**TWG 4: State of the art in thinking about machine learning – implications for education**
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New partnerships between humans and machines are changing learning interactions, and the scope and range of learning opportunities. Artificial intelligence applications, such as language and voice recognition and intelligent personal learning environments, are changing learning. Decisions are being made based on the new affordances that machine learning offers, resulting in new challenges for learners, teachers, researchers and administrators. Machine learning, simply stated, is a way for computers to learn from data - for example detecting patterns, classifying data and making predictions. Deep learning often increases the complexity and reduces the transparency of the machine learning processes. The increasing prevalence of machine learning raises questions such as: Who will be teaching whom, who will be leading whom and what roles will be available to humans and machines?

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artificial intelligence

machine learning

deep learning
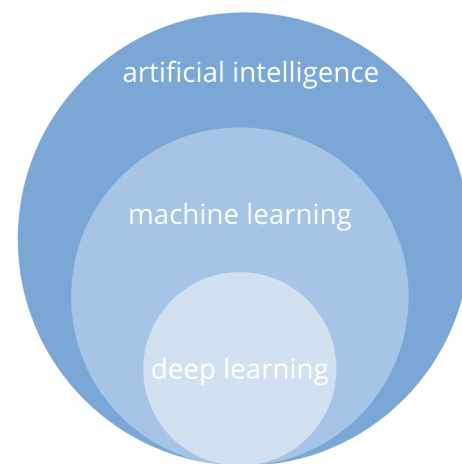
Issues - Machine Learning in Education
1. To optimize student learning there is a need to identify machine learning concepts necessary to be understood by teachers and students by the end of compulsory education, to prepare for lifelong learning.
2. There is, however, a lack of clarity around literacies needed to support the development of machine learning in education. Data, algorithm and machine learning literacies need to be described.
3. How machines make decisions/predictions can be a "black box" because deep learning algorithms and models can be very complex. There is a need for transparency so that decisions and conclusions made by machines can be explained. This transparency is essential to minimize bias and ensure that decision making based on machine learning is fair, interpretable and accessible for all.
4. Creators of machine learning systems/models should be held accountable for these issues of bias and transparency.
5. Because biases can be built into machine learning systems (intentionally and/or unintentionally) there is a need for a code of conduct to guide the development of machine learning for education.
6. There is limited information on the policy and practice of machine learning in countries around the world.
7. For machine learning to be useful and equitable data must be of high quality, accurate, complete and diverse. Conversely, there can be negative consequences when data used are unidentified, unstructured, incomplete, and/or mislabeled.

8. Adoption of machine learning in education is complex and impacts many areas of education including policy development, curriculum development (ethics, social-emotional, cognitive aspects), professional development (discernment and self-efficacy) and equity (allowing for

learner and cultural differences).

9. As humans and machines become partners in learning and problem solving, there is a need to explore and better understand human-machine power relationships.

10. To develop their conceptual understanding of algorithms, models and how machine learning works, students must have opportunities to use and apply machine learning.

11. As a powerful tool that may not be used to its full potential, there is a need for students to understand how machine learning can be used to identify and solve real-world problems.

12. It is difficult to keep curriculum and professional development up to date with the rapidly evolving machine learning field.

Strategies and Actions:

- Reform curricula to ensure that all students develop a strong background in machine learning. (policymakers, practitioners, researchers, and/or developers)

- Identify and define emerging literacies related to machine learning, algorithm, data/big data, and modeling. (practitioners and/or researchers)

- Report on the status of policy and practice of machine learning in education across various countries around the world. (researchers)

- Update policies and practices to keep pace with developments in the field. (policymakers, practitioners and researchers)

- Develop a Code of Conduct for machine learning in education for users and developers. (policymakers, researchers and learners)

- Provide machine learning professional development and resources for teachers, educational leaders and other key stakeholders to support education reform. (policymakers, practitioners, researchers, and/or developers)

- Support educators and learners in conducting risk analysis in the use of machine learning in education. (policymakers, learners, and/or developers)