Co-designing with Children: Exploring Changes in Special Education Teachers' Attitudes and Design Belief towards Pedagogical Agents

Exploring changes in special education teachers' attitudes and design belief towards pedagogical agents in co-designing with children

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ABSTRACT

Special education teachers' perception and attitudes towards technology and design play a critical role in pedagogical practices. The study aims to explore changes in special education teachers' attitudes and design beliefs through a co-design process with children. The initial pilot study focused on preparing special education teachers for effective integration of pedagogical agents into teaching and learning. The initial pilot study followed the mixed-method design and was guided by the following research question: In what ways the co-design process influenced teachers' attitudes and design beliefs towards pedagogical agents through the co-design process with children? The preliminary results indicated by the end of the program that teachers' attitudes towards pedagogical agents increased significantly with moderate effect sizes, which might contribute to the co-design process and interactions with pedagogical agents. Qualitative analysis based on teacher interviews, lesson projects, and field notes also suggested that the shifts in participant's attitudes and design beliefs are influenced by a variety of personal and contextual factors including i) The didactic use of pedagogical agents; ii) the usefulness of pedagogical agents for inclusive education; (iii) teachers' attitudes about the role of the teacher as a designer, and (iv) leadership support to facilitate the immersive learning experience created through the interaction between the human and pedagogical agents.

CCS CONCEPTS

• **Pedagogical agents**; • **collaborative learning**; • **special education**;

KEYWORDS

Assessment, Curriculum Design and Development, Inclusive Education, Professional Development, Teacher Belief

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1 INTRODUCTION

There is an increasing demand for special education teachers to utilize pedagogical agents to address children's academic and social emotional needs in preparing for the unpredictable classroom learning and teaching [1][2]. During the first five years of the 21st century, multiple research scholars proposed an interpretation of teacher knowledge necessary [2] for effective integration of pedagogical agents into teaching and learning as the interconnection [3] and intersection of knowledge repository and classroom practices [4].

Collaborative learning with robots and agents has created new opportunities for innovative teaching in special education classrooms, leveraging more learning opportunities to support all children from culturally and linguistically diverse communities. Studying and identifying the effective practices could inform teachers to select, design, and innovate pedagogy to meet the needs of diverse learners [5]. Pedagogical agents, which are identified as effective artifacts, could engage learners in social dialogue and enable new ways for children to reflect, reason, and learn [6]. It has served as cognitive tutors [7], peer learners [8], conversational agents [9], and mentees [10] to develop young learners' reading literacy, problem-solving and analytical thinking skills.

In viewing the complex process of collaborative learning with pedagogical agents, it is critical to explore processes to practice and design for educators to create meaningful pedagogical practices and promote lifelong learning [11]. This is especially critical given the challenges of COVID-19, children have struggled with online learning environments with limited opportunities for social interaction and resources for these disruptive times. [12].

The study was conducted in responses to COVID-19 challenges to support children with disabilities – namely limited opportunities to prepare special education teachers to effectively utilize the pedagogical agents to provide high-quality, inquiry-based instruction and practices [13]. The study explored teachers' attitudes and design belief towards pedagogical agents as they interacted with agents to co-create interactive simulations [14], prompt high cognitive tasks [15], provide emotional support [16], train algorithmic models, and build autonomous agents [17]. Numerous literatures have identified an interactive co-design process involving both teachers and children could facilitate the design of inclusive practices [18].

The key premise of the study was that the pedagogical agent was a catalyst for preparing teachers to innovate pedagogy and design inclusive, collaborative, and culturally relevant practices [19]. The research paper explored changes in special education's attitudes and

design beliefs towards pedagogical agents to implement inclusive teaching practices through the co-design process.

2 LITERATURE REVIEW

2.1 Pedagogical Agents for K-12 Education

Pedagogical agents have been seen in diverse fields across educational disciplines [20] to support children with special learning needs, including sensing, processing sensory information, and performing actions in the classrooms [21]. The pedagogical agents could serve as peers, partners, mentees, or tutors to develop associated cognitive and affective learning outcomes [22]. Beyond personalized support, pedagogical agents can also mimic human characteristics through human emotional attachments and build companionship with young learners [23]. Also, the dialogic agents can serve as an intelligent device that can detect abnormal voice tones and sentiment in speech, and respond with therapeutic offerings such as music therapy [24], to help alleviate some pain from mood disorders [25] and adolescent depression [26].

Recent advancement in learning technology and learning sciences have helped expand the range of concepts children can explore with different robotic systems and machine learning platforms. Robotics as interdisciplinary disciplines have potential to enrich the concepts of math, science, engineering, and computational thinking [27]. The effective meaningful practices to prepare teachers to design and innovative effective teaching practices with the use of pedagogical agents have been suggested as a promising way to improve children's learning experience in STEM disciplines [28].

2.2 Deficit Thinking and Special Teacher Education

Even though pedagogical agents serve as a catalyst to make changes in teaching and learning, it has historically been implemented inequitably across schools. As a result, children who come from socially and economically disadvantaged communities often have limited resources and curriculum compared to the children in the mainstream classrooms [29]. This deficit teaching model has historically hindered children's academic success [30], especially when schools and teachers categorize children with special needs, and do not understand that children with special needs are capable of success, especially when they are able to learn through curriculum [31].

Moreover, cultural stereotypes and deficit thinking might be roadblocks to persuade teachers to re-conceptualize their preconceived notions about children with disabilities, and view children as capable learners who can benefit from the curriculum [32]. Teachers who employ cultural stereotypes and deficit thinking could easily create inaccurate characterizations of academic ability to children [33] based on race, ethnicity, and special learning accommodations [34]. Therefore, it is critical to prepare teachers and administrators to become more deeply involved in multi-fold issues of equity and design an authentic culturally inclusive learning environment [35].

2.3 Deficit Thinking and Special Teacher Education

Literature review have shown that teachers' attitudes and design beliefs about pedagogical agents affect inclusive teaching practices in the classroom [36]. Also, their design belief might also influence teachers' ability to create a student-centered, interdisciplinary learning experience [37] Research also showed that authentic learning exercises with technology led to a significant increase in teachers' ability to design [38]. Additionally, the studies also showed that teachers' design beliefs could be a significant predictor of their ability to design [39], however, the lack of design thinking could become a barrier to technology integration [40].

Researchers and practitioners have recognized the importance of co-design to meet the needs of diverse learners [41]. Understanding the effective teaching practices in response to learning sciences principles, it is critical for teachers to develop the ability to design that create a meaningful learning experience and provide opportunities for deepening children's understanding of content. The ability to design shows the promising means that help teachers to reflect curriculum goals, facilitate formative assessments, and engage diverse children in this kind of inquiry-based learning environment.

To amplify the impact of design practices, several research studies have highlighted the values of co-design with teachers in engaging an authentic learning experience and involving tangible innovation challenges. The Understanding by Design framework [42] and Universal Design for Learning [43] provided teachers with general guidelines for learning and teaching inclusive practices [44]. Both the "backward-design" and UDL approach allowed teacher-educators to consider different pedagogical approaches and modalities to present information to meet the demands of all children, regardless of instructional environment and academic disciplines [45]. Other co-design studies emphasized the values of incorporating culturally relevant practices to build design capacities to meet the needs of diverse learners and adopt the inclusive practices [46].

Considering the complexity of the learning environment, limited research study has explored education teachers' attitudes and design belief towards pedagogical agents throughout the co-design process [47]. Therefore, the research study took a mixed method approach to explore special education teachers' changing attitudes and design beliefs as they utilized the pedagogical agents to create inclusive practices. The study might further contribute to our understanding in the co-design process to create inclusive and culturally responsive teaching practices.

3 STUDY CONTEXT

The co-design process was conducted on an online educational technology program that modeled the use of pedagogical agents to innovate pedagogical practices. The session was conducted in a total of five sessions with the emphasis on promoting computational thinking, transfer of learning, critical thinking, problem-solving, and decision-making. Participants were challenged to identify and investigate inclusive pedagogical practices for introducing diverse pedagogical agents into the classroom across disciplines. The program met for fifteen consecutive weeks, with two sessions per week: a two-hour session led by doctoral student-mentors. Participants were introduced to the theoretical foundations of effective

Table 1: Co-designing Inclusive Pedagogical Agents Practices

Week	Topics	Hands-on projects	Pedagogical agents
Phase 1	Positioning teachers as designers with the use of pedagogical agents.	Introduce theoretical foundations for pedagogical agents	Exploring the use of PoseBlocks to create interactive games
Phase 2	Exploring higher-order thinking tasks to rethink the use of pedagogical agents.	Explore high order thinking tasks with pedagogical agents.	Creating chatbot in affective computing
Phase 3	Developing problem-solving and research skills to enhance understanding	Create basic simulation with the use of pedagogical agents.	Training Cute Bot to optimize learning path in reinforcement learning
Phase 4	Engaging learners in collaborative learning.	Create hands-on robotic car simulation in small groups	Engaging human-robot teaming in computer visions
Phase 5	Conducting assessments (Formative, summative, pre-assessment).	Utilize pedagogical agents to conduct formative assessments	Utilizing Arduino to build the line sensing control robot

technology use in K-12 teaching and learning, they experienced the integration of pedagogical agents, integrated activities from a student perspective, and then discussed their experience from a teacher's perspective. During the session, teachers also had the opportunity to learn how to use pedagogical agents and apply their knowledge to develop their own K-12 activities.

To challenge participants to identify and investigate diverse use of pedagogical agents as learning tools across disciplines, the researcher modeled five core instructional practices. The modeling practices included positioning teachers as designers with the use of pedagogical agents [48]; exploring higher-order thinking tasks to rethink the use of pedagogical agents [49]; developing problem-solving and research skills to enhance understanding; engaging learners in collaborative learning [50]; and conducting formative, summative, as well as pre-assessment assessments [51].

Through the co-design process, participants were able to utilize and explore diverse pedagogical agents and technology platforms. Specifically, teachers were modeled to use PoseBlocks that incorporated the hand-sensing, body-sensing, and face-sensing blocks to design interactive games. Other modeling sessions included utilizing Amazon Alexa, a conversation robot, to design music therapy to provide children with emotional support; train Cutebots to optimize learning path while enhancing the understanding of reinforcement learning; and explored vision-based vehicles to team with autonomous agents. The session outline is shown in the following Table 1

4 METHODS

The research focused on the use of pedagogical agents in designing inquiry-based learning environments for students with disabilities, especially for children from the low-income school districts. The primary research question was in what ways the co-design process influenced teachers' attitudes and design belief to support children with disabilities. The secondary research question is what are the critical principles that prepare special education educators to design curriculum with the use of pedagogical agents to leverage more learning opportunities for children with disabilities. The pilot study followed a mixed-method design to analyze quantitative and qualitative data to capture the change of teachers' attitudes and design beliefs through the co-design process. The study was implemented in inclusive classroom settings in both public and private elementary schools in the New York City and Connecticut areas. Both school districts had diverse urban centers, and populations of learners with diverse learning needs. A total of twenty teachers were recruited, including teachers who (i) were full-time employees in inclusive classrooms; (ii) those who had at least one to two years of teaching experience; and (iii) a demonstrated commitment to participating in a six-month intervention. The children from the twenty participating teachers' classrooms also participated in the research study.

4.1 Procedures

Throughout the intervention, the researcher worked with both teachers and children to interact with pedagogical agents throughout the 15 weeks intervention. Because situating is a critical element in the study, the researcher first worked with participating teachers to model diverse techniques from both teachers and children's perspective with the use of pedagogical agents. This included i) exploring the use of PoseBlocks to create interactive games; ii) creating a conversational AI bot to introduce affective computing; iii) training Cutebots to optimize learning path to introduce reinforcement learning; iv) engaging human-robot teaming in computer visions; and v) utilizing Arduino to build the line sensing robot to introduce interaction. Then, the researcher worked with teachers to co-design a project with the integration of the pedagogical agents. Finally, the researcher supported the implementation of the co-design curriculum in the classrooms and served as resources to support children with disabilities. A follow-up reflection was conducted to capture the shifts of teachers before and after the intervention.

4.2 Instruments

The study adapted the assistive technology pedagogical belief questionnaire that uses Likert scale to measure three core constructs related to technology: beliefs about pedagogical agents to deliver

instruction, differentiate instruction; and create inclusive environments [52]. The values of Cronbach's α ranged from .874 to .9 for three domains of the teacher questionnaire; the overall value of .89 indicated high internal consistency of the classroom observation protocol [53].

4.3 Data Collection and Analysis

Quantitatively, the survey was administered during the beginning and the end of the program using Qualtrics. In addition, a semi-structured survey with four open-ended questions about the experiences in using instructional technology to design projects for classroom teaching and learning was administered weekly and used to interpret results of quantitative analysis. Qualitatively, teacher interviews were collected to capture the interactions, including engagement, participation, interests' development through the intervention. Teacher interviews were conducted to analyze teachers' attitudes and beliefs towards pedagogical agents on their classroom practices through the open-ended questions mentioned above. For example, some items asked included: How much value do you see pedagogical agents to support classroom lessons in supporting children with special learning needs (Question 4) and how flexible do you think the pedagogical agents can support curriculum design and plan to support children with special learning needs (Question 5). The researcher conducted teacher interviews before and after the intervention to capture shifts in teachers' perceived usefulness of pedagogical agents for delivering instructions, differentiating instructions, and creating inclusive environments. Also, the interview protocol invited teachers to share external factors that might facilitate and inhibit the implementation of pedagogical agents to allow the researcher to explore diverse decision-making factors in this context. Classical content analysis based on the key theme from the core classroom observation, interview, and open-ended questionnaires were used to analyze contextual and personal factors that might contribute to both student-level and teacher-level learning outcomes. Student artifacts were analyzed throughout the co-design process.

5 RESULTS

5.1 Quantitative Analysis

Participants generally achieved an average level (M = 4.76, SD =0.03) in week sixteen. Participants started at the agreement level based on their perception(s) of the usefulness of pedagogical agents (M = 4.31, SD = 0.26) in week one. Participating teachers' perceived usefulness of pedagogical agents decreased from week two (M = 3.91, SD = 0.42) to week four (M = 3.5, SD = 0.1). Beginning in week five, participants' perceived usefulness of pedagogical agents increased and then fluctuated between weeks five (M = 4.26, SD =0.32) through seven (M = 4.36, SD =0.2). During weeks eight and nine, perceived usefulness plateaued (M = 4.7, SD =0.08). By the end of the program in week fifteen, most participants recognized the values of pedagogical agents in designing projects (M = 4.76, SD =0.03). One-way repeated measures ANOVA was performed to compare the effect of time on the perceived usefulness of pedagogical agents to provide instruction, differentiate instruction, and create an inclusive environment. Mauchly's test indicated that the assumption of sphericity had not been violated $\chi 2(5) = 3.471$, p = .612. This conclusion was supported by the Greenhouse–Geisser estimates of sphericity value very close to 1 (ϵ =.934) and by the perfect Huynh–Feldt estimate (ϵ = 1.000). Thus, time had a significant effect on the mean of the perceived usefulness of pedagogical agents, F(2, 37) =27.25, p < 0.01 with medium effect size ($\omega 2$ = .60). A repeated contrast test indicated that teachers' perceived usefulness of pedagogical agents increased significantly from the first five weeks to the middle five weeks (4.02±0.09 vs. 4.06±0.1, respectively), which was not statistically significant (p = 1.0). However, the last five weeks increased to 4.72±0.07, which was statistically significantly different from the first five weeks (p < .001) and the middle five weeks (p < .001). Thus, implementing the co-design process in the two participating schools resulted in a statistically significant increase in teachers' pedagogical thinking in perceiving the usefulness of pedagogical agents, but not after only four weeks of training.

5.2 Qualitative Analysis

5.2.1 The didactic use of pedagogical agents. Emerging themes from pre-interview revealed that teachers initially revealed that for the most part, technology was used primarily in a didactic way. In the ELA classroom, teachers encouraged children to build a chatbot to raise the awareness of environmental science. As a follow-up assignment, children were encouraged to match vocabulary with key concepts to design the chatbot. In the science classroom of school B, the teacher used the game-based media software - BrainPOP - to explain the impact of the light on plants. In the technology classroom of School II, the teacher assigned children to work on projects at code.org with a set of instructions. No evidence was found that teachers used technology to innovate pedagogy or to create a student-driven inquiry learning environment before the intervention.

5.2.2 The usefulness of pedagogical agents for inclusive education. Emerging themes from the field notes and post-interviews proposed that teachers perceived the usefulness of pedagogical agents to differentiate instruction that supported children with disabilities. During the interview, teacher participant 3 expressed this: by visualizing the PoseBlocks, children could more easily understand the concepts of face sensing and body sensing. Teacher 10 from School II shared that "combining drama with technologies was a fun way to make these projects and develop their creativity" in the implementation phase. The teacher participants took an active approach to work with the researcher to incorporate different hands-on challenges into their daily classroom teaching to support children with disabilities.

5.2.3 Teachers' attitudes about the role of the teacher as designers. Field notes and teacher post interviews suggested that teachers were gradually aware of the value of design and felt excited that their children were more engaged in the inclusive teaching projects using pedagogical agents. Throughout the co-design process, most of the teacher participants recognized the value of engaging children in pedagogical agents that further developed children's problem-solving and analytical thinking skills through the design process. Teacher participant 5 explained that "[children] will learn about their personal impact on our climate and immediate environment

and how that can be measured [by using the PoseBlocks]." Teacher participants identified the common advantages to become designers to create inclusive teaching experience. For instance, teacher participant 11 expressed the excitement to use conversational chatbot to engage conversation and acknowledged the values of pedagogical agents by stating "I want to [integrate] fun chatbot projects for children to explore environmental science". Teacher participant 11 was aware of the importance to design lesson projects that helped children to make connections with abstract concepts, developed their understanding of AI literacy, and encouraged children to conduct research to deepen their knowledge of the ideas.

5.2.4 Leadership support to facilitate the immersive learning experience. Qualitative data suggested that teachers' decision-making in selecting pedagogical agents was multifaceted, depending upon the available resources in schools and districts (e.g., public, or private institutions), structural support (e.g., administrative support, co-planning), and professional development (e.g., instructional support, innovative teaching methods). Leadership support was identified from the qualitative analysis of the teacher interviews. Although administrators expressed the need to support and develop teachers' ability to design curriculum, teachers expressed the need for administrative support to do the work. One school principal encouraged teachers to rethink the existing curricula in special needs classrooms to design inclusive teaching practices. Teacher participants also approached their principal and expressed the need to think about pedagogical agents to support interdisciplinary, culturally relevant projects while engaging children's interests across disciplines.

6 DISCUSSION

The initial pilot study showed that upon completion of the co-design process, on average, participating teachers' scores for attitudes towards the usefulness of pedagogical agents increased significantly with medium effect sizes. These changes might be attributed to the program design, specifically, inclusion of co-design process that position teachers as designers, situate the process to utilize ze pedagogical agents in the classrooms, model of pedagogical practice, focus on high-impact teaching strategies, and choice of an interactive online platform. These results are consistent with findings by Banda & York [54] who demonstrated that an authentic technology-enhanced learning environment could be one of the factors leading to positive changes in the attitudes towards technology integration and self-perceived usefulness of technology. For instance, in the beginning of the program, teacher participants expressed some discomfort with using pedagogical agents for teaching as evident from the following comment made by teacher participant 16: "I think it is also a challenge for me, it also needs the [integration] of PoseBlocks, which I cannot proficiently use now" (week 2 survey). Similarly, teacher participant 1 indicated that "To be honest, I don't have much confidence at the moment" (week 2 survey). By the end of the week 4 teachers expressed higher confidence in their abilities to integrate pedagogical agents into teaching a specific topic of their choice, as evident from this statement from the same teacher participants: "After four weeks [of] explorations and lessons, I felt more confident to use PoseBlocks [technology platform] to introduce the topic of social robots" (week 7 survey). Teacher participant 1 progressed and explained that "I learned how to use the tools of PoseBlocks in teaching to diversify the curriculum (week 7 survey).

The fluctuation between weeks five (M = 4.26, SD =0.32) through seven (M = 4.36, SD =0.2) in their views about the perceived usefulness of pedagogical agents could be explained by the fact that as participants engaged in the co-design sessions, they have realized the complexity to use it as an instructional tool and integrate it into the curriculum to meet the needs of diverse learners. A third of participants stated that they are gaining a sense of confidence in using pedagogical agents for specific tasks and starting to feel comfortable using the tools, however, they expressed the need for continuous support to design, create, and implement the projects.

Additionally, prior to intervention, it seemed that teachers relied more on "techniques" for control and incremental skill acquisition and missed the need to teach for understanding. The underlying assumption of teachers' pedagogical belief was not based on the science of learning and development that equipped children with the skills to "find, analyze and apply knowledge" in real life. For example, teacher participant 4 created a list of task-oriented tasks to improve children's understanding of data. The teacher created a list of question banks for children to evaluate the concept of data, then required children to complete a quiz to assess their understanding.

After exploring diverse applications of pedagogical agents, the teacher participants were more reflective on the use of diverse pedagogical agents and appreciated the value of design to create a student-centered learning environment.

The plateau between weeks eight and nine (M = 4.7, SD =0.08) could be explained by the fact it takes time to gain knowledge repository and skills to utilize pedagogical agents into classroom teaching. Having been exposed to co-design teachers, participating teachers require more preparation and practice to be able to create projects. This was also explained by teacher participant 15, "I would want to know about [pedagogical agents] before designing the projects" (week 9 survey)".

By the end of the program in week fifteen, most participants recognized the values of pedagogical agents in designing projects (M = 4.76, SD =0.03) could be explained by the program support structure and participants' interests in the co-design process. It was an elective program, so participants who were selected to enroll in it were already interested in the topic and believed in the role of the teacher in cultivating effective learning experiences for children This is evident from the following comment by the participants made in week 1 survey: "[The co-design] enriched my learning about how to integrate technology in education and learn about how to design projects [in using pedagogical agents] (Participant 16)".

7 CONCLUSION

Overall, the study seeks a way to explore the co-design process to support special education teachers who serve children with disabilities to design inclusive practices with the integration of pedagogical agents. The overall results revealed a statistically significant shift in terms of teachers' attitudes and design beliefs to design inquiry-based projects that integrated pedagogical agents. The initial qualitative results also showed the importance of co-design process to strengthen the design capacity for special education and give

them ownership to design projects that are inclusive and culturally meaningful for children Also, the co-design process showed the values for special education teachers to re-conceptualize teaching practices and rethinking the use of pedagogical agents to innovate inclusive pedagogical teaching.

The ongoing technological and pedagogical challenges require a more nuanced understanding of pedagogical agents throughout the co-design process to meet the needs of diverse learners. Beyond teaching and professional development, administrative support is critical in leveraging opportunities for children with special learning needs. Future studies should examine the administrative support, pedagogical practices, and resources existing in schools serving children with special needs and how the principal supports teachers in common planning and teaching [55].

Human robot interaction as a rather complex process requires ongoing efforts from interdisciplinary collaboration to understand effective factors that contribute to learning autonomy of children with special needs, examining critical learning outcomes in relation to pedagogical agents, and developing teaching capacities and ability to design inclusive practices [56]. By exploring the co-design process, the study has potential to raise awareness for and broaden access for providing children with disabilities to a diverse learning experience by strengthening teaching capacities [57].

Finally, to create a systematic design process to improve teaching practices, this research suggested an ongoing need to create a common societal understanding of inclusive education to move beyond "inclusion" and the cultural, institutional, and educational boundaries of the school system [58]. It is a joint effort to create an equitable while collaborative learning environment to support children with learning differences in pedagogical agents by strengthening the capacities of educators, teachers, school administrators, and district leaders and design an inclusive learning experience [59].

REFERENCES

[1] Sutcher, L., Darling-Hammond, L., & Carver-Thomas, D. (2019). Understanding teacher shortages: An analysis of teacher supply and demand in the United States. *Education Policy Analysis Archives, 27*(35).

[2] Podolsky, A., Kini, T., & Darling-Hammond, L. (2019). Does teaching experience increase teacher effectiveness? A review of US research. Journal of Professional Capital and Community.

[3] Richards, D., & Dignum, V. (2019). Supporting and challenging learners through pedagogical agents: Addressing ethical issues through designing for values. *British Journal of Educational Technology, 50*(6), 2885-2901.

[4] Martha, A. S. D., & Santoso, H. B. (2019). The design and impact of the pedagogical agent: A systematic literature review. *Journal of Educators Online, 16*(1), n1.

[5] Rosenberg-Kima, R. B., Koren, Y., & Gordon, G. (2020). Robot-supported collaborative learning (RSCL): Social robots as teaching assistants for higher education small group facilitation. *Frontiers in Robotics and AI*, 148

[6] Papadopoulos, I., Lazzarino, R., Miah, S., Weaver, T., Thomas, B., & Koulouglioti, C. (2020). A systematic review of the literature regarding socially assistive robots in pre-tertiary education. *Computers & Education, 155*, 103924

[7] Grawemeyer, B., Johnson, H., Brosnan, M., Ashwin, E., & Benton, L. (2012, June). Developing an embodied pedagogical agent with and for young people with autism spectrum disorder. In International Conference on Intelligent Tutoring Systems (pp. 262-267). Springer, Berlin, Heidelberg.

[8] van den Berghe, R., Verhagen, J., Oudgenoeg-Paz, O., Van der Ven, S., & Leseman, P. (2019). Social robots for language learning: A review. *Review of Educational Research, 89*(2), 259-295

[9] Luria, M., Reig, S., Tan, X. Z., Steinfeld, A., Forlizzi, J., & Zimmerman, J. (2019, June). Re-Embodiment and Co-Embodiment: Exploration of social presence for robots and conversational agents. In *Proceedings of the 2019 on Designing Interactive Systems Conference* (pp. 633-644)

[10] Eguchi, A., & Okada, H. (2018, March). Learning with social robots—The World Robot Summit's approach. In *2018 IEEE Integrated STEM Education Conference (ISEC)* (pp. 53-56). IEEE

[11] Okita, S. Y., & Clarke, S. N. (2021). Robots and Agents to Support Collaborative Learning. In *International Handbook of Computer-Supported Collaborative Learning* (pp. 407-424). Springer, Cham

[12] UNESCO. (2020). COVID-19 educational disruption and response. https://en.unesco.org/covid19/educationresponse

[13] Darling-Hammond, L., & Hyler, M. E. (2020). Preparing educators for the time of COVID. . . and beyond. European Journal of Teacher Education, 43(4), 457-465.

[14] Schroeder, N. L., Romine, W. L., & Craig, S. D. (2017). Measuring

[15] pedagogical agent persona and the influence of agent persona on learning. *Computers and Education, 109,* 176–186. doi:10.1016/j.compedu.2017.02.015

[16] Schroeder, N. L., & Gotch, C. M. (2015). Persisting issues in pedagogical agent research. *Journal of Educational Computing Research, 53*(2), 183-204.

[17] Johnson, W. L., & Lester, J. C. (2016). Face-to-face interaction with pedagogical agents, twenty years later. *International Journal of Artificial Intelligence in Education, 26*(1), 25–36. doi:10.1007/s40593-015-0065-9

[18] Van Brummelen, J., & Lin, P. (2020). Engaging Teachers to Co-Design Integrated AI Curriculum for K-12 Classrooms. arXiv preprint arXiv:2009.11100.

[19] Lin, P., & Van Brummelen, J. (2021, May). Engaging Teachers to Co-Design Integrated AI Curriculum for K-12 Classrooms. In Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (pp. 1-12).

[20] Meier, E. (2018) The Collaboration Imperative. In L. Lin & J.M. Spector (Eds.), C*onstructive* Articulation Between the Sciences of Learning and the Instructional Design and Technology Communities. New York: Routledge

[21] Savin-Baden, M., Bhakta, R., Mason-Robbie, V., & Burden, D. (2019). An evaluation of the effectiveness of using pedagogical agents for teaching in inclusive ways. In *Artificial Intelligence and Inclusive Education* (pp. 117-134). Springer, Singapore

[22] Azevedo, R., Martin, S. A., Taub, M., Mudrick, N. V, Millar, G. C., & Grafsgaard, J. F. (2016). Are pedagogical agents' external regulation effective in fostering learning with intelligent tutoring systems? In A. Micarelli, J. Stamper, & K. Panourgia (Eds.), Intelligent Tutoring Systems, ITS 2016 (Vol. 9684; pp. 197–207). doi:10.1007/978-3-319-39583-8_19

[23] Castro-Alonso, J. C., Wong, R. M., Adesope, O. O., & Paas, F. (2021). Effectiveness of multimedia pedagogical agents predicted by diverse theories: A meta-analysis. *Educational Psychology Review, 33*(3), 989-1015.

[24] Coninx, A., Baxter, P., Oleari, E., Bellini, S., Bierman, B., Henkemans, O., ... & Hiolle, A. (2016). Towards long-term social child-robot interaction: using multi-activity switching to engage young users. *Journal of Human-Robot Interaction.*

[25] Xu, Y., Aubele, J., Vigil, V., Bustamante, A. S., Kim, Y. S., & Warschauer, M. (2021). Dialogue with a conversational agent promotes children's story comprehension via enhancing engagement. *Child Development*

[26] Cha, I., Kim, S. I., Hong, H., Yoo, H., & Lim, Y. K. (2021, May). Exploring the Use of a Voice-Based Conversational Agent to Empower Adolescents with Autism Spectrum Disorder. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (pp. 1-15)

[27] Jung, S. E., & Won, E. S. (2018). Systematic review of research trends in robotics education for young children. *Sustainability, 10*(4), 905

[28] Hussin, H., Jiea, P. Y., Rosly, R. N. R., & Omar, S. R. (2019). Integrated 21st century Science, Technology, Engineering, Mathematics (STEM) education through robotics project-based learning. *Humanities & Social Sciences Reviews, 7*(2), 204-211

[29] Johal, W. (2020). Research trends in social robots for learning. *Current Robotics Reports, 1*(3), 75-83

[30] Klehm, M. (2014). The effects of teacher beliefs on teaching practices and achievement of students with disabilities. *Teacher Education and Special Education, 37*(3), 216-240

[31] Peters, A. L. (2019). Desegregation and the (dis) integration of black school leaders: Reflections on the impact of brown v. Board of Education on Black Education. *Peabody Journal of Education, 94*(5), 521-534.

[32] Reece, J. (2021). Confronting the Legacy of "Separate but Equal": Can the History of Race, Real Estate, and Discrimination Engage and Inform Contemporary Policy?. *RSF: The Russell Sage Foundation Journal of the Social Sciences, 7*(1), 110-133.

[33] Nightengale-Lee, B. (2017). Educating critically: challenging the familiar contours of literacy teacher education.

[34] Schroeder, S. (2020). "Bad Inquiry": How Accountability, Power, and Deficit Thinking Hinder Pre-Service Practitioner Inquiry. *Journal of Practitioner Research, 5*(1), 1.

[35] Legette, K. B., Halberstadt, A. G., & Majors, A. T. (2021). Teachers' understanding of racial inequity predicts their perceptions of students' behaviors. *Contemporary Educational Psychology, 67*, 102014.

[36] Lane-Myler, J. (2015). Encountering and accounts of" the other:" Teachers' perceptions and curricular planning following an immersion abroad. The Pennsylvania State University.

[37] Savin-Baden, M., Bhakta, R., Mason-Robbie, V., & Burden, D. (2019). An evaluation of the effectiveness of using pedagogical agents for teaching in inclusive ways. In Artificial Intelligence and Inclusive Education (pp. 117-134). Springer, Singapore.

[38] Schwab, S., & H Alnahdi, G. (2020). Do they practise what they preach? Factors associated with teachers' use of inclusive teaching practices among in-service

teachers. *Journal of Research in Special Educational Needs, 20(*4), 321-330.
[39] Theelen, H., Van den Beemt, A., & Brok, P. D. (2020). Enhancing authentic learning experiences in teacher education through 360-degree videos and theoretical lectures: reducing preservice teachers' anxiety. European journal of teacher education, 1-20.
[40] Makki, T. W., O'Neal, L. J., Cotten, S. R., & Rikard, R. V. (2018). When first-order barriers are high: A comparison of second-and third-order barriers to classroom computing integration. *Computers & Education, 120,* 90-97.
[41] Bowman, M. A., Vongkulluksn, V. W., Jiang, Z., & Xie, K. (2020). Teachers' exposure to professional development and the quality of their instructional technology use: The mediating role of teachers' value and ability beliefs. *Journal of Research on Technology in Education*, 1-17.
[42] Holstein, K., McLaren, B. M., & Aleven, V. (2019). Co-designing a real-time classroom orchestration tool to support teacher–AI complementarity. *Journal of Learning Analytics, 6*(2).
[43] McTighe, J., & Willis, J. (2019). Upgrade your teaching: Understanding by design meets neuroscience. ASCD.
[44] Evmenova, A. (2018). Preparing teachers to use universal design for learning to support diverse learners. *Journal of Online Learning Research, 4*(2), 147-171.
[45] Al Hazmi, A. N., & Ahmad, A. C. (2018). Universal Design for Learning to Support Access to the General Education Curriculum for Students with Intellectual Disabilities. *World Journal of Education, 8*(2), 66-72.
[46] Jeremy Roschelle, William Penuel, and Nicole Shechtman. 2006. Co-design of innovations with teachers: Defnition and dynamics. In Proceedings of the 7th international conference on Learning sciences. International Society of the Learning Sciences, 606–612.
[47] Troy D Sadler, Aidin Amirshokoohi, Mahsa Kazempour, and Kathleen M Allspaw. 2006. Socioscience and ethics in science classrooms: Teacher perspectives and strategies. Journal of Research in Science Teaching: *The Ofcial Journal of the National Association for Research in Science Teaching 43, 4* (2006), 353–376
[48] William R Penuel. 2019. Co-design as infrastructuring with attention to power: Building collective capacity for equitable teaching and learning through designbased implementation research. In Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning. Springer, Cham, 387–401.
[49] Li, W., Wang, F., Mayer, R. E., & Liu, H. (2019). Getting the point: Which kinds of gestures by pedagogical agents improve multimedia learning?. Journal of Educational Psychology, 111(8), 1382.
[50] Ahmad, M., Mansor, N. R., Rashid, R. A., Ain, N., Zakaria, C. R., & Sung, C. M. (2021, February). Implementation of Digital Games in Advancing Students' Higher-Order Thinking Skills: A Review. In Journal of Physics: Conference Series (Vol. 1793, No. 1, p. 012069). IOP Publishing.
[51] Iqbal, T., & Riek, L. D. (2019). Human-robot teaming: Approaches from joint action and dynamical systems. Humanoid robotics: A reference, 2293-2312.
[52] Mohammadhasani, N., Fardanesh, H., Hatami, J., Mozayani, N., & Fabio, R. A. (2018). The pedagogical agent enhances mathematics learning in ADHD students. *Education and Information Technologies, 23*(6), 2299-2308.
[53] Du, X. & Meier, E. B. (2022, Apr 21 - 26) Inquiry-based Classroom Practices: Designing Effective Professional Development for Equitable and Inclusive Learning Environments [Paper Session]. AERA Annual Meeting. Annual meeting of the American Educational Research Association, Upcoming 2022 AERA Annual Meeting
[54] Du, X. & Meier, E. (2021). Professional Development in Virtual Learning Environment: Designing Computational Thinking Enriched Practices through Project-based Learning. In E. Langran & D. Rutledge (Eds.), Proceedings of SITE Interactive Conference (pp. 353-355). Online, United States: Association for the Advancement of Computing in Education (AACE).
[55] Banda, J.R. & York, C.S. (2014) Authentic learning exercises as means to influence preservice teachers' technology integration self-efficacy and intentions to integrate technology. Australasian Journal of Educational Technology. 30(6).
[56] Wang, W., Chen, Y., Li, R., & Jia, Y. (2019). Learning and comfort in human–robot interaction: a review. *Applied Sciences, 9(*23), 5152.
[57] Lee, S. S., & Kim, J. (2020). An exploratory study on student-intelligent robot teacher relationship recognized by middle school students. *Journal of Digital Convergence, 18*(4), 37-44.
[58] Dobrosovestnova, A., & Hannibal, G. (2020, March). Teachers' Disappointment: Theoretical Perspective on the Inclusion of Ambivalent Emotions in Human-Robot Interactions in Education. In 2020 15th ACM/IEEE International Conference on Human-Robot Interaction (HRI) (pp. 471-480). IEEE.
[59] Savolainen, H., Malinen, O. P., & Schwab, S. (2020). Teacher efficacy predicts teachers' attitudes towards inclusion–a longitudinal cross-lagged analysis. *International journal of inclusive education,* 1-15.