Rethinking the Relationship Between AI and Education: It's About More than Applications

Shayan Doroudi[1], Yusuf Ahmad[2], Ahmed Zaidi[3], and Paula Buttery[3]

[1] University of California Irvine
[2] Massachussetts Institute of Technology
[3] University of Cambridge

1 Introduction

In the 1960s-1980s, research on artificial intelligence was deeply intertwined with research on human learning and cognition. Researchers simultaneously studied how humans think and learn and the possibility of creating machines that can think and learn. Ideas from the psychology and education shaped how researchers developed the field of AI. Similarly, AI often served as "an object-to-think-with"[4], a conceptual tool for understanding and building models for human learning and cognition. See, for example, Simon and Newell [1971], Minsky and Papert [1972], and Pask [1972].[5]

This mode of interdisciplinary research no longer pervades work in AI or education. Moreover, over the past three decades, the field of AI in education (AIED) has primarily explored applications of AI as a tool to enhance education, rather than the overlap and duality between AI and human learning, and the interdisciplinary techniques needed to tackle broad questions around thinking and learning.

In this workshop, we ask how we might reinvigorate deeper connections between AI and education in order to advance research in both fields. We hope to engage a range of approaches to studying thinking and learning, spanning what we will refer to as the "four C's": cognitivist, constructivist, connectionist, and cybernetic approaches[6]. It is our belief that emphasising the role of artificial intelligence as "an object-to-think-with" will inspire new directions and paradigms of research.

2 Workshop Format

We plan to host a half-day workshop that will be divided into three sections: **Past**, **Present**, and **Future**.

[4] This phrase is appropriated from Papert [2020], who used it to describe objects or tools that can make our thinking about a subject more concrete.
[5] Representative quotations from these papers are provided in the appendix.
[6] We will describe these approaches in more detail at the workshop itself, but suffice it to say that each of these approaches span different disciplines (psychology, AI, education, neuroscience, etc.).

In the **Past** section, the workshop organizers will give a 30 minute presentation on the interdisciplinary history of thinking about learning in humans and machines. This will overview the various approaches that researchers, including pioneers of artificial intelligence, such as Simon, Newell, Minsky, and Papert were taking at the interplay of these fields (as alluded to in the quotes above).

The **Present** section of the workshop will explore the way researchers currently approach the interdisciplinary study of learning. It will be split into two parts. The first part will be composed of a panel discussion with a group of four or five invited speakers. The discussion will last around 60 minutes. We plan to invite leading researchers who investigate the underlying principles of thinking and learning in humans and machines. These speakers will have varying levels of involvement in the AIED community to ensure a diverse set of perspectives. Specifically, we hope to invite speakers who represent each of the "four C's." This will simultaneously allow us to bring new voices and perspectives into the AIED community as well as bring the existence of AIED to the attention of researchers in other areas (e.g., cognitive science, machine learning, and cybernetics).

Through our workshop, we hope to evoke divergent perspectives, points of disagreement, and areas of common ground. For example, historically, Newell, Simon, and their colleagues took a drastically different approach to Papert, Minsky, and their colleagues, but they overlapped in that (a) both groups agreed that thinking about cognition in both humans and machines could advance AI and education (i.e., the topic of this workshop), and (b) interestingly enough, they were both critical of connectionist techniques.

The second part of the **Present** section will consist of a mix of invited and submitted lightning talks (60 minutes). We anticipate having 4-6 lightning talks. Each talk will be 8-10 minutes, with time for questions.

The **Future** section of the workshop will be an interactive exploration of how to make progress on the workshop topic. For the first 45 minutes, participants will self-organize into breakout groups around topics, with each group brought together based on a specific theme that came up in the panel discussion and/or lightning talks. Each group will be tasked with a specific set of questions, with the goal being to brainstorm various ways to synthesize research in AI and education. While typical workshop sessions like this are aimed at broad agenda-setting goals, we will strive to encourage participants to be as concrete as possible. Specifically, we will encourage them to work with "objects-to-think-with" to ground their conversations, such as toy neural network models, agent-based models, knowledge representations, math problems, or Piagetian experiments. The hope is that such brainstorming may surface concrete problems and foster collaborations that go beyond the workshop.

In the last half hour, the group will reconvene and discuss potential next steps. We will collectively craft a document outlining a new trajectory of work on interdisciplinary inquiries into the nature of learning that can mutually benefit AI and education.

3 Organizer Biographies

Shayan Doroudi - Shayan is an Assistant Professor at the University of California, Irvine School of Education and (by courtesy) Department of Informatics. He conducts research at the interface of educational technology, educational data science, and learning analytics. He is particularly interested in learning from the rich history of these fields, and is currently writing a paper on the intertwined histories of artificial intelligence and education, a theme that will be discussed in this workshop.

Yusuf Ahmad - Yusuf is an MIT researcher and founder of Samba Ventures, a design studio that works with governments, foundations, and startups building education tools and new school models. His recent work includes scaling up Montessori across Africa with the Indaba Foundation, supporting the South African Government in building a new platform for teachers, and starting a pan-African University where he led pedagogy, curriculum design, and academic operations.

Ahmed Zaidi - Ahmed is a postdoctoral researcher at Cambridge University. He is part of the Cambridge University Institute for Automated Language Teaching and Assessment (ALTA) where he specializes in adaptive learning models. He is particularly interested in cognitively and psychologically motivated deep learning models both for the purposes of improving AI models but also evaluating theories of learning. He is also an advisor to the Pakistani Prime Minister's Knowledge Economy Taskforce where he is involved with policy and implementation of educational technology across the country.

Paula Buttery - Paula is a Professor of Language and Machine Learning at the University of Cambridge. She is the Director of the Cambridge Institute for Automated Language Teaching and Assessment (ALTA). Her research interests include building NLP tools that work with non-canonical forms of natural language (spoken language, learners, aphasics, social media language) and also with low resource languages (endangered languages, dialects). She is also interested in both the automatic machine processing of non-canonical language and the cognitive processes underlying that language. Paula is also a member of the University of Cambridge Digital Teaching and Learning Sub-committee.

4 Workshop Details

Length of Workshop: Half-day
Estimated Number of Participants: 30-40
Abstract Submission Deadline: May 14
Confirmation Notification Submission Deadline: May 20

1. **The Past** - 30 minutes

2. **The Present**
   (a) **Speaker Panel** - 60 minutes
   (b) 15 Minute Break
   (c) **Lighting Talks** - 60 minutes

3. **The Future**
   (a) **Interactive Sessions** - 45 minutes
   (b) **Whole Group Discussion and Closing** - 30 minutes

5 Appendix: Representative Quotations

Simon and Newell [1971] discussed how studying the mind from the lens of information-processing psychology (a field they created, which influenced early artificial intelligence as well as psychology) could contribute to both basic science (in psychology as well as AI) and practical applications (in education):

> The experience of other fields of knowledge teaches us that serious attempts at practical application of basic science invariably contribute to the advance of the basic science as well as the area of application. Unsuspected phenomena are discovered that can then be carried back to the laboratory; new questions are raised that become topics for basic research. Both psychology and education stand to benefit in major ways if we make an earnest effort over the next decade to draw out the practical lessons from our understanding of human information processes.

Minsky and Papert [1972] in discussing the state of their Artificial Intelligence Lab at MIT, how their interest in studying children's learning and education went hand-in-hand with their AI projects:

> Our evolution of theories of Intelligence has become closely bound to the study of development of intelligence in children, so the educational methodology project is symbiotic with the other [AI] studies, both in refining older theories and in stimulating new ones; we hope this project will develop into a center like that of Piaget in Geneva.

Pask [1972] suggested that the fields of computer-assisted instruction (CAI) and artificial intelligence were once intimately connected through their mutual connection to "cognitive psychology and applied epistemology":

> For a period, the sub-cultures of CAI and "Artificial Intelligence," so clearly companions in cognitive psychology and applied epistemology, were separated. Gladly, their estrangement has ended in reunion rather than divorce. The change in thinking came about for several reasons, but one of them was the resolution of a prevailing confusion between

computation science (cybernetics, system theory or just computation unqualified) and the operation of existing computing machines. It is true that computation science often uses computers as tools. But its subject-matter is much broader. Computation science deals with relational networks and processes that may represent concepts; with the structure of knowledge and the activity of real and artificial minds. Computation science lies in (even *is*) the kernel of CAI; it lends stature to the subject and bridges the interdisciplinary gap, between philosophy, education, psychology and the mathematical theory of organisations. Computer techniques, in contrast, bear the same relation to CAI as instrument making to physics or reagent manufacture to chemistry.

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