Information Technology Research And Planning Monograph Series

Leading Schools in the Age of Artificial Intelligence

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How do you prepare today's students for tomorrow's future when things are changing so rapidly? One of the few certainties is the ongoing development and deployment of artificial intelligence (AI). How do we know? Because the massive investment in dollars and human resources guarantees this reality now and for the future. (1) One need only look at the supercomputer each of us carries in our pockets for confirmation. Our smartphones contain significant artificial intelligence manifested in the Siri and Google personal agents. They have smart-texting capabilities that forecast our language before we type. They even present us with targeted suggestions as we navigate the web. But what exactly is artificial intelligence? And what will the impact of this technology on K-12 education?

ARTIFICIAL INTELLIGENCE

Generally speaking, there are two categories of artificial intelligence. The most commonly talked about is General AI, which attempts to replicate the behavior of human beings. It is this form of AI that people think of when they consider human-like robots that interact with people in a naturalistic way. An example of General AI is the robot Sophia. (2)

The other main category of artificial intelligence is Narrow AI. Narrow AI is, as the name implies, focused on very specific tasks. To see the distinction between General AI and Narrow AI, look at the video of an Amazon warehouse robot. (3) The artificial intelligence embodied in these machines is optimized to move a specific type of material within the limits of a well-defined problem set, including the boundaries of the warehouse, the size and weight of the pallets, the organization of the corridors, etc. The intelligence behind this system uses combinatorial mathematics and probability to constantly map movement of these machines to maximize efficiency.

Because of the extreme complexity and cost, it is unlikely that General AI systems will be deployed into K-12 education in the near future. However, Narrow AI is already being deployed, and the number of applications employing it are continuing to grow. Let's look at some current examples of Narrow AI already in use in K-12.

"There are several companies such as Content Technologies and Carnegie Learning currently developing intelligent instruction design and digital platforms that use AI to provide learning, testing and feedback to students from pre-K to college level that gives them the challenges they are ready for, identifies gaps in knowledge and redirects to new topics when appropriate." (4)

"Artificial intelligence tools can help make global classrooms available to all including those who speak different languages or who might have visual or hearing impairments. Presentation Translator is a free plug-in for PowerPoint that creates subtitles in real time for what the teacher is saying." (5)

Furthermore, the article "10 Roles For Artificial Intelligence In Education" suggests there is both promise of, and development in, the following 10 areas:

1. Automating basic activities in education, like grading
2. Adapting software to student needs
3. Identifying areas where courses need improvement
4. Providing additional supports from AI-based tutors
5. Providing educators and students helpful real-time feedback
6. Changing our interaction with information
7. Changing the role of teachers to enable more human personalization
8. Make trial-and-error learning less intimidating
9. Providing additional data to inform teaching and learning
10. Altering how students learn, who teaches them and how they acquire basic skills. (6)

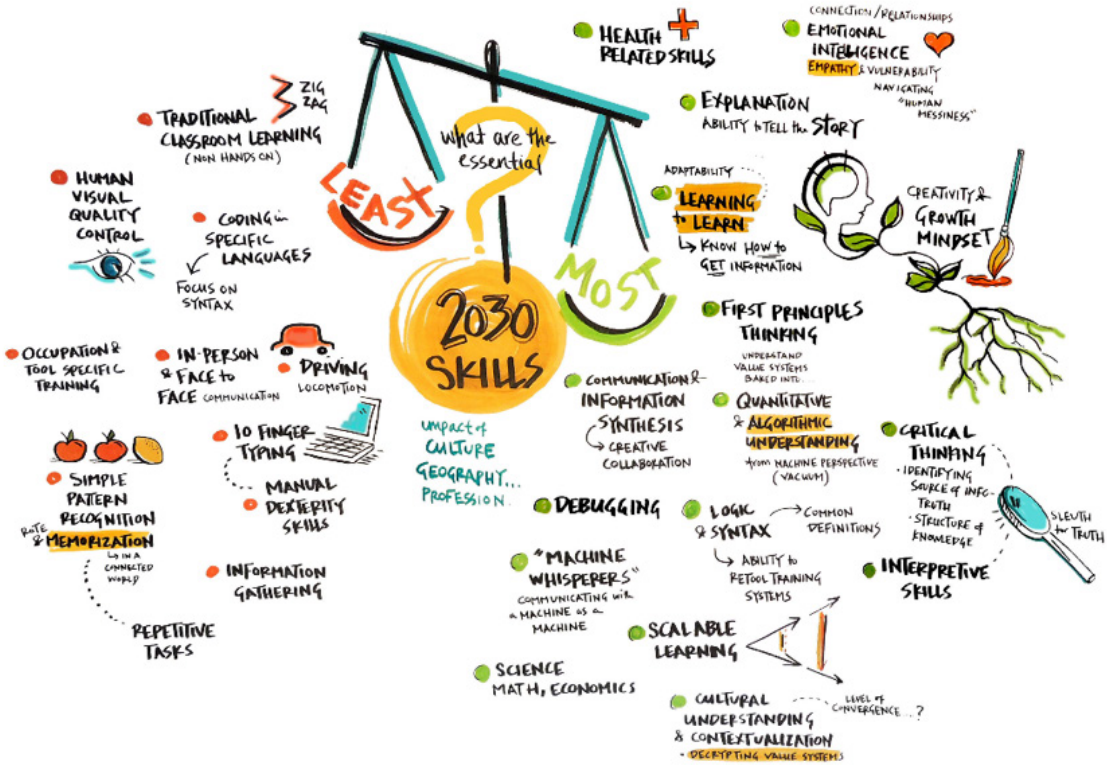
Given this information, how do we prepare? There are two things we should consider. First, what is the role of the teacher in an AI-infused education space? Secondly, what knowledge and skills must students have in order to function successfully in an AI world?

The data suggests that the role of the teacher will need to evolve. Many, if not most, districts use Learning Management Systems (LMS's). As the LMS's continue to adapt to AI, teachers will be confronted with tools that do many of the same tasks they currently provide. Rather than be threatened by this change, we should consider what can be done with the extra time when AI takes on some of the tasks typical to a 20th century teacher.

Districts could adopt an LMS-AI system that manages the day-to-day movement of materials and information between the teacher and the students. It could grade assignments and post the scores to an electronic grade book. It could make suggestions to teachers for individualized interaction with students based upon their responses to homework, quizzes and tests. It could automatically link under-performing students to online materials to strengthen their knowledge or develop their skills. It could also identify cross-content needs, such as vocabulary, reading comprehension or basic arithmetic requirements, and then provide remedial instruction in those skills.

If these type of tools are made available, and many of them surely will be, then the teacher will be able to recover valuable time to do other things in the classroom. This work should focus on those things that AI doesn't do well—namely, interact with the students individually and/or in small groups and provide individualized personal attention.

But what do students need to focus on to be successful? Recently, the Institute for the Future met with CEO's and CIO's of major companies and asked them to brainstorm, discuss and agree upon those skills they felt the employee of 2030 should have to be successful. It is called "The Future of AI Skills and Work Flows." From that research, they derived the following whiteboard of information. (7)



Not surprisingly, the emphasis on science, mathematics and economics continues. But there are several things on the list with which many people may be unfamiliar. Specifically, the following items on the whiteboard need explanation:

First Principles Thinking

A first principle is a foundational proposition or assumption that stands alone. We cannot deduce first principles from any other proposition or assumption.

Information Synthesis – Creative Collaboration

Synthesis creatively fuses multiple elements, often from different areas, into something new and memorable. Synthesis is not a summary. Synthesis takes A + B + C and then derives D, where D encompasses the essence of A, B and C, but also adds something new that resonates deeply with people.

Scalable Learning

Scalable learning harnesses the power of a large network of peers to learn faster than we could ever hope to learn on our own.

Algorithmic Understanding

Algorithmic understanding is a pool of abilities that are connected to constructing and understanding algorithms and computer programs. These abilities include:

- analyzing given problems
- specifying a problem precisely
- finding the basic actions that are adequate to the given problem
- constructing a correct algorithm to a given problem using the basic actions
- thinking about all possible, special and normal cases of a problem
- improving the efficiency of an algorithm

Whether any, or all, of these skills will be as important as these leaders forecast, it is clear that students need to prepare for a very different future—a future in which they will be expected to gather information, think critically about it and work with others to synthesize that information into something new and meaningful. Much of the information will be both quantitatively and qualitatively more sophisticated than the data they work with currently, and this will require strong mathematics and technology skills. Consistently, the research has pointed to a possible widening gap between the creators of high tech tools and consumers of them. For example, David Lankes, professor and director at the University of South Carolina School of Library and Information Science, wrote:

> *"There is simply no doubt that, on aggregate, automation and large-scale application of algorithms have had a net-positive effect. People can be more productive, know more about more topics than ever before, identify trends in massive piles of data and better understand the world around them. That said, unless there is an increased effort to make true information literacy a part of basic education, there will be a class of people who can use algorithms and a class used by algorithms." (8) (Highlighting by this author)*

This shift to an increasingly more sophisticated technology-infused future will require some fundamental recasting of our K-12 education space if our students are going to be successful. Here are some recommendations for possible consideration:

1. Blended Instruction

If your district hasn't yet moved to some blended instruction, this is a good place to start. Blended learning combines classroom learning with online learning in which students can, in part, control the time, pace and place of their learning. This is a terrific way to move teachers into instruction utilizing tools outside of the classroom to engage their students.

2. Flipped Classrooms

Flipped classrooms provide information dissemination during the evening from home or libraries. This shift allows teachers more time in classrooms to discuss the prior evening's information then tie it together for their students using face-to-face interaction. In most cases, flipped instruction is delivered via technology—a medium many of today's students prefer.

3. Project-based Learning & Collaboration

There are no buildings built that are designed and constructed by one person. Similarly, there is no software written by one person. In today's society, teams of people collaborate to create and build the world we live in. To prepare students for this world, we need to give them practice working in groups on "real-world" problems. The more authentic the problems, the better. And the more cross-content, the better. In a world where robotics and AI will dominate, it takes very large and diverse teams of highly-skilled workers to be successful. For instance, for the creation of the AI-based toy robot, Cozmo, hundreds of team members worked together to make the product. The team included:

- Artists
- Designers
- Marketers
- Mechanical engineers
- Programmers
- Project managers
- Technical writers
- Sound editors
- Sound engineers
- Video editors
- Video engineers

4. Technical Writing

Technical writers explain things. They take complicated concepts and break them down into easy-to-understand pieces. They're also skilled at organizing information so it flows logically. With these skills, a technical writer is often responsible for many kinds of writing: manuals, online help systems and even video tutorials. And this field is growing. A part of your English Language Arts curriculum in high school should thus be devoted to technical writing. Even if your students never become technical writers, understanding the structure of technical writing will better enable them to be readers of technical materials.

5. Computer Skills – Algorithmic Understanding

Some people make the mistake of thinking that if you can read, you are literate. While this is partially true, to be truly literate you should understand language well enough that you can use it to construct new meaning of your own creation by writing. The same is true of algorithms and computational skills. As suggested above, the world may soon become differentiated by those who use algorithms and computer programs and those that create them. At minimum, your students should exit your high school being able to create computer pseudocode. What is pseudocode?

> *"Pseudocode is a detailed yet readable description of what a computer program or algorithm must do, expressed in a formally-styled natural language rather than in a programming language. Pseudocode is sometimes used as a detailed step in the process of developing a program. It allows designers or lead programmers to express the design in great detail and provides programmers a detailed template for the next step of writing code in a specific programming language." (9)*

6. Critical Thinking

We all know what critical thinking is. But did you know that there are specific guidelines for critical thinking? Here is a detailed set of instructions from The National Council for Excellence in Critical Thinking:

- "Knowing that something is so, is not simply a matter of believing that it is so, it also entails being justified in that belief (Definition: Knowledge is justified true belief).
- There are general, as well as domain-specific, standards for the assessment of thinking.
- To achieve knowledge in any domain, it is essential to think critically.
- Critical thinking is based on articulable intellectual standards and hence is intrinsically subject to assessment by those standards.
- Criteria for the assessment of thinking in all domains are based on general standards such as: clarity, precision, accuracy, relevance, significance, fairness, logic, depth, breadth, evidentiary support, probability and predictive or explanatory power.
- Instruction in all subject domains should result in thinking critically within that domain. For instance, instruction in science should lead to disciplined scientific thinking; instruction in mathematics should lead to disciplined mathematical thinking; instruction in history should lead to disciplined historical thinking and in a parallel manner in every discipline and domain of learning.
- Disciplined thinking with respect to any subject involves the capacity on the part of the thinker to recognize, analyze and assess the basic elements of thought; the purpose or goal of the thinking; the problem or question at issue; the frame of reference or points of view involved; assumptions made; central concepts and ideas at work; principles or theories used; evidence, data or reasons advanced; claims made and conclusions drawn; inferences, reasoning and lines of formulated thought and implications and consequences involved.
- Critical reading, writing, speaking and listening are academically essential modes of learning. To be developed, they must be systematically cultivated in a variety of subject domains as well as with respect to interdisciplinary issues.
- The earlier children develop sensitivity to the standards of sound, thought and reasoning, the more likely they will develop desirable intellectual habits and become open-minded persons responsive to reasonable persuasion.
- Education - in contrast to training, socialization and indoctrination - implies a process conducive to critical thought and judgment. It is intrinsically committed to the cultivation of reasonability and rationality." (10)

7. Professional Development

It's almost impossible to provide enough professional development (PD) for your teaching staff to acquire the knowledge and skills they need to prepare their students for an artificial intelligence-based future. Most will not know how to put together blended or flipped classrooms. Few will know anything about algorithms or pseudocode. And only a handful will know the critical thinking structures associated with the disciplines they are teaching. Your staff will need a significant investment in new technologies, new techniques and time to acquire this information and skills.

One place to start is with an Information Technology Center (ITC), like NEOnet. There, you'll find effective instructional models for integrating technology efficiently and effectively. In addition to working with your ITC, you should consider outreach programs that allow you to place teachers in external settings so they are able to witness the demands of 21st century business and industry. This is important because many teachers went from school to college and from college right into the profession. Their work experience and world view is siloed around education. By providing them opportunities outside of the school to see how the larger society works, you'll provide them a framework from which to view the skills and knowledge you're asking them to adopt.

ENDNOTES

(1) https://www.businesswire.com/news/home/20180919005045/en/Worldwide-Spending-Cognitive-Artificial-Intelligence-Systems-Forecast
(2) https://www.youtube.com/watch?v=omgJi5-YT6U
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(4) https://www.forbes.com/sites/bernardmarr/2018/07/25/how-is-ai-used-in-education-real-world-examples-of-today-and-a-peek-into-the-future/#64fcb1c6586e
(5) IBID
(6) https://www.teachthought.com/the-future-of-learning/10-roles-for-artificial-intelligence-in-education/
(7) http://www.iftf.org/future-now/article-detail/what-are-the-least-essential-skills-in-the-ai-future/
(8) https://www.researchgate.net/publication/221437678_Algorithmic_Thinking_The_Key_for_Understanding_Computer_Science/download
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