External member:* Collen Cannon-Ruffo (Learning Services – Naperville)
*School Partners:* Naperville School District, Elementary schools

**Research goal and significance:**
This project sought to address the increasing need to provide students with opportunities to actively engage in the practice of scientific inquiry and reasoning. The project has created research-based STEM learning opportunities that are effective in engaging students in the
process of acquiring critical inquiry and problem-solving skills. The project expanded the implementation of an integrated STEM curriculum, using a pool of approximately 125 students and 25 teachers from grades K-4 in elementary schools in Naperville, IL. The project is ongoing and examines how learning occurs when students engage in robotic problem-solving activities aimed at fostering domain knowledge acquisition, collaborative learning, computational thinking, and metacognitive skill development.

3.1.2 Secondary Education

**Research Project: Physical Activities and Cognitive Engagement, Year 2019-2020**

*Project team:*
*Leaders:* Dr. Yanghee Kim (Morgridge Chair)  
*Members:* Dr. Fatih Demir (Assist Prof, ETRA), Dr. Michael Tscholl (CREATE Center)  
*External Members:* Dr. Sungchul Lee (University of Wisconsin-Whitewater),  
*School Partners:* Hononegah School District, Rockton, IL

This project served approx. 200 students in PE classes in Hononegah High School.

*Research goals and significance:*
The project sought to explore the connection between cognitive learning and physical movements and was conducted in collaboration with Hononegah School District officials. The project was broadly grounded in the increasing recognition that the body is involved in cognition, and that the study of learning should include measures related to bodily activities. Implemented jointly with external collaborator Dr. Sungchul Lee from the University of Wisconsin-Whitewater, the project has developed a mobile app as a testbed to measure and analyze students’ physiological data in real time while they were engaged in physical activity. Specifically, using the app for automated data collection and analysis, students’ balance while walking was studied as an indicator of balanced cognitive functions. The findings are expected to inform teachers and school administrators about early identification of struggling students especially in STEM domains.

**Research Project: AppleAscend: Online High School Mathematics Learning, Year 2018-2020**

*Project team:*
*Leaders:* Dr. Yanghee Kim (Morgridge Chair and Center Director) & Dr. Mary Shafter (Assoc Prof, Mathematical Sciences)  
*Community Partner:* Dr. Daniel S. Domin (Chief Development Officer, for the non-profit organization, AppleSTEM [https://www.mathascend.com]),  
*School Partner:* Elgin High School
**Research goal and significance:**
This project aimed to provide high-school mathematics teachers and students with an improved online mathematics learning environment (*AppleAscend*), where the students practiced problem-solving individually until they master the concepts. The Center’s community partner Dr. Domin developed the initial version of the environment by working with mathematics teachers in Elgin High School, and it has served approximately 700 students over the years. In 2018, Drs. Kim and Shafter collaborated to improve the MathAscend curriculum and instructions by making them closely aligned with the Common Core Standards as well as applying well-grounded mathematics pedagogy. This improved version has been used in Algebra II classes in the school, serving approximately eighty students per year. Efforts to improve the environment are ongoing, and Drs. Kim and Shafer will assist in securing funding to further refine and expand the environment for broader use.

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**Research Project: STEM Teacher Professional Development for Teaching Remotely, Year 2020-2021**

**Project team:**
Dr. Kristin Brynteson (Director, the Center for P-20 Engagement) and Dr. Yanghee Kim (Morgridge Chair)

**Research goals and significance:**
The project goal was understanding STEM teachers’ urgent needs for teaching remotely due to the Covid-19 pandemic. The NIU P-20 Center ran professional development courses on effective remote teaching strategies in Spring and Summer 2020 committed solely to the support of STEM teachers (called the *NIU STEAM Virtual Summer Institute*). Drs Kim and Brynteson implemented a study with twenty participating teachers to identify their needs. Data were collected through interactive discussions and pre and postworkshop surveys. The consensus among the teachers was that the greatest need was for resources that would engage children in learner-centered, hands-on activities and facilitate social and emotional learning. The finding convinced the CREATE Center team to continue with research and development of technology-enhanced high-quality educational materials that could be seamlessly used by both teachers and students.

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**Research Strand: Providing Touchable Knowledge Structure Graphic Feedback for Visually Impaired Learners: Tablet-Based Haptic Feedback and Paper-Based Tactile Feedback, Year 2018-2020**

**Project team:**
*Leader:* Dr. Kyung Kim (ETRA)
*Mentor:* Dr. Yanghee Kim (Morgridge Chair)
*External members:* Dr. Wanli Xing (Texas Tech University) and Dr. Pavlo Antonenko (University of Florida).
Research goals and significance:
The project goal was studying how the visualization of knowledge structure might support science instructors’ practice and scaffold students’ science learning, thereby supporting the design of instructional strategies which targeted individual learning problems to derive better outcomes. This approach was intended to promote students’ active engagement in the development of their knowledge structure during learning by providing individualized knowledge structure feedback, as well as benefiting teachers’ understanding of students’ knowledge structure and thinking. Notable findings included that the complexity of knowledge structure in the student’s native language influenced the knowledge structure complexity in the second language (L2), and that complex L2 knowledge structure influenced the comprehension of science text in a second language. The immediate visual feedback of knowledge structure helped online students learn more effectively due to increases in comprehension and a decrease in misconceptions. Fostering information sharing during collaboration helped learners better construct a knowledge structure and improved problem solving specifically for ill-structured problems.

Research Strand: A Research-Practice Partnership to Promote Transformative Social and Emotional Learning through K-12 Physical Education (SEL K-12), Year 2020-2021

Project team:
Leader: Dr. Paul Wright (Prof, KNPE, College of Education)
Mentor: Dr. Yanghee Kim (Morgridge Chair)
Members: Dr. Elvira Martínez-Arroyo (Curriculum & Instruction), Dr. Jim Ressler (KNPE), Dr. Ricklefs Mariana (Curriculum & Instruction), Dr. Victoria Shiver (KNPE)
School Partners: U-46 School District, Elgin (IL)

Research goals and significance:
This partnership will expand a mutually beneficial collaboration between the College of Education and the U-46 school district in Elgin. The inter-departmental team will work with administrators and teachers to design, implement, and evaluate a year-long professional development initiative focused on developing culturally responsive pedagogies for addressing social and emotional learning in physical education (PE). The project builds on increasing evidence that social-emotional learning (SEL) programs support positive outcomes related to personal and social skills as well as mental and emotional well-being. To address issues related to social inequity, culture and linguistic differences, the project will extend SEL programs by developing and implementing a transformative SEL program adapted to students’ varied realities. The COVID-19 pandemic disrupted the delivery of PE, but also heightened teachers’ awareness of students’ needs related to SEL. Thus, 2021-2022 is an opportune time to reinvent the culture of PE in the U-46 district, to retain the focus on the whole student and their social context, and to create spaces in PE to explore issues of culture and equity.
3.1.3 Adult Learning and Workforce Development

**Research Project: Technology Augmenting Teamwork Efficacy (TATE)**

**Project team:**
*Leader:* Dr. Yanghee Kim (Morgridge Chair)
*Members:* Dr. Hamed Alhoori (Asst Prof, Computer Science), Dr. Sachit Butail (Asst Prof, Mechanical Engineering), and Dr. Kyung Kim (Asst Prof, ETRA).
*External member:* Dr. Xiaojun Qi (Prof in Computer Science, Utah State University).

**Research goal and significance:**
This project sought to address an urgent workforce challenge in the U.S. that college graduates are not well prepared for success in the workplace due to a lack of team-working skills. The project aims to develop an AI-based learning system that assists college students in developing these skills. The project examined how an array of cutting-edge technologies could be coordinated synergistically to augment the efficacy of knowledge building, decision making, and enhancing the social and affective dynamics of work groups. This also necessitates developing new technology-based measures of social and cognitive group work processes and prototyping an intelligent robot system to facilitate effective teamwork skills among undergraduate students.

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**Project team:**
*Leader:* Dr. Yanghee Kim (Morgridge Chair)
*Member:* Dr. Jaejin Hwang (Asst Prof, Industrial and Systems Engineering) and Dr. Michael Tscholl (CREATE Center).
*External members:* Dr. Brent Chamberlain (Asst Prof, Environmental Sciences, Utah State University) and Dr. Xiaojun Qi (Prof, Computer Science, Utah State University).

**Research goal and significance:**
Addressing a need for workforce development, this project aims to understand the relationship between individuals’ perception, action, and affect in real-world problem solving. Young adults aged eighteen to twenty-two will perform an ambiguous spatial navigation task in an immersive virtual reality environment repeatedly over several sessions. In two phases, the project will conduct randomized experiments to understand how contextual and temporal feedforward and feedback influences problem solvers’ perceptions of the environment and their problem-solving behaviors. During the experiments, we will measure participants’ perception, action, and emotion (arousal and valence) unobtrusively and simultaneously using cutting-edge techniques, such as eye tracking, facial recognition, and interaction logs. These measures will be complemented by traditional psychological measures, observations, and post-session interviews. Next, grounded in the embodied
learning perspective, we will conduct exploratory modeling of the multimodal data to examine the relationship among these three variables. In both education research and practice, there is a lack of understanding on how to teach students to solve problems reflecting the complexity and ambiguity of the real world. The project influences fundamental theory and pedagogy on the natural interactions between the real environment and behavior in a more holistic way. The project plans are fully developed, and the project team is seeking external funding for implementation.

Research Project: AI Institute for An Adaptive, Inclusive, and Transformative Adult Learning Ecosystem (AITALE)

Project team:
NIU Leader: Dr. Yanghee Kim (Morgridge Chair)
External Leaders: Dr. Cheng Xiang Zhai, (Computer Science0 and Dr. Chad Lane, (Learning Science, University of Illinois-UC); Dr. Kevyn Collins-Thompson (Computer Science, University of Michigan); and Dr. Noah Schroeder, (Educational Psychology, Wright State University)

External Members: Seventeen multidisciplinary researchers from nine other universities in the U.S.

Research goal and significance:
This AI Institute aims to research and develop an AI-enabled flexible open learning environment that will augment adults’ capabilities to learn Information Technology (IT) job skills in both formal and informal settings. Grounded in the science of adult learning and powered by advances in AI, the multidisciplinary team will investigate novel models and theories for precise content delivery and inclusive, personalized coaching for adult learners who come from diverse personal, social, and economic backgrounds. The NIU branch of the Institute is charged with addressing critical issues on achieving gender and ethnic equity in IT-related education and workforce development. The underrepresentation of gender and ethnic minorities in IT fields is attributed to negative social influence (e.g., stereotyping) and lack of role models. As a solution, the branch will investigate the efficacy of frequent social encouragement and in-group virtual role models on engaging minority groups of young adults in learning IT topics. To this end, we will study the design of personalized interaction between an AI-enabled coach and a learner, and the persona of the coach to facilitate diverse learners’ positive affect and skill acquisition. This research will generate new teaching models and pedagogy enabling teachers and instructors at all educational levels to equitably teach students with diverse cultural backgrounds. The Institute is being developed and is seeking funding.

Research Project: Smart Glasses for Formative Feedback

Project team:
Leaders: Dr. Michael Tscholl (CREATE Center) and Dr. Fatih Demir (ETRA)
**Member:** Dr. Chris Hill (Asst prof, KNPE)

**Research goal and significance:**
The project leverages the potential of smart glasses (specifically: Google Glass Enterprise Edition 2) to provide instantaneous, personalized feedback to students during their in-class presentations. It compares the differential impacts of such feedback with the more traditional summative feedback given after a presentation. Data will be collected both during classroom presentations and during therapy sessions aimed to improve physical movements of stroke patients. The project is still being developed. If successful, the project will provide classroom teachers at all levels with materials to teach presentation skills to students.

**Research Strand:** *Using Virtual Academic Advising to Enhance STEM Success for Underrepresented Community College Students, Year 2018-2019*

**Project team:**
*Leader:* Dr. Xiaodan Hu (CAHE)
*Mentor:* Dr. Yanghee Kim (Morgridge Chair)
*External members:* Dr. Justin C. Ortagus (University of Florida) and Dr. Timothy, J. Wilson (Bellwether College Consortium)

**Research goals and significance:**
This project aimed to build a virtual academic advising model with technological solutions to identify student needs, increase student engagement, and support STEM success in the community college setting effectively and efficiently. With a focus on STEM success, this project investigated the characteristics of effective virtual academic advising to make technology-mediated advising effective and examined whether technology-mediated advising improves STEM success for underrepresented community college students.’

**3.1.4 Research Enhancement Workshops**
The Center has organized pioneering, national and international workshops to bring multidisciplinary expertise together to collaboratively develop cutting-edge research programs which intersect technology and education. In this capacity, the Center demonstrated leadership in the humanoid robotic integration research community.

**National Workshop on Child Robot Interaction and Alternative Input Methods, Year 2018-2019**
This was an NSF-sponsored workshop which was funded through a third party, Digital Promise.

*Location:* The Holms Student Center, NIU
Participants: Approx. 35 participants including fifteen invited experts in social robotics, artificial intelligence, learning sciences, and engineering from prestigious universities (e.g., MIT, Standford, UCLA, etc.), their doctoral student proteges, and NIU faculty affiliates.

Child-robot interaction research and development has been growing rapidly since 2010, but our knowledge about child/robot interaction is still fragmented across several disciplines. This two-day workshop aimed to elucidate the current statuses of designing and evaluating the efficacy of child/robot collaborative systems and to tackle educational challenges in child development. The workshop confirmed the educational potential of embodied sociable robots for facilitating balanced development of young children physically, socio-emotionally, and intellectually.

**International Workshop on Child Robot Interaction Design and Research, Year 2018**

**Location:** The IEEE conference on RO-MAN 2018 in Nanjing, China  
**Participants:** Twenty select participants specialized in robotics, computer science, psychology, and learning sciences from France, Germany, China, Japan, and the U.S.

This half-day workshop brought international scholars in child-robot interaction development together to present their current works and discuss research issues and challenges. There was a consensus among the participants that research on child robot interaction necessitated multidisciplinary collaboration to develop pedagogically and technologically sound applications and broader adoption in schools and homes.

**International Workshop on Children’s Theory of Mind, Year 2019**

**Location:** University of the Sacred Heart, Milan (Italy), Department of Psychology.  
**Participants:** Dr. Yanghee Kim and Dr. Michael Tscholl (CREATE Center); Dr. Davide Massaro, Dr. Antonella Marchetti, Dr. Cincia Di Dio, and Dr. Federico Manzi (University of the Sacred Heart, Milan).

This two-day workshop explored topics and research and design approaches related to children’s attribution of animacy to social robots. Through presentations and discussions, participants addressed three main issues: Which aspects of robot behavior prompt children to attribute a 'mind' and 'social agency' to a humanoid robot? How is the attribution manifest in children's behavior (e.g., fairness)? How can the attribution be leveraged to promote equity and fairness?
International Workshop on Advances in Speech Processing and Face Recognition in Robotic Research, Year 2019

Location: GIPSA (Grenoble Images, Speech Signal and Control), Grenoble (France).  
http://www.gipsa-lab.grenoble-inp.fr/  
Participants: Dr. Gérard Bailly and Dr. Frédéric Elisei (GIPSA); Dr. Yanghee Kim and Dr. Michael Tscholl (CREATE Center).

This half-day workshop sought to compare research results pertaining to human-robot interaction and to learn about the latest technical and computational developments on speech processing and face recognition as well as their use in developing responsive, intelligent human-robot interaction.

3.2 Research Output

3.2.1 A Summary of Publications

Table 1 presents the number of scholarly outputs directly resulting from the research projects and strands in Section 3.1.

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<thead>
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<th>Year</th>
<th>Journal articles</th>
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3.2.2 Peer-Reviewed Journal Articles


### 3.2.4 Peer-Reviewed Conference Presentations


3.2.5 Others

Symposia

Book Chapter

Invited talks

4. Diversity and Engagement

4.1 Supporting Diversity

CREATE Center strived to achieve equity and support diversity through both research programs and diverse team membership. First, one core aspect of Center research is developing equitable technologies to help teachers and learners overcome explicit and implicit biases in real-world
educational settings. Second, the Center’s research teams consist of faculty affiliates and students who come from diverse cultural and linguistic backgrounds. This diverse team not only enabled the Center to develop a broad range of research projects and strands but also enriched the team’s experience in embracing diverse perspectives. In this section, we present the Center diversity profile compared to the profiles of the College of Education (CEDU) and NIU. In relation to membership of ethic/racial groups, we distinguish between White and Person of Color (POC).

4.1.1 Racial Diversity

*Center Personnel and Faculty Affiliates*

![Figure 1. CREATE](image)

![Figure 2. CEDU](image)

![Figure 3. NIU](image)

*Student Research Assistants*

![Figure 4. CREATE](image)

![Figure 5. CEDU](image)

![Figure 6. NIU](image)

4.1.2 Gender Diversity

*Center Personnel and Faculty Affiliates*

![Figure 7. CREATE](image)

![Figure 8. CEDU](image)

![Figure 9. NIU](image)
4.2 Level of Engagement

4.2.1 Center Personnel and Faculty Affiliates

Currently, the Center has one permanent full-time position (Kim) and one temporary full time research associate (Tscholl) in 2019-2021. The Center is in the process of hiring one staff member for program coordination and administration. The Center research activities therefore have been carried out in collaboration with faculty affiliates in and outside NIU and student researchers at NIU under the leadership of Drs. Kim and Tscholl. The level of engagement of the faculty affiliates is not feasible to present as FTE, and the level of Center support of their engagement varies depending on the affiliates’ needs: e.g., summer month pay, research implementation costs, GA/RA support, and course buyouts. More information about this support is presented Section 9.2.2.

Table 2.

<table>
<thead>
<tr>
<th>Name</th>
<th>Role/Expertise</th>
<th>Department</th>
<th>FTE</th>
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<tr>
<td>Kim, Yanghee</td>
<td>Morgridge Chair/CREATE Director</td>
<td>Educational Technology Research and Assessment (ETRA)</td>
<td>100%</td>
</tr>
<tr>
<td>Tscholl, Michael</td>
<td>Research Assoc Prof</td>
<td>CREATE Center</td>
<td>100%</td>
</tr>
<tr>
<td><strong>NIU Faculty Affiliates:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Strand Leaders</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burgin, Ximena</td>
<td>Culturally Responsive Classrooms</td>
<td>ETRA</td>
<td></td>
</tr>
<tr>
<td>Hu, Xiaodan</td>
<td>Educational Equity in Community Colleges</td>
<td>Counselling and Higher Education</td>
<td></td>
</tr>
<tr>
<td>Hwang, Jaejin</td>
<td>Multimodal Behavioral Analytics</td>
<td>Industrial and Systems Engineering</td>
<td></td>
</tr>
<tr>
<td>Kim, Kyung</td>
<td>Knowledge Visualization</td>
<td>ETRA</td>
<td></td>
</tr>
<tr>
<td>Shafer, Mary</td>
<td>Mathematics Teacher Education</td>
<td>Mathematical Science</td>
<td></td>
</tr>
<tr>
<td>Smith, Tom</td>
<td>Educational Statistics</td>
<td>ETRA</td>
<td></td>
</tr>
</tbody>
</table>
### Members

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wright, Paul</td>
<td>Teaching Personal and Social Responsibility</td>
<td>Department of Kinesiology and Physical Education (KNPE)</td>
</tr>
<tr>
<td>Alhouri, Hamed</td>
<td>Intelligent Systems Development</td>
<td>Computer Science</td>
</tr>
<tr>
<td>Butail, Sachit</td>
<td>Dynamic Systems Development</td>
<td>Mechanical Engineering</td>
</tr>
<tr>
<td>Daniel, Mayra</td>
<td>Bi-lingual Education</td>
<td>Curriculum and Instruction (C&amp;I)</td>
</tr>
<tr>
<td>Demir, Fatih</td>
<td>User Experience, Eye-tracking</td>
<td>ETRA</td>
</tr>
<tr>
<td>Hill, Chris</td>
<td>Reinforcement-based Motor Learning</td>
<td>KNPE</td>
</tr>
<tr>
<td>Johnson, Laura</td>
<td>Community-based Qualitative Research</td>
<td>ETRA</td>
</tr>
<tr>
<td>Liu, Lichuan</td>
<td>Digital Audio Signal Processing</td>
<td>Electrical Engineering</td>
</tr>
<tr>
<td>Martinez-Arroyo, Elvira</td>
<td>Community School Teaching</td>
<td>C&amp;I</td>
</tr>
<tr>
<td>Reeves, Todd</td>
<td>Assessment Teacher Education</td>
<td>ETRA</td>
</tr>
<tr>
<td>Ressler, Jim</td>
<td>Social and Emotional Learning</td>
<td>KNPE</td>
</tr>
<tr>
<td>Ricklefs, Mariana</td>
<td>Global Education</td>
<td>C&amp;I</td>
</tr>
<tr>
<td>Shiver, Victoria</td>
<td>Social and Emotional Learning</td>
<td>KNPE</td>
</tr>
<tr>
<td>Xie, Ying</td>
<td>Emerging Educational Technologies</td>
<td>ETRA</td>
</tr>
</tbody>
</table>

### External Faculty Affiliates

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antonenko, Pavlo</td>
<td>Educational Technologies and Scaffolding</td>
<td>College of Education, University of Florida</td>
</tr>
<tr>
<td>Brush, Thomas</td>
<td>Teacher Professional Development</td>
<td>School of Education, Indiana University</td>
</tr>
<tr>
<td>Cannon-Ruffo, Collen</td>
<td>K-12 Curriculum Design</td>
<td>Learning Services, Naperville School District</td>
</tr>
<tr>
<td>Dalkilik, Mehmed</td>
<td>Virtual Reality Applications</td>
<td>School of Informatics, Computing and Engineering, Indiana University</td>
</tr>
<tr>
<td>Kwon, Kyungbin</td>
<td>Augmented Reality and Computational Thinking</td>
<td>School of Education, Indiana University</td>
</tr>
<tr>
<td>Ortagus, Justin</td>
<td>Higher Education Administration and Policy</td>
<td>College of Education, University of Florida</td>
</tr>
<tr>
<td>Qi, Xiaojun</td>
<td>Intelligent Systems Analytics</td>
<td>Computer Science, Utah State University</td>
</tr>
<tr>
<td>Wilson, Timothy</td>
<td>Content Strategy and Career Paths</td>
<td>Bellwether College Consortium</td>
</tr>
<tr>
<td>Xing, Wanli</td>
<td>Emerging Technologies for STEM Learning</td>
<td>College of Education, Texas Tech University</td>
</tr>
</tbody>
</table>

---

Center Report 2018-2021

Cross-disciplinary Research on Equitable Advanced Technology for Education (CREATE)
4.2.2 Student Research Assistants

The Center supported both graduate and undergraduate students by enriching their research experience within the framework of research apprenticeship (learning research through taking part of research). This model is well grounded in the education research literature. Over the last four years, the Center supported approx. forty students through direct hire to the Center projects and faculty affiliate support for the research strands. Table 3 presents the student researchers who have worked for the Center research projects.

Table 3.

<table>
<thead>
<tr>
<th>Name</th>
<th>Task Area</th>
<th>FTE / Years Active</th>
<th>Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chunduri, Vamsi</td>
<td>Center Tech Coordination</td>
<td>25% / 2019</td>
<td>Graduate</td>
</tr>
<tr>
<td>Khalid, Danish</td>
<td>Center Tech Coordination</td>
<td>50% / 2019</td>
<td>Graduate</td>
</tr>
<tr>
<td>Mukhopadhyay, Saurav</td>
<td>Center Tech Coordination</td>
<td>25% / 2019</td>
<td>Graduate</td>
</tr>
<tr>
<td>Kramer, Chris</td>
<td>Center Tech Coordination</td>
<td>25% / 2021</td>
<td>Graduate</td>
</tr>
<tr>
<td>LaFond, Annabelle</td>
<td>CRI Interaction Design</td>
<td>50% / 2019-2021</td>
<td>Undergraduate</td>
</tr>
<tr>
<td>Sharath, Kumar</td>
<td>CRI Interaction Design</td>
<td>50% / 2020-2021</td>
<td>Graduate</td>
</tr>
<tr>
<td>Abdi, Beheshteh</td>
<td>Literature review</td>
<td>25% / 2018</td>
<td>Graduate</td>
</tr>
<tr>
<td>Gross, Kelly</td>
<td>Multimodal Data Analysis</td>
<td>25% / 2019</td>
<td>Undergraduate</td>
</tr>
<tr>
<td>Lemke, Kelly</td>
<td>Multimodal Data Analysis</td>
<td>50% / 2019</td>
<td>Undergraduate</td>
</tr>
<tr>
<td>Martinez, Bryan</td>
<td>Multimodal Data Analysis</td>
<td>25% / 2019</td>
<td>Undergraduate</td>
</tr>
<tr>
<td>Munns, Mitchell</td>
<td>Multimodal Data Analysis</td>
<td>50% / 2019</td>
<td>Undergraduate</td>
</tr>
<tr>
<td>Weiss, Adam</td>
<td>Multimodal Data Analysis</td>
<td>50% / 2019-2020</td>
<td>Undergraduate</td>
</tr>
<tr>
<td>Acosta, Xandre</td>
<td>Multimodal Data Analysis</td>
<td>25% / 2020</td>
<td>Undergraduate</td>
</tr>
<tr>
<td>Dinesh, Shiva</td>
<td>Multimodal Data Analysis</td>
<td>50% / 2020-2021</td>
<td>Graduate</td>
</tr>
<tr>
<td>Kurukundu, Ananya</td>
<td>Multimodal Data Analysis</td>
<td>50% / 2020-2021</td>
<td>Graduate</td>
</tr>
<tr>
<td>Addepalli, Karthik</td>
<td>Multimodal Data Analysis</td>
<td>50% / 2021</td>
<td>Graduate</td>
</tr>
<tr>
<td>Chandra, Alluri</td>
<td>Multimodal Data Analysis</td>
<td>50% / 2021</td>
<td>Graduate</td>
</tr>
<tr>
<td>Mobasshira, Zaman</td>
<td>Multimodal Data Analysis</td>
<td>50% / 2021</td>
<td>Graduate</td>
</tr>
<tr>
<td>Valluri, Harika</td>
<td>Multimodal Data Analysis</td>
<td>50% / 2021</td>
<td>Graduate</td>
</tr>
<tr>
<td>Yerriboina, Venkata</td>
<td>Multimodal Data Analysis</td>
<td>50% / 2019-2021</td>
<td>Graduate</td>
</tr>
<tr>
<td>Anand, Koushik</td>
<td>Robotic App Development</td>
<td>50% / 2018</td>
<td>Graduate</td>
</tr>
<tr>
<td>Bailey, Chris</td>
<td>Robotic App Development</td>
<td>50% / 2018-2019</td>
<td>Graduate</td>
</tr>
<tr>
<td>Karri, Hari Durga</td>
<td>Robotic App Development</td>
<td>50% / 2018</td>
<td>Graduate</td>
</tr>
<tr>
<td>Pothireddy, Rahul</td>
<td>Robotic App Development</td>
<td>50% / 2018</td>
<td>Graduate</td>
</tr>
<tr>
<td>Tangalla, Sai Varun</td>
<td>Robotic App Development</td>
<td>25% / 2018</td>
<td>Graduate</td>
</tr>
<tr>
<td>Imandi, Abhinay</td>
<td>Robotic App Development</td>
<td>50% / 2019</td>
<td>Graduate</td>
</tr>
<tr>
<td>Alubelli, Saijeja</td>
<td>Robotic App Development</td>
<td>25% / 2020</td>
<td>Graduate</td>
</tr>
<tr>
<td>Raman, Satwik</td>
<td>Robotic App Development</td>
<td>50% / 2021</td>
<td>Graduate</td>
</tr>
<tr>
<td>Zey, Demir</td>
<td>Robotic App Development</td>
<td>25% / 2021</td>
<td>Undergraduate</td>
</tr>
<tr>
<td>Zhou, Mengxi</td>
<td>School Implementation</td>
<td>50% / 2018-2019</td>
<td>Graduate</td>
</tr>
<tr>
<td>Adewumi, Oluwafikayo</td>
<td>School implementation</td>
<td>50% / 2019</td>
<td>Graduate</td>
</tr>
<tr>
<td>Coli Coli, Sheila</td>
<td>School implementation</td>
<td>25% / 2019</td>
<td>Graduate</td>
</tr>
<tr>
<td>Rath, Sahil</td>
<td>Transcription, English</td>
<td>50% / 2019-2021</td>
<td>Graduate</td>
</tr>
<tr>
<td>Patil, Sumog</td>
<td>Transcription, English</td>
<td>50% / 2020-2021</td>
<td>Graduate</td>
</tr>
<tr>
<td>Anna, Ramos</td>
<td>Transcription, Spanish</td>
<td>25% / 2021</td>
<td>Graduate</td>
</tr>
<tr>
<td>Montes, Regina</td>
<td>Transcription, Spanish</td>
<td>50% / 2021</td>
<td>Undergraduate</td>
</tr>
</tbody>
</table>
5. Securing External and Internal Funds

The Center has strived to secure funds for high quality research on technology integration in teacher education and, more broadly, for innovating educational theories and practices for all ages. Table 4 presents the number of funding proposals submitted and awarded, costs requested and awarded, and the NIU Facilities and Administration costs (F&A) awarded. Details about all grants submitted are presented in Appendix A.

Table 4.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of projects</th>
<th>Funding amounts</th>
<th>F&amp;A Earned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>External sub* awarded</td>
<td>Intramural sub awarded</td>
<td>External External req awarded</td>
</tr>
<tr>
<td>2018</td>
<td>4</td>
<td>1</td>
<td>$4,056,685</td>
</tr>
<tr>
<td>2019</td>
<td>2</td>
<td>1</td>
<td>$1,511,020</td>
</tr>
<tr>
<td>2020</td>
<td>4</td>
<td>0</td>
<td>$2,307,251</td>
</tr>
<tr>
<td>2021</td>
<td>1</td>
<td></td>
<td>$642,621</td>
</tr>
<tr>
<td>Totals</td>
<td>10</td>
<td>3</td>
<td>$7,874,956</td>
</tr>
</tbody>
</table>

* sub: submitted, req: requested

5.1 External Grants Awarded

- The National Science Foundation – Innovative Technology Experiences for Students and Teachers (ITEST). Awarded $1,367,577. Collaborative Research. **Principal Investigator Dr, Yanghee Kim (PI).** Co-PI: Dr. Jaejin Hwang from Industrial Systems and Engineering at Northern Illinois University. In collaboration with Drs. Kyungbin Kwon, Thomas Brush, and Mehmet Dalkilic at Indiana University.
  a. Grant number: NSF #2049046
  b. Project Title: *Implementing Mixed Reality for Inclusive and Embodied Learning Experience for Young Children (IMRIEL)*
  c. Duration: Sep 1, 2021 – Aug 31, 2024
  d. NIU Budget: $642,621

  a. Project Title: *Robots, Young Children, and Alternative Input Methods.*
  b. Duration: Jan 1, 2018 – Dec 31, 2019

- The National Science Foundation – Cyberlearning and Future Learning Technologies. Awarded $436,025. **PI.** Co-PIs: Dr. Sachit Butail (Mechanical Engineering), Dr. Lichuan Liu (Electrical Engineering), and Dr. Michael Tscholl.
  a. Grant number: NSF-IIS #1839194
b. Project Title: *Inclusive Design for Engaging all Learners (IDEAL): Designing Technology for Cultural Brokering*

c. Duration: Jan 1, 2018 – June 30, 2020

5.2 Intramural Grants Awarded


6. Reputation and Prominence

CREATE Center has been broadly recognized by national and international audiences and invited much attention locally and globally. We document the Center’s reputation using two numerical measures. First, we report counts of visitors to the Center website ([http://createcenter.net](http://createcenter.net)) by year and by geographical location since its inception in 2018. Next, we report scholarly prominence of the Center researchers (Drs. Kim and Tscholl) using the most reputable worldwide index for scholarly impacts, [Google Scholar Citations](https://scholar.google.com).

6.1 CREATE Website Visits by Years

Table 5 shows the number of unique visitors (per month), total visitors, and pages visited by quarter, starting from March 2018. The drop in quarter 2, 2020, is due to Covid-19.

<table>
<thead>
<tr>
<th>Year</th>
<th>Unique visitors</th>
<th>Total visitors</th>
<th>Pages visited</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>71</td>
<td>215</td>
<td>226</td>
</tr>
<tr>
<td>2019</td>
<td>278</td>
<td>545</td>
<td>1152</td>
</tr>
<tr>
<td>2020</td>
<td>424</td>
<td>665</td>
<td>974</td>
</tr>
<tr>
<td>2021</td>
<td>605</td>
<td>734</td>
<td>1120</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1317</strong></td>
<td><strong>2061</strong></td>
<td><strong>3381</strong></td>
</tr>
</tbody>
</table>

6.2 CREATE Website Visits by Geographic Locations

Figures below illustrate all CREATE website visits by geographic locations. Figure 13 shows the percentage of the visits from the U.S. and other countries for all years: US-based visitors comprised 43% and international visitors comprised 57%. Figure 14 details international visitors by their countries. Visitors from countries with 1% or less of total visits are grouped as ‘Others’.
6.3 Prominence in Scholarly Impact

Google Scholar Citations is recognized as the most valid and reliable measure for scholarly impacts by researchers in all academic disciplines. It has been used broadly in colleges and universities nationally and internationally. Table 6 presents the citation reports by Google Scholars for the Center researchers (Kim and Tscholl), as of October, 26th, 2021.

Table 6.

<table>
<thead>
<tr>
<th>Researchers</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yanghee Kim</td>
<td>208</td>
<td>240</td>
<td>218</td>
<td>283</td>
<td>1004</td>
</tr>
<tr>
<td>Michael Tscholl</td>
<td>70</td>
<td>100</td>
<td>92</td>
<td>111</td>
<td>308</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>278</td>
<td>340</td>
<td>310</td>
<td>394</td>
<td>1,312</td>
</tr>
</tbody>
</table>
7. Relationships and Partnerships

The Center has established collaborative partnerships with schools, districts, and peer institutions, and industry to conduct its applied research. Of note is that our research informs participating teachers with technology-enhanced equitable pedagogies. The teachers and students in the schools have praised our robotic apps for their educational benefits and desire to collaborate with the research teams in the future. Representative partners of the Center include:

Central Elementary School, Rochelle, IL ([https://www.d231.rochelle.net/](https://www.d231.rochelle.net/))

The IDEAL project team collaborated with two kindergarten teachers at this school to implement our design research in after-school programs. Our robotic apps were used by twenty-two children in Fall 2018. The learning goal was developing children’s equitable friendship behaviors.

Cortland Elementary School, Cortland, IL ([https://sites.google.com/a/d428.org/cortland/](https://sites.google.com/a/d428.org/cortland/))

The IDEAL project team extended their collaboration to Cortland Elementary School in the DeKalb School District. Our robotic apps served five teachers and eighty-five children over three months in Spring 2019. The learning goal was engaging children in equitable collaborative behaviors.

Hononegah High School, Rockton, IL ([http://www.hononegah.org/](http://www.hononegah.org/))

A research partnership with this high school was used to identify ways to improve students learning through increased physical activity. We collaborated with five District officials and teachers and implemented our mobile app with 200 students in PE classes.

U-46 school district, Elgin, IL ([https://www.u-46.org/](https://www.u-46.org/))

The research project AppleAscend and the research strand SEL K-12 collaborated with schools in the Elgin District to implement the learning programs with secondary school students. SEL K-12 further collaborates with administrators and teachers to design, implement, and evaluate a year-long professional development initiative.

Naperville School District 203, IL ([https://www.naperville203.org/domain/873](https://www.naperville203.org/domain/873))

The research strand Integrated STEM curriculum aims to understand and facilitate students’ computational thinking development through an integrated STEM curriculum by involving students (2nd to 4th grades) in learning activities centered on building LEGO robots. The project involves school administrators to enable them to adopt the curriculum with minimal training.

Data & System Lab, University of Wisconsin-Whitewater ([http://cs.uww.edu/~lees/](http://cs.uww.edu/~lees/))

A long-standing partnership exists between CREATE Center and Data & Systems Lab. The Lab leader Dr. Sungchul Lee advised the Center project teams on software development and system support of innovative digital technology.
School of Education, and School of Informatics, Computing and Engineering, Indiana University. Jointly with faculty from these departments, the Center was awarded an NSF grant (PI: Dr. Yanghee Kim) to study the potential of Mixed Reality for Inclusive and Embodied Learning Experience for Young Children. The project commenced in Fall 2021.

Department of Landscape Architecture and Environmental Planning, and Department of Computer Science, Utah State University. A partnership was established with these departments to develop a project studying the interplay between perception, action, and emotion in an ambiguous navigation task. Broadly, the project sought to examine how emotional states influence learning to solve complex problems, using a Virtual Reality environment as the study setting. The collaboration resulted in submitting a grant proposal to the Army Research Institute for the Behavioral and Social Sciences.

AppleSTEM (https://www.mathascend.com) This university/industry partnership has been established between CREATE Center and the non-profit organization AppleSTEM. Its online mathematics problem-solving environment (AppleAscend) has been used by mathematics teachers in U-46 high schools and served hundreds of students in Algebra I & II. The Center leadership (Dr. Kim) and the faculty affiliate Dr. Mary Shafer advised them on not only improving the curriculum and pedagogy but also developing fundable research programs.

Van Robotics (https://www.smartrobottutor.com/) This university/industry partnership between the Center and the humanoid robotics company Van Robotics was established in 2019. Van Robotics manufactures the robot brand ABii and sought the Center’s advice on research-based educational app development. The partnership continues to grow developing classroom-based applied research programs.

Mektebim College, Turkey (https://www.mektebim.k12.tr/en/anasayfa) Of notable mention is the Center’s involvement in UNESCO’s International Bureau of Education (IBE). The Center is strongly involved in curriculum development to prepare children for the future world. IBE’s current focus is to define, create and implement an integrated STEM curriculum for K-12 educators seeking to foster future-oriented competencies in robotics, artificial intelligence, augmented reality, and other competencies involving digital technologies.

Also, CREATE Center has strived to reach out to the NIU and DeKalb communities through local news media (e.g., CEDU News and Daily Chronicles). It disseminated the research activities and outcomes by posting promotional videos on national public outreach sites (e.g., STEM Video Showcase) and social media sites (Instagram, Facebook and Twitter). The Center social media channels have been used to advocate for the Center’s vision and how the vision has been implemented through the research and development of advanced technology for education.
8. Other Criteria: Innovation and Cutting-Edge Research

The CREATE Center is one of the leading research centers internationally on the development of cutting-edge digital technology for education, which occupies a unique niche at the human-technology frontier. This includes research on the learning affordances of social robots, of AI student advising systems, and mixed reality applications that exemplify the advanced theory embodied cognition and learning. Center research has been successfully published in the most prestigious peer-reviewed academic journals and conferences. Examples of these include:

- *International Society for Artificial Intelligence in Education (AIED)*
- *The Institute for Electrical and Electronic Engineers (IEEE)*
- *The Association of Computing Machinery (ACM)*
- *International Society for Learning Analytics & Knowledge (LAK)*
- *International Society of the Learning Sciences (ISLS)*
- *American Educational Research Association (AERA)*
- *American Psychological Association (APA)*

The Center contributions to education research, as well as computer science and engineering, attest that the Center is at the forefront of development and application of innovative analytical approaches and methods to the study of learning. Thus, the Center is a key contributor to both NIU’s and COE’s mission to conduct innovative research on teacher education and cutting-edge technology for the benefit of the local community, the nation, and the world.

9. Center Values and Enhancement of Affiliated Scholarship

9.1 Center Values: Equity and Multidisciplinarity

9.1.1 Achieving Equity

The Center values achieving equity through innovative use of advanced technology, which is also aligned with NIU’s commitment to social justice, equity, and inclusivity. The Center’s research focus is on developing advanced technological tools in response to increasing diversity in school and modeling equitable pedagogical approaches for teachers which engender equitable communication, collaboration, and learning. Five Center research programs are notable in this regard as presented in Section 3 (page 2). Their focal contribution to achieving equity is highlighted here:

- *Project IDEAL* (see p. 2 for more information): For elementary children, a humanoid robot to facilitate equitable collaboration among young children from diverse backgrounds.
- *Project IMRIEL* (p. 4): A robot equitably invites every child to AR-enhanced play with a robot playmate that is free from judgments and social biases, enabling the children’s positive affect and learning.
- *SATT* (p. 5): This project identified the teachers’ needs for integrating students' culture and linguistic diversity into lesson planning.
• *SEL K-12* (p. 8): The project seeks to develop social-emotional learning programs to address issues related to social inequity and cultural and linguistic differences.

• *AI-TALE* (p. 10): This AI Institute aims to research and develop an AI-enabled, flexible open learning environment. The NIU branch seeks to address critical issues on achieving gender and ethnic equity in IT-related education and workforce development.

By conducting rigorous research, the Center has sought to develop new models and pedagogical approaches to achieving equity. The Center research findings therefore can ripple out broadly beyond the study setting. They can inform both teachers and administrators in schools and the educational-technology research community about the use of technology for the purpose of expanding human capacities.

9.1.2 Multidisciplinarity

One of the CREATE Center’s missions involves studying the use of advanced technological tools so that the affordances they provide can enable solutions for critical issues in education. This necessitates the inclusion of a broad array of disciplinary knowledge and skills. Since its inception, the Center has established multidisciplinary collaborations with departments and colleges across campus and outside NIU. Figure 17 depicts CREATE Center as the nexus where multidisciplinary researchers collaboratively develop research programs to address educational challenges, acting as the leader of the multidisciplinary programs. Of note, the Center’s emphasis on multidisciplinary research dovetails with the new NIU initiative to foster transdisciplinary research and education. Figure 17 shows the number of the faculty affiliates by the home departments and colleges.
9.2. Enhancement of Affiliated Scholarship

To sustain high-quality research programs over the long term, it is crucial for the Center to commit to the enhancement of affiliated scholarship. To this end, the Center has supported junior faculty affiliates and student researchers and helped to develop the next generation of scholars. Research support for junior scholars was implemented through two channels: by inviting them to research projects where the Center leadership mentored in grant writing, and coauthoring manuscripts, and by providing financial support for implementation and to secure their time for research. The Center also enriched graduate and undergraduate students’ learning experiences at NIU through research assistantships in nationally funded, rigorous research programs. We hope this new generation of researchers will conduct advanced research that crosscuts education and cutting-edge technology.

9.2.1 Mentoring for Grant Writing

The Center has committed to developing fundable research programs and successfully secured external funds. The Center aided junior faculty in grant development by involving them as co-PIs. Since its inception in 2018, the Center leadership has mentored 11 junior faculty affiliates at NIU. Table 7 shows grant submissions with the involvement of NIU junior faculty affiliates as co-PIs. For details of the projects displayed in the table, see Section 5 and Appendix A.

<table>
<thead>
<tr>
<th>Project title</th>
<th>Year</th>
<th>Target agency</th>
<th>No. of NIU faculty affiliates</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDEAL</td>
<td>2018</td>
<td>National Science Foundation (NSF)</td>
<td>3</td>
</tr>
<tr>
<td>TATE</td>
<td>2018</td>
<td>NSF</td>
<td>4</td>
</tr>
<tr>
<td>IPAE</td>
<td>2019</td>
<td>Army Research Institute</td>
<td>2</td>
</tr>
<tr>
<td>MathAscend</td>
<td>2020</td>
<td>NSF</td>
<td>1</td>
</tr>
<tr>
<td>ITEST</td>
<td>2020</td>
<td>NSF</td>
<td>1</td>
</tr>
</tbody>
</table>

9.2.2 Financial Support for NIU Faculty Affiliates

Over the last 4 years, the Center has financially supported faculty affiliates across campus, totaling $236,444 (details in Section 10). Table 8 presents the types of financial support and case counts.

<table>
<thead>
<tr>
<th>Type of Support</th>
<th>No. of faculty affiliates supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional pay</td>
<td>9</td>
</tr>
<tr>
<td>Course buyouts</td>
<td>2</td>
</tr>
<tr>
<td>Summer months</td>
<td>5</td>
</tr>
<tr>
<td>Travel support</td>
<td>2</td>
</tr>
<tr>
<td>Graduate assistants</td>
<td>3</td>
</tr>
</tbody>
</table>
Additionally, in 2020, the Morgridge Chair/Center Director established the Morgridge Researcher/practitioner Partnership Accelerator Grant (MRPAG) within the College of Education (CEDU). The goal was to support CEDU faculty researchers in developing their own lines of research in teacher education and strengthening their unique research portfolios. The grant invited small teams of faculty researchers (i.e., three to five members) within CEDU to develop cross-departmental projects that address the needs of K-12 teachers and students by collaborating with local schools and districts. For the 2020-2021 funding cycle, two teams were selected through open competition and awarded $20,000 each. The teams joined as Center research strands: Integrated STEM Curriculum and Social and Emotional Learning in Physical Education (for details of these strands, see Section 3).

9.2.3 Supporting Student Researchers

Over four years the Center has committed to developing the next generation of researchers and scholars by adopting a research apprenticeship model. The Center has invited over 40 graduate and undergraduate students to the Center’s research across campus and financially supported them to continue with their own programs of study: 36 students participated as research assistants in the Center’s core projects and several more students as part of research strands led by faculty affiliates.

Figure 18 presents the disciplinary backgrounds of the students who have participated in the Center projects. These student researchers had an opportunity to apply disciplinary knowledge and skills they learned from their home programs to address educational challenges. Importantly, the students learned and honed their research skills, such as developing teaching and learning programs which were used in the real-world educational settings, dealing with human subjects, the processes of scientific data collection and analysis, and presenting research outcomes to professional communities. In addition, some of the students produced their theses from this research apprenticeship.

In Spring 2021, the CREATE Center conducted a survey among its current and former students to examine their views and experiences while working for the Center. Overall, a synthesis of their responses documented that the multidisciplinary research experiences not only strengthened their disciplinary understanding but also led them to be open-minded beyond their disciplinary frame of thinking. A summary of this student feedback is presented in Appendix B.
Of note, their involvement in and learning from the Center’s multidisciplinary projects addresses an urgent need in job markets in our society, developing transdisciplinary problem-solving mindsets and skills to resolve complex societal challenges.

10. Budget

10.1 Revenue

The Center personnel does not have direct access to all CREATE budget accounts, so the numbers reported in this section are only an estimation obtained from available spending sheets provided by the CEDU Dean’s office and the Sponsored Program Administration in mid-September, 2021. Based on this information, the CREATE Center revenue for the years 2018 to 2021 was estimated as $1,097,863. The revenue reported for External Grants excludes F&A charges and the new NSF-ITEST grant that started on September 1, 2021.

Figure 19. CREATE Center Revenue 2018 - 2021, by Source

<table>
<thead>
<tr>
<th>Source</th>
<th>Revenue</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morgridge Foundation</td>
<td>$656,470</td>
<td>60%</td>
</tr>
<tr>
<td>CREATE Center</td>
<td>$66,274</td>
<td>6%</td>
</tr>
<tr>
<td>RIPS</td>
<td>$13,500</td>
<td>1%</td>
</tr>
<tr>
<td>External Grants</td>
<td>$361,619</td>
<td>33%</td>
</tr>
</tbody>
</table>

10.2 Expenditures

CREATE Center expenses for January 2018 – August 2021 were estimated as $1,099,971. Figure 20 presents expenses by budget categories.

Figure 20. CREATE Center Expenses 2018 - 2021, by Type

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>26%</td>
<td>$286,083</td>
</tr>
<tr>
<td>Student Support</td>
<td>28%</td>
<td>$284,453</td>
</tr>
<tr>
<td>Travel</td>
<td>1%</td>
<td>$12,100</td>
</tr>
<tr>
<td>Faculty Research Support</td>
<td>19%</td>
<td>$215,484</td>
</tr>
<tr>
<td>Material and Services</td>
<td>28%</td>
<td>$299,852</td>
</tr>
</tbody>
</table>
11. Strategic plan for the next 5 years

As we look forward, the educational challenges that CREATE Center has sought to address have become even more urgent and necessary today than they were five years ago. We have addressed challenges, such as achieving equity in teaching and learning, technology-enhanced support for teachers and learners in classrooms, and multidisciplinary collaborative endeavors to resolve educational problems. Policy makers and institutions in the State and across the Nation have recently embarked on initiatives which mandate that teachers and administrators address these challenges in research and practice.

Reflecting this trend, CREATE Center will continue to focus on its core missions (stated in Section 2) over the next five years. The Center will continue to excel in innovative and leading research and scholarship locally, nationally, and internationally. Driven by its core mission, advanced technology integration for education, the Center will commit to these focal areas:

- Studying the application of advanced technology to provide technology-enhanced supplemental materials for teachers and students.
- Investigating equitable designs of such technologies to address diversity and equity in teaching and learning.
- Collaborating with diverse academic and professional communities to develop multidisciplinary and transdisciplinary research and education programs.
- Developing junior faculty affiliates and students through research mentorship and financial support.
- Demonstrating leadership in and through research and scholarship locally, nationally, and internationally.
- Securing external funds to sustain robust research programs.

Table 9 summarizes the estimated budget projection of the Center for the next five years (July 1, 2022 through June 30, 2027). Based on the current funding availability, there is an estimated budget gap. We expect that the gap could be filled with the RIPS support on student employment costs and by securing additional external funding. More details of these estimations are presented in Appendix C.

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Revenue</td>
<td>$1,398,276</td>
</tr>
<tr>
<td>Estimated Expenditure</td>
<td>$1,739,520</td>
</tr>
<tr>
<td>Estimated Budget Gap</td>
<td>-$341,244</td>
</tr>
</tbody>
</table>

12. Conclusions

Over the last four years, the Center leadership has faced many obstacles and challenges. Particularly, the COVID-19 shelter-in-place restrictions for almost one and a half years in 2020 – 2021 inhibited our performance and narrowed the timeframe during which we could perform our mission. In fact, the actual performance time frame of the Center has been much shorter than four years. Nonetheless, the Center has accomplished its missions successfully since its inception in fall 2018. We hope the Center will continue to play a role in addressing current trends in education research and urgent needs in teacher education and continue to make substantial contributions through rigorous research and scholarship.