

Review of: "Artificial Intelligence and Digital Technologies in the Future Education"

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Potential competing interests: No potential competing interests to declare.

First of all, thank you Michael for publishing your draft pre-print to Qeios. I can appreciate the work that has gone into developing this paper and am humbled to be asked to provide feedback.

The paper at hand addresses the increasingly salient topic of integrating Artificial Intelligence (AI), e-learning tech/platforms, and social robots into educational practices, with a particular emphasis on the emerging context of the Fourth Industrial Revolution (4IR). While the goals of the research are clear and ambitious, attempting to elucidate the complex intersections of these advanced technologies with pedagogical approaches, the paper introduces many terminologies and themes that, at times, lack sufficient distinction and integration. A comprehensive definition of terms (e.g. in a single table) and a better integration of concepts such as 4IR and IoT into the education landscape would greatly enhance the paper's narrative and overall impact. Furthermore, the paper's exploration of AI's influence on education could be deepened by addressing the nuances within the AI field itself (and bring this discussion forward rather than in final sections), such as the distinctions between soft vs hard, symbolic vs connectionist AI, and their specific impact on educational practice and outcomes. Moreover, the distinctions between data, information, and knowledge in the first place.

Conceptually, the paper makes a significant attempt to contribute to our understanding of how advanced technologies are revolutionizing the education sector. The author engages with the promising potential of (a pool/collection of) AI technologies in education but could provide a deeper and more explicit engagement with educational literature, theories, and frameworks. The paper's premise is indeed interesting, but the application of the methods needs to be more thoroughly explained. For instance, understanding the impact of specific AI tools and e-learning technologies on the elements of the "5 E's" acronym—engagement, exploration, explanation, elaboration, evaluation—would enhance the overall contribution. Similarly, elaborating on how these technologies influence the search, creativity, and evaluation processes and customize learning methods and content to individual learning styles would strengthen the paper's conceptual overview.

Please see some more detailed feedback below.

Major points:

1. The author introduces several terminology and keywords like AI, Soft Computing, e-learning, social robots, throughout the text but does not describe much their distinction from one another and introduces new terms rather haphazardly which makes it hard to follow. Specifically, the author introduces the idea of 4IR but then does not convincingly

integrate this concept and IoT specifically into the latter sections of the paper (or with their specific impact on education practice or focus/outcomes – does 4IR change required skills? If so, which ones are more and less demanded? How should educators (teachers, principles, admin, etc.) at primary, secondary, tertiary levels respond? How does AI and specific types of AI/e-learning tech specifically “change the way of our life, our habits and our behaviours” on p. 11 of 14, and what does this mean for the field of education?). The field of AI itself can be sliced up or conceptualised in many ways (e.g., soft vs hard, symbolic vs connectionist, AI winter summer autumn and spring, natural language vs multi-modal) which, with further treatment or attention from the author, would enrich the discussions in this paper. The current discussion misses, e.g., event and situation calculus (symbolic logic), knowledge graphs, cognitive architectures, there are different types of ANNs (static, dynamic, sparsity, ...) and learning mechanisms like reinforcement learning, etc. Either that, or focus more on one specific tech or area, for example, I really liked the discussion around case-based reasoning and analogical reasoning, and its relation to computational thinking (a synthesis of other modes of thinking like you describe). Another example could be focusing on the implications of a specific type of AI, e.g., large language models (LLMs) like the gpt’s and bard, on education practices and outcomes. By either re-focusing or taking a bigger picture (and hence, much more detailed and comprehensive coverage) approach would help avoid or minimise readers losing the overall narrative of the paper, and avoid terms like e.g., e-learning and various types of AI being confounded with or masked by one another.

2. Further to the first comment, there needs to be much more explicit engagement with the education literature, theories, frameworks, in terms of how AI (and different AI methods, and/or e-learning technologies and platforms) specifically impacts different elements of e.g., the “5 E’s” acronym – engagement, exploration, explanation, elaboration, evaluation, connectivism. How do AI tools (and more specifically, how do specific AI tools like language models, reinforcement learning agents, symbolic logic, or statistical tools like econometrics through software’s or programming languages like stata, R, python, etc) impact student engagement? How do they influence the search, elaboration and creative processes? How do they help in conceptual elaboration and ideating? How do they help us evaluate the quality of students work? How do they help students evaluate their own work, or the work of others? How do they facilitate feedback and instruction? How do they influence customisation of learning methods and content according to individual learning styles and preferences? These are just some questions that are currently missing and would be worth addressing or highlighting in future versions of this paper.
3. The link to Papert is great from education context, to help with the feedback on the current discussion of AI literature (see first “major” feedback comment above) a good starting place may be Papert’s links to/collaborations with Marvin Minsky (in field of AI) and vice versa. The literature of Aaron Sloman (for AI) and Herbert Simon (for AI, knowledge management, problem solving, etc) might also be worth exploring.
4. The idea of arithmetic and algebraic calculations and rediscovery of proofs need to continued forever (page 4/14) is intuitive and nice to highlight – it sort of refers to information/knowledge singularity and the human- vs AI-in-the-loop discussion. However, I would appreciate if the discussion was expanded a little more. For example, what is a satisfiable “proof” in the age of deep learning or quantum computing for the context of education? Can we ever really be sure of the outcomes of such complex algorithms and computations? How does this relate to the use of mixed methods, e.g. AI first to model or draw out insights then econometrics and statistics to explain the findings? This would

then give an intersection with explainability, interpretability, transparency, trust, etc. topics in the AI literature which would be worth mentioning in future versions of this paper. Also, can AI not be used to help teach this mathematical/critical thinking process? E.g. through instruction, examples, guidance, feedback, simulations, etc.

5. What about the implications of AI (and different types of AI + e-learning tech) in different levels of education (e.g. primary, secondary, tafe or work-ready skills, university, etc).

Minor points:

1. Check for spelling errors in abstract. Need to insert space between “The” and “paper” in the following sentence:
“Thepaper discusses the benefits and limitations...” Not sure if just a printing error, but there are a few instances like this in the abstract and throughout the text.
2. Need to substantiate the claim “the Fourth Industrial Revolution, which, under normal conditions, is expected to lead humanity to an era of nearly free energy, goods and services”

Thank you again Michael for the opportunity to review your work. I hope some of the comments/feedback help inform the next revision of your paper, and I look forward to seeing how this work of yours develops over time.