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The Role of Artificial Intelligence in STEM Education

Siu Cheung KONG[a*], Hiroaki OGATA[b], Ju-Ling SHIH[c] & Gautam BISWAS[d]
[a]*The Education University of Hong Kong, Hong Kong*
[b]*Kyoto University, Japan*
[c]*National Central University, Taiwan*
[d]*Vanderbilt University, USA*
*sckong@eduhk.hk

Abstract: STEM education is a recent focus in curriculum design across different educational levels. Artificial intelligence (AI) is a growing attention in different educational sectors in the digital era. STEM education targets at cultivating students' creative mindset and cross-disciplinary ability to create artifacts that solve problems of humankind and serve human needs. AI targets at solving problems together with computers for automating parts of the problem-solving processes in a manner comparable with humans' processes. This panel will provide a platform for sharing an international perspective with panelists from different countries about the role of AI in STEM education. The discussion will focus on three directions: (1) the role of STEM activities in promoting students to effectively develop AI literacy; (2) the role of AI elements in promoting students to develop STEM knowledge with fun; and (3) the synergy between AI elements and STEM activities for closely linking up students' school learning with daily life, especially through applying AI literacy in the design of STEM artifacts.

Keywords: Artificial intelligence, STEM education, role, curriculum, digital era, international perspective

1. Introduction

Creativity and problem-solving skills are two very important capabilities for the success in the digitalized society in the 21st century (Murray & Pérez, 2014; Santos & Serpa, 2017). Students who are creative problem-solvers are ready for making innovation, creation, and contribution to the knowledge economy in the digital era (Andrade, 2016; Santos & Serpa, 2017). The implementation of STEM education is one of the promising approaches for educational practitioners to nurture creative problem-solvers, in which students are provided with many opportunities to solve problems by applying multi-disciplinary knowledge (Basu et al., 2016; Weintrop et al., 2016). Artificial intelligence (AI) literacy refers to a set of competencies in effectively communicating and collaborating with AI; critically evaluating AI technologies; and using AI as a tool for problem-solving (Kong & Zhang, 2021; Kong, Cheung, & Zhang, 2021; Long & Magerko, 2020; Touretzky et al., 2019). It is now the time for a scholarly discussion to explore how to meaningfully integrate AI elements into STEM education for fostering learners across different educational levels to be creative problem-solvers in the digital era.

2. Abstracts of Individual Panelists' Presentation

2.1 A Case Study of Data-Driven STEM Education (Hiroaki OGATA)

This talk will introduce two case studies of data-driven STEM education. The first is pen-stroke analysis because pen-based drawing and writing is still important in STEM education. The second is a data-driven group-learning support scenario because group work is also important in STEM education. Then, future directions of AI and data-driven STEM education will be proposed.

2.2 Robotic Positioning System and Automatic Response Scientific Inquiry Game (Ju-Ling SHIH)

In my previous research, an interdisciplinary robotic game was designed to let students role-play in the historical scenario and write block programming to control robotic ships to voyage on a room-size map to achieve gaming goals. In the game, students employ diplomatic strategies, cooperate or compete with other groups, to solve conflicts and historical crises. In order to add in science education element into learning, we designed a scientific inquiry game <Source of Sea> to allow students to drive the robotic survey ship to probe for natural resources under the sea. We developed a robotic positioning system with automatic response function with which students' exploration ships can do ocean mining. When the ships stop at a certain location, corresponding resource information will be automatically sent to the users through the mobile devices. The users can use the oceanic data collected in the process to induce inferences of oceanic conditions, including currents, mines, fishes, obstacles, or dangers. In the STEM-oriented game-based learning, students learn to generate scientific models for natural resource data expression and probing. Further integration into complex board game is possible with artificial intelligent system and authentic data which enhances the interaction between robots, map, and users.

2.3 Using AI/ML to Understand Students' Learning Behaviors in STEM Learning Environments (Gautam BISWAS)

AI pedagogy is relatively new. It makes sense to introduce AI topics through STEM disciplines, which help connect the learning and problem solving to real world phenomena. In a new curriculum on earth science, SPICE (Science Projects integrating Computing and Engineering), we have introduced Engineering design into middle school science curricula. Students learn simple heuristic search methods to find "optimal" solutions to a playground design problem. We have also used AI/ML methods to analyze student learning behaviors in our environments and used approaches to provide adaptive scaffolding to support student learning. Our goal is to present students with Open Learner models and use explainability methods to help them understand and improve their learning behaviors. This increases transparency of the system and students learn about AI/ML algorithms in a context that interests them.

2.4 Pedagogical Design of Incorporating AI Elements in STEM Activities (Siu Cheung KONG)

This talk will share a pedagogical design which incorporates artificial intelligence (AI) elements into STEM activities in Hong Kong senior primary classrooms. The pedagogical design integrates the Five Big Ideas in AI (i.e. perception, representation and reasoning, learning, natural interaction, and societal impact) into STEM classroom activities on creating artifacts for solving real-world problems. It targets at promoting students to build up an awareness to two main dimensions of AI literacy during STEM learning – the cognitive dimension (such as an understanding that there is a probability of errors-making in AI applications after AI model-training processes); and the affective dimension (such as an understanding that humans have empowerment to take the leading role during AI applications for an ethical use of AI techniques for solving problems). The pedagogical design can enrich students' experience of STEM learning with a humanistic concern – to be open-minded about the potential to integrate technology for task automation into creative artifacts for better solving real-world problems.

3. Discussion and Conclusion

There is a growing trend of promoting STEM education for cultivating students' creative mindset and cross-disciplinary ability to create artifacts that solve problems of humankind and serve human needs. There is an increasing attention to the promotion of AI literacy education for cultivating students' ability to solve problems through the use of computers for automating parts of the problem-solving processes in a manner comparable with humans' processes. This creates an emerging need for planning

curriculum initiatives across different educational sectors to meaningfully engage students in co-developing AI literacy and STEM knowledge for their success in the digital era. The panel will provide an insightful discussion about an international perspective in relation to the role of AI in STEM education.

The panel will first consist of panelist presentations which share a country/region-specific perspective about the integration of AI elements into STEM education. The panelists will share their insights into the synergic development of AI literacy and STEM education among students across different educational levels, with a concern on three important issues: (1) the role of STEM activities in promoting students to effectively develop AI literacy; (2) the role of AI elements in promoting students to develop STEM knowledge with fun; and (3) the synergy between AI elements and STEM activities for closely linking up students' school learning with daily life, especially through applying AI literacy in the design of STEM artifacts.

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