Artificial Intelligence in Education: a Promise, a Threat or a Hype?

Niklas Humble and Peter Mozelius
Mid Sweden University, Östersund, Sweden
niklas.humble@miun.se
peter.mozelius@miun.se
DOI: 10.34190/ECIAIR.19.005

Abstract: The idea of creating intelligent machines and artificial intelligence (AI) have been around for centuries, and can be traced back to at least to the 14th century. Artificial Intelligence in Education (AIED) is a much younger discipline, but during the last 25 years there have been achievements in a number of fields which have made impact on education. Critical voices have been raised against the over-optimism in contemporary AI research. Less has been written about the high expectation of AIED and its potential impact on education. The aim of this study was to analyse and discuss AIED from the teacher perspective. This study was carried out as a SWOT-analysis, with data gathered from a literature study. Main keywords in the literature search were: artificial intelligence, artificial intelligence in education, AIED, teacher perspective, education and teacher. Themes and patterns in the four main categories where further processed as a deductive-inductive thematic analysis. Findings indicates that there are both promises and threats for the teacher in the contemporary AIED. In several aspects the field seems to be in a state of hype but as other hype areas there is a potential for maturing and with concrete applications in daily teaching and learning activities. Recommendations is to learn from traditional AI and to open up for an informative and nuanced discussion concerning the role of AI in education. Otherwise there is a risk for artificial education instead of artificial intelligence in education.

Keywords: Artificial intelligence in education, AIED, AI, Teacher perspective, Education

1. Introduction

The idea of creating artificial intelligence (AI) has been around for a long time, and in the 14th century Ramon Llull outlined his idea of implementing reasoning and thought processes in an intelligent machine in his Ars Magna. Ideas that later inspired scientists such as Giordano Bruno, Athanasius Kirchner, Agrippa of Nettesheim and Gottfried Wilhelm Leibniz. (Jensen 2017) Centuries later a more modern calculation model for intelligent reasoning was formalised by Alan Turing (1937), and his machine model has been the foundation of computer science and the idea of computers as intelligent problem solvers.

Turing (1950) extended his ideas in *Computing Machinery and Intelligence*, which is seen as the bedrock of AI (Castelfranchi 2013), even if the term was not coined until 1956, around two years after Turing's death (McCarthy et al 2006). Attempts to formalise intelligent reasoning and to further develop AI has been an ongoing process since Turing built the first prototype for computer chess engines in the 1950s. As suggested by Claude Shannon, computer chess is an interesting testbed for computer science and AI (Keene, Jacobs & Buzan 1996). An increasing percentage of successful computer programs have challenged chess grandmasters, but still without reaching a lobster's level of social skills and handling real world problems. A comparison made by John Searle (1990), who also has coined the terms strong AI and weak AI.

Recently the terms strong and weak AI have been renamed as narrow AI and artificial general intelligence (AGI). The term AGI was popularised by the AI-researchers Shane Legg, Mark Gabrud and Ben Goertzel with the term defined as general artificial intelligence on the level of human intelligence. (Tegmark 2017) Strong AI or AGI can also be illustrated by the Turing test, where true and general AI is accomplished when there no longer is possible to tell the difference between a natural language conversation between a human being and an AI system (Turing 1950).

Weak or narrow AI, can be exemplified by more specialised AI applications such as digital devices communicating via Bluetooth, or when the chess engine Deep Fritz beat GM Vladimir Kramnik (Hoffman 2002).

A recent example of narrow AI on superhuman level was when the machine learning based AlphaGo defeated the Korean Go grandmaster Lee Sedol (Zhang 2016). Machine learning is the AI field that has made a fast progress during the last decade, but as pointed out by Lee and Shin (2017), all developed AI systems so far must be classified as weak or narrow AI. Finally, the answer to the question if AI systems can replace human doctors in the treatment of patients is still NO. There are today no computational algorithms or heuristics to understand human emotions at a deeper level. (Zhang 2016)

The concept of Artificial Intelligence in Education (AIED) is a much younger one, but during the last 25 years AI have in various ways been introduced into educational sessions (Koedinger & Corbett 2006; Heffernan & Heffernan 2014). AIED started off as a playground for computer scientists (Cumming & McDougall 2000), but have gradually made a stronger impact on education (Koedinger & Corbett 2006; Heffernan & Heffernan 2014). Two examples of AIED that might facilitate students' learning situation are to improve student collaboration and enable mass individualisation (Luckin et al 2016). A focused area in the AIED community has been on reaching the same efficiency as one-to-one human-tutoring in interactive learning environment (VanLehn 2011).

An interesting aspect of the implementation of AIED is its potential consequences on the role of the teacher, depending on the degree of intelligence the AI possesses. A possible shift in the teacher's role is that from a central figure of knowledge to that of a supporter on the side-line (King 1993). This could enable teachers to use more of their time to knowledge building processes through supporting collaboration, collection, discussion and integration of information among their students; instead of possessing the information and knowledge themselves (Roll & Wylie 2016).

In the wide variety of research on how AI might be applied in educational settings, there are relatively few studies with a focus on the opportunities and challenges of AIED from the teacher perspective. The current general AI hype seems to have brought in a tendency of over-optimism in AIED research as well (Murphy 2019). Before implementing new AI-based techniques there is a need to investigate the strengths and weaknesses of this field. The aim of this study was to analyse and discuss artificial intelligence in education from the teacher perspective, and the main research question to answer was: "Which are the strengths, weaknesses, treats and opportunities of a large-scale implementation of artificial intelligence in education?"

2. Method and data collection

This study was conducted as a SWOT-analysis, with data gathered from a literature study. The SWOT framework depicted in Figure 1 below was used for categorising results from a deductive thematic analysis following the main SWOT idea of identifying strengths, weaknesses, opportunities and threats. The upper level with strengths and weaknesses represents the internal level and the lower level with opportunities and threats represents the external dimension.

SWOT Model	Helpful to achieve objectives	Harmful to achieve objectives
Internal	**S**trengths	**W**eaknesses
External	**O**pportunities	**T**hreats

Figure 1: The SWOT analysis framework

In a SWOT analysis patterns of actions should match found strengths and opportunities, and weaknesses and threats have to be concerned (Stacey 1993). The SWOT framework has been criticised for being a naïve tool, and the recommendation is to use a complementary analytical model (Pickton & Wright 1998). This study used the SWOT components as the four main categories of a deductive thematic analysis. Themes and patterns in the four main categories where further processed in an inductive analysis based on emerging themes from the findings.

The study was conducted during the autumn of 2018 and spring 2019, with author attendance at a seminar on AI and Robotics in education at Mid Sweden University as a starting point for the work. The conducted study could be classified as a central literature study, in the sense of reviewing a collection of literature that is central to meet the research aim. Main keywords in the literature search where: artificial intelligence, artificial intelligence in education, AIED, teacher perspective, education and teacher. Keywords have been combined using the Boolean operators 'and' and 'or'. Google Scholar was used as the main search engine to find relevant articles to answer the research question. Results were filtered with a time frame that was set to include articles with a publication year no older than 2015, with the exception of backwards searches.

The articles that were not accessible through Google Scholar were accessed through the aggregation of research databases at the Mid Sweden University library. Although the different combinations of keywords in the searches gave a large number of hits, the relevance to the research question was often limited since a lot of the articles did not necessarily study AI systems that could be classified as to incorporate some degree of intelligence. A total of 20 articles was included in the final selected for this study, with the *International Journal of Artificial Intelligence in Education* as one of the most frequently mentioned sources in both the final selection and in the overall searches. The thematic analysis was carried out as described by Braun and Clarke (2006) and article selection was done on the basis of contributing to answer the research question.

Table 1: Selected articles

Year:	Author:	Title:	Publication:
2016	Baker	Stupid tutoring systems, intelligent humans.	International Journal of Artificial Intelligence in Education, 26(2), 600-614.
2016	Kulik & Fletcher	Effectiveness of intelligent tutoring systems: a meta-analytic review.	Review of Educational Research, 86(1), 42-78.
2016	Luckin et al	Intelligence unleashed: An argument for AI in education.	Pearson
2016	Nye	Its, the end of the world as we know it: transitioning aied into a service-oriented ecosystem.	International Journal of Artificial Intelligence in Education, 26(2), 756-770.
2016	Roll & Wylie	Evolution and revolution in artificial intelligence in education.	International Journal of Artificial Intelligence in Education, 26(2), 582-599.
2016	Timms	Letting artificial intelligence in education out of the box: educational cobots and smart classrooms.	International Journal of Artificial Intelligence in Education, 26(2), 701-712.
2017	André et al	Artificial Intelligence in Education	In proceedings of the18th International Conference on AIED
2017	Barnes et al	Preface for the special issue on AI-supported education in computer science	International Journal of Artificial Intelligence in Education, 27(1), 1-4.
2017	Ogan et al	Proficiency and Preference Using Local Language with a Teachable Agent.	International Conference on Artificial Intelligence in Education (pp. 548-552). Springer, Cham.
2017	Popenici & Kerr	Exploring the impact of artificial intelligence on teaching and learning in higher education.	Research and Practice in Technology Enhanced Learning, 12(1), 22.
2018	Crow, Luxton-Reilly & Wuensche	Intelligent tutoring systems for programming education: a systematic review.	Proceedings of the 20th Australasian Computing Education Conference (pp. 53-62). ACM.
2018	Liu	The Application and Development Research of Artificial Intelligence Education in Wisdom Education Era.	In proceedings of the 2nd International Conference on Social Sciences, Arts and Humanities

Year:	Author:	Title:	Publication:
2018	Nichols & Holmes	DON'T DO EVIL: IMPLEMENTING ARTIFICIAL INTELLIGENCE IN UNIVERSITIES.	Towards Personalized Guidance and Support for Learning, 109.
2018	Sellar	Education, work and Australian society in an AI world.	Gonski Institute for Education
2018	Wogu et al	Artificial Intelligence, Artificial Teachers and the Fate of Learners in the 21 st Century Education Sector: Impli-cations for Theory and Practice.	International Journal of Pure and Applied Mathematics, 119(16), 2245-2259.
2019	Goksel & Bozkurt	Artificial Intelligence in Education: Current Insights and Future Perspectives.	Handbook of Research on Learning in the Age of Transhumanism (pp. 224-236). IGI Global.
2019	Karsenti	Artificial Intelligence in Education: The Urgent Need to Prepare Teachers for Tomorrow's Schools.	Formation et profession, 27(1), 112-116.
2019	Mohammed	Towards Inclusive Education in the Age of Artificial Intelligence: Perspectives, Challenges, and Opportunities.	Artificial Intelligence and Inclusive Education(pp. 17-37). Springer, Singapore.
2019	Murphy	Artificial Intelligence Applications to Support K–1 2 Teachers and Teaching.	RAND Corporation DOI: https://doi.org/10.7249/PE315
2019	Walkington & Bernacki	Personalizing Algebra to Students' Individual Interests in an Intelligent Tutoring System: Moderators of Impact.	International Journal of Artificial Intelligence in Education, 29(1), 58-88.

3. Findings and discussions

Main findings from the literature study were grouped into the categories of strengths, weaknesses, opportunities and threats as depicted in Table 1 below.

Table 2: SWOT-categorised findings

Findings	Helpful to achieve objectives	Harmful to achieve objectives
Internal	**Strengths:** Step-based STEM systems Effective computer-aided teaching Teachable agents for natural language learning Ecosystems of learning tools Evaluation of learning models	**Weaknesses:** Stupid tutoring systems Data bias and algorithmic bias HLMI customisation meddles with the standardisation of what is expected
External	**Opportunities:** Changes in the teacher role – from 'the sage on the stage' to 'the guide on the side' Assist teachers and free teachers from tedious routine work Assist students anytime and anywhere Truly personalised learning / mass individualisation	**Threats:** Changes in the teacher role – the teacher as a system maintainer Extinction risk fears / fear of being replaced Lack of preparation in education to take advantage of AIED HLMI impairs students developing independently learning skills Hype can lead to unquestioned panacea

3.1 Strengths

In the general belief of AI as a catalyst of effective computer-aided teaching and learning (Liu 2018), an area with many applications and success stories is STEM education. STEM topics with step-based and well-defined problems can be enhanced with software systems built on narrow AI (Roll & Wylie 2016). STEM subjects where several successful tutoring systems have been used are in programming education (Crow, Luxton-Reilly & Wuensche 2018) and computer science (Barnes et al 2017). Natural languages are more complex and irregular, but the research studies by Ogan et al (2017) and André et al (2017) reports on successful attempts where teachable agents help out to reduce language barriers.

Another possible strength is the potential for AI systems to serve learners across schools, boundaries and platforms in the creation of ecosystems of interacting learning tools. Furthermore, AIED systems might be used to evaluate different learning models across school boundaries (Nye 2016). Without requirements of strong AI, tutoring systems could provide learners with rapid feedback and to enable stimulating interaction (Sellar 2018). With a realistic view, weak to medium-strong narrow AI, AIED systems have a good probability to support teaching and learning and facilitate teachers' daily routine work.

3.2 Weaknesses

Intelligent tutoring systems often involve less artificial intelligence than expected, not least when it comes to interaction with students. Baker (2016) took a critical standpoint and classified many existing tutoring systems as stupid tutoring systems. His concept for online learning is rather data driven amplification of human intelligence than data driven artificial intelligence (Baker 2016).

In a more dynamic use of AIED there is a need of training-data, one problem that arises is the question of how to ensure that the data is representative and free from bias (Nichols & Holmes 2018; Murphy 2019). As stated by Popenici and Kerr (2017) the complex algorithms of AI is designed by human programmers that have the possibility to include their own agendas or biases in the development of the system. An important aspect of High-Level Machine Intelligence (HLMI) is that it customises the learning to suite every student, but in doing so it meddles with the standardisation of the material and what is expected of the student (Wogu et al 2018).

3.3 Opportunities

As pointed out by Luckin et al (2016) it is hard to see a future where teachers are replaced by AI systems or softbots. The positive and more realistic scenario is that the role of the teacher evolves and transforms, freeing teachers from tedious routine tasks. Furthermore, AIED has the potential to free the teacher from the burden of possessing all the knowledge and information that could be relevant to the students (Roll & Wylie 2016). A possible future use of AIED is in the form of cobots (co-working robot) that will assist teachers in their daily work and tailor-make the learning experience to suite each student (Goksel & Bozkurt 2019), for example in recording and analysing students work and reporting to the teacher (Timms 2016).

The use of Intelligent Tutoring Systems (ITS) can provide customised instructions or feedback immediate to the students at any given time of the day (Goksel & Bozkurt 2019; Nichols & Holmes 2018), but the depth of the customisation is a critical feature of truly, and not superficial, personalised learning (Walkington & Bernacki 2019). Studies indicate that developers of ITS have succeeded in their goal of matching and go beyond the tutoring of computer assisted instructions (CAI) and those of human tutor in raising the test scores of students (Mohammed 2019; Kulik & Fletcher 2016).

3.4 Threats

A negative change of the teacher role might be by stereotypical MOOCs with examination by low-level multiple-choice items and teachers as content developers (Roll & Wylie 2016). Most school curricula and teacher training programs are badly prepared to take advantages of AIED due to a lack of offered AI courses to their teachers (Karsenti 2019). This could further lead to a technology abuse if teachers are not trained in the use of AI (Karsenti 2019), for example in privacy and the handling of personal data to influence (Nichols & Holmes 2018; Popenici & Kerr 2017). According to Nicholas and Holmes (2018) an ethical framework needs to be developed and adapted for the use of AIED, and even when adopted there must be a continuously discussion and update of the framework to reflect the capability and breadth of AI and its potential use.

A rising concern among many workers in education is the extinction risk fear that High-Level Machine Intelligence (HLMI) systems will fully take over the job of the teacher (Wogu et al 2018). According to Popenici

and Kerr (2017) AI already have the potential to replace a large number of teaching assistants and administrative staff in education and therefore it is yet more important to investigate its effect on education. Studies have shown that a wide use of HLMI systems may impair student's ability to learn independently and develop 21th century skills such as problem solving and critical thinking (Wogu et al 2018). Finally, the most severe AI-threat for students might be surveillance cameras with built-in face recognition. Beside machine learning, face recognition is one of the fields where AI makes a fast progress, much faster than AI ethics. A secondary school in Skellefteå, Sweden has been reported to the Swedish Data Protection Authority for collecting biometric student data. According to the principal at the school, the reason for the initiative was to reduce the 17 000 hours per year that the staff spent on attendance registration (Feber 2019).

3.5 General discussion

This section could be criticised for not bringing up all aspects of AIED in previous research. This can be exemplified by the 26 positive impacts of AI on education mentioned by Karsenti (2019). The reason for some discrimination on aspects of AIED is that many falls outside the definition of intelligence as an ability to accomplish complex goals (Tegmark 2017:50), which should be perceived as a central requirement for a system to bear the label AIED. The reason for this ambiguity in the concept of AI might be that the field is in a stage of hype considering its possibilities on education, which is a reason to stay aware of the real limits of AI in education. Hype in AI can lead to a belief in AIED as an unquestioned panacea, however, an academic scepticism should be maintained since the goal of education is to build responsible citizens and educated minds (Popenici & Kerr 2017).

There are certainly areas where AIED have a capacity to support teaching and learning, and two of them are in individualised STEM activities and in automatized and adaptive language learning. An example of adaptive language learning are the courses provided by the Estonian online platform. Courses in languages such as English, Estonian, French, German, Russian and Spanish have been constructed based on large text corpora and statistical analyses. (Lingvist 2019) However, the learning platforms must be carefully designed, otherwise there is an obvious weakness with the use of so called 'stupid tutoring systems' (Baker 2016). Part of the careful design must be to handle data bias (Zou & Schiebinger 2018) and algorithmic bias (Bellamy et al 2018).

The potential teaching support from AIED systems and robotics is certainly an opportunity, but social robots are still in their infancy and with limited social skills (Uppsala University 2019). In the near future the realistic opportunity lies in so called cobots that can provide individualised content and fast feedback (Goksel & Bozkurt 2019). Like in the manufacturing industry, teachers could soon be able to reprogram cobots with the use of block programming interfaces that does not require advanced programming skills (Nair, Kuhn & Hummel 2019). There are also threats, and for bare economic reasons we will probably experience cases where teachers are replaced by AIED solutions. Universities with financial problems would probably be tempted to try solutions like at Deakin University in Australia where the IBM developed besserwisser Watson 7/24/365 offers the service that: “every student who asks Watson a question can expect tailored information and advice based on their individual profile” (Deakin University 2014). However, since frequently answered questions are on how to submit assignments and how to pay for parking (Scheepers, Lacity & Willcocks 2018), such systems for cognitive automation would rather be a threat to administrative staff than to teachers.

Finally, like for AI in general, ethics is an urgent challenge (Sadeghi 2017), even if the threats in AIED might not be that dramatic as in other AI areas, AIED will not automatically be beneficial. Quality teaching is a complex and creative profession involving improvisation and spontaneity where humans are not that easily replaced as in a conveyor belt in the industry (Murphy 2019).

4. Conclusion

As the findings have shown there seem to be some ambiguity about what should be classified as intelligence in AIED. The authors would like to suggest a new terminology when talking about AI and AIED, where weak and strong AI is combined with narrow AI and AGI, to better define which level of AI is intended in the research and discussion. Narrow AI can be exemplified by an intelligent system that can solve a specific problem of different complexity (weak narrow AI or strong narrow AI). AGI can be exemplified by an intelligent system that can generalise its knowledge in solving many different kinds of problems at a human-level or beyond (weak AGI or strong AGI).

Despite the rapid progress in machine learning there are no signs of AGI in AIED, but at best medium-strong narrow AI. Authors recommendation is that teachers and other stakeholders in education learn more about AI and the many sub-categories, to enable them to make informed decisions about the strengths, weaknesses, opportunities, and threats in buying and implementing such systems. Ask yourself the question: if someone really had the algorithms or heuristics for AGI, why would they freely, or at low cost, share that knowledge in the field of education?

On the other hand, weak narrow AI could be a valuable contributor in freeing teachers from tedious routine work and to assist in online learning. Well-designed and medium-strong narrow AIED would definitely have a potential to support mass individualisation in large student groups and provide students with basic feedback on a 24/7 basis. The scenario that looks promising is the one where teachers will have more time for activities that humans carry out best, assisted by AIED systems that takes care of the tasks that computers handle best.

Contemporary AIED definitely seems like a hype, but as depicted in a Gartner's hype curve (Fenn & Time 2007), an initial overenthusiasm, followed by disillusion often leads to an eventual understanding of a technology's relevance and role in the specific domain.

5. Future research

This was a relatively small literature study that only analysed AIED from the teacher perspective. An interesting follow-up would be to more directly ask the teachers about their beliefs and fears. This might be carried out both quantitatively in a large-scale survey or qualitatively by interviews. Important to catch the teachers' opinions, with the idea of future AIED investments that are truly based on teachers' needs.

References

André, E., Baker, R., Hu, X., Rodrigo, M. T., & du Boulay, B. (2017). Artificial Intelligence in Education. In proceedings of the18th International Conference on AIED, Wuhan, China

Baker, R. S. (2016). Stupid tutoring systems, intelligent humans. International Journal of Artificial Intelligence in Education, 26(2), 600-614.

Barnes, T., Boyer, K., Sharon, I., Hsiao, H., Le, N. T., & Sosnovsky, S. (2017). Preface for the special issue on AI-supported education in computer science. International Journal of Artificial Intelligence in Education, 27(1), 1-4.

Bellamy, R. K., Dey, K., Hind, M., Hoffman, S. C., Houde, S., Kannan, K., ... & Nagar, S. (2018). Ai fairness 360: An extensible toolkit for detecting, understanding, and mitigating unwanted algorithmic bias.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative research in psychology, 3(2), 77-101.

Castelfranchi, C. (2013). Alan Turing's "Computing machinery and intelligence". Topoi, 32(2), 293–299.

Crow, T., Luxton-Reilly, A., & Wuensche, B. (2018). Intelligent tutoring systems for programming education: a systematic review. In Proceedings of the 20th Australasian Computing Education Conference (pp. 53-62). ACM.

Cumming, G., & McDougall, A. (2000). Mainstreaming AIED into education? International Journal of Artificial Intelligence in Education (IJAIED), 11, 197-207.

Deakin University (2014). IBM Watson now powering Deakin. A new partnership that aims to exceed students' needs. Retrieved from: http://archive.li/kEnXm [Accessed 2019, May]

Feber (2019). Skola testar ansiktsigenkänning för närvarorrapportering / School testing face recognition for attendence control. Retrieved from: https://feber.se/samhalle/art/393736/skola_testar_ansiktsigenknning/ [(Accessed 2019, May 31]

Fenn, J., & Time, M. (2007). Understanding Gartner's hype cycles, 2007. Gartner ID G, 144727.

Goksel, N., & Bozkurt, A. (2019). Artificial Intelligence in Education: Current Insights and Future Perspectives. In Handbook of Research on Learning in the Age of Transhumanism (pp. 224-236). IGI Global.

Heffernan, N. T., & Heffernan, C. L. (2014). The ASSISTments ecosystem: Building a platform that brings scientists and teachers together for minimally invasive research on human learning and teaching. International Journal of Artificial Intelligence in Education, 24(4), 470-497.

Hoffman P. (2002) 'Brains in Bahrain:' Man and Machine Call It Quits. TIME. Retrieved from: http://content.time.com/time/arts/article/0,8599,366855,00.html [Accessed 2019, April 19]

Jensen, T. (2017). Ramon Llull's Ars Magna. In R Moreno-Diaz, A. Quesada-Arencibia and F. Pichler (Eds.), EUROCAST: International conference on computer aided systems theory (pp. 19–24). Cham, Switzerland: Springer.

Karsenti, T. (2019). Artificial Intelligence in Education: The Urgent Need to Prepare Teachers for Tomorrow's Schools. Formation et profession, 27(1), 112-116.

Keene, R. D., Jacobs, B. A., & Buzan, T. (1996). Man v Machine: The ACM Chess Challenge: Garry Kasparov v IBM's Deep Blue. BB Enterprises.

King, A. (1993). From sage on the stage to guide on the side. College Teaching, 41(1), 30-35.

Koedinger, K. R., & Corbett, A. T. (2006). Cognitive tutors: Technology bringing learning science to the classroom. In K. Sawyer (Ed.), The Cambridge handbook of the learning sciences (pp. 61–78). New York: Cambridge University Press.

Kulik, J. A., & Fletcher, J. D. (2016). Effectiveness of intelligent tutoring systems: a meta-analytic review. Review of Educational Research, 86(1), 42-78.

Lingvist (2019). Take your language skills to the next level. Retrieved from: https://lingvist.com/ [Accessed 2019, April 31]

Liu, M. (2018). The Application and Development Research of Artificial Intelligence Education in Wisdom Education Era. In proceedings of the 2nd International Conference on Social Sciences, Arts and Humanities

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). Intelligence unleashed: An argument for AI in education.

McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (2006). A proposal for the dartmouth summer research project on artificial intelligence, august 31, 1955. AI magazine, 27(4), 12-12.

Mohammed, P. S. (2019). Towards Inclusive Education in the Age of Artificial Intelligence: Perspectives, Challenges, and Opportunities. In Artificial Intelligence and Inclusive Education(pp. 17-37). Springer, Singapore.

Murphy, R. F. (2019). Artificial Intelligence Applications to Support K–1 2 Teachers and Teaching. RAND Corporation, DOI: https://doi.org/10.7249/PE315

Nair, V. V., Kuhn, D., & Hummel, V. (2019). Development of an easy teaching and simulation solution for an autonomous mobile robot system. Procedia Manufacturing, 31, 270-276

Nichols, M., & Holmes, W. (2018). DON'T DO EVIL: IMPLEMENTING ARTIFICIAL INTELLIGENCE IN UNIVERSITIES. Towards Personalized Guidance and Support for Learning, 109.

Nye, B. D. (2016). Its, the end of the world as we know it: transitioning aied into a service-oriented ecosystem. International Journal of Artificial Intelligence in Education, 26(2), 756-770.

Ogan, A., Yarzebinski, E., De Roock, R., Dumdumaya, C., Banawan, M., & Rodrigo, M. M. (2017). Proficiency and Preference Using Local Language with a Teachable Agent. In International Conference on Artificial Intelligence in Education (pp. 548-552). Springer, Cham.

Pickton, D. W., & Wright, S. (1998). What's swot in strategic analysis?. Strategic change, 7(2), 101-109.

Popenici, S. A., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. Research and Practice in Technology Enhanced Learning, 12(1), 22.

Roll, I., & Wylie, R. (2016). Evolution and revolution in artificial intelligence in education. International Journal of Artificial Intelligence in Education, 26(2), 582-599.

Sadeghi, A. R. (2017). Ai industrial complex: The challenge of ai ethics. IEEE Security & Privacy.

Searle, J. R. (1990). Is the brain's mind a computer program?. Scientific American, 262(1), 25-31.

Sellar, S. (2018). Education, work and Australian society in an AI world.

Scheepers, R., Lacity, M. C., & Willcocks, L. P. (2018). Cognitive Automation as Part of Deakin University's Digital Strategy. MIS Quarterly Executive, 17(2).

Stacey, R. (1993). Strategic Management and Organisational Dynamics, Pitman, London.

Tegmark, M. (2017). Life 3.0: Being human in the age of artificial intelligence. New York: Knopf.

Timms, M. J. (2016). Letting artificial intelligence in education out of the box: educational cobots and smart classrooms. International Journal of Artificial Intelligence in Education, 26(2), 701-712.

Turing, A. M. (1937). On computable numbers, with an application to the Entscheidungsproblem. Proceedings of the London mathematical society, 2(1), 230-265.

Turing, A.M. (1950). Computing machinery and intelligence, Mind, 54(236), 433-460.

Uppsala University, Social Robotic Lab (2019). Artificial teachers on the way. Retrieved from: https://www.uu.se/en/news/news-document/?id=9436&typ=artikel [Accessed 2019, June 1]

Walkington, C., & Bernacki, M. L. (2019). Personalizing Algebra to Students' Individual Interests in an Intelligent Tutoring System: Moderators of Impact. International Journal of Artificial Intelligence in Education, 29(1), 58-88.

VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. Educational Psychologist, 46(4), 197-221.

Wogu, I. A. P., Misra, S., Olu-Owolabi, E. F., Assibong, P. A., & Udoh, O. D. (2018). Artificial Intelligence, Artificial Teachers and the Fate of Learners in the 21 st Century Education Sector: Impli-cations for Theory and Practice. International Journal of Pure and Applied Mathematics, 119(16), 2245-2259.

Zhang, Z. (2016). When doctors meet with AlphaGo: potential application of machine learning to clinical medicine. Annals of translational medicine, 4(6).

Zou, J., & Schiebinger, L. (2018). AI can be sexist and racist—it's time to make it fair.