A review of the use of artificial intelligence in the field of education

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Abstract

This brief exploratory review was aimed at evaluation of the use of artificial intelligence and its effectiveness in educational field. The literature search of Google Scholar yielded 26 usable papers, which were discussed from the point of view of conceptual frameworks, applications and evaluation of artificial intelligence.

Many conceptual frameworks were identified. They differed with respect to their contexts of use while the basic principles remained the same. Use of augmented technology has been very promising.

AI has been in use for some time now. Various types of AI applications in tutoring, learning music, drawing, reading comprehension etc. have been tested successfully. Many of the AI applications have been evaluated successfully. However, sometimes, problems of slower speed and software problems, lower utility of feedback messages and their contents, lower level of learning, sometimes no advantage of using the tool over conventional teaching were noticed.

Keywords: Artificial Intelligence, Education, Applications, Review, Trend

Background

The current status of artificial intelligence (AI) in the field of education in USA, with a focus on marketing scope, was discussed by Marr (2018). The author noted that AI has started to alter education tools and institutions and changing education to an entirely new way of teaching and learning, which has never been possible so far. In USA, AI applications in education is expected to grow by 47.5% during 2017-2021. Teachers may still be needed, but in different roles. Already AI has been successfully applied in some aspects of education.

AI solutions to education are continuing to evolve. When it reaches relatively more mature stages, AI may be able to fill gaps in learning and teaching needs. This may facilitate schools and teachers to do more than what were done so far. The advantages of AI are that it can drive efficiency, increase personalization and streamline administration tasks. These advantages allow teachers to devote more time with greater freedom to provide understanding and adaptability. Thus, the best attributes of machines and teachers can be leveraged for maximum advantage in terms of the best outcome for students. The current students need to work in a technology-rich future. So, it is important that educational institutions expose students to and use the technology at an early stage. Currently, teachers struggle to adjust their methods to the individual needs of students. AI will make this easier with better differentiation and individualisation. Ai can enable global classrooms accessible to all irrespective of languages and even to those with learning disabilities. People, unable to attend schools, can use Presentation Translator. This till gives power point subtitles of real time teaching in classes. Learning a subject, not available in the school is also possible with this tool. If AI tools are used in administration tasks like enrolment and admission. Teachers may be able to give greater focus to teaching. Grading home-works and assignments with comments on closing learning gaps are made possible by some emerging AI

applications. AI is also very useful for tutoring on difficult subjects like algebra, difficult home-works and tests. Smart content and virtual global conferences help teachers to interact with other teachers across the world and adapt the best practices of AI in education.

Ten roles of AI in education have been described in Staff (2018). These roles are: automation of basic activities in education, admissions and grading; AI software can be adapted to student needs; AI can point out where the courses need improvement; additional support for students can be provided; helpful feedbacks can be given to teachers and learners; AI changes methods of finding and interacting with information; role of teachers can be changed; trial and error learning made less problematic; AI-powered data can change the ways in which schools find, teach and support students and AI can change the basic framework of teaching with respect to where students learn, who teaches them and how they are taught and learn skills. Some of these roles were discussed by Marr (2018) also, as described above.

The aim of this paper is to undertake a brief exploratory review of application of AI in the field of education. The review consists of the examination of conceptual frameworks, applications of AIED and evaluation of its usefulness.

Method

A brief literature search was done in Google Scholar using search terms related to the topic with Any Time frame and from 2015-time frame for recent works. The search yielded 26 usable papers. These are reviewed under different sections below.

Results

Conceptual frameworks

Many conceptual frameworks of AIED exist. Some of the early conceptual frameworks are traced historically. These frameworks are discussed even in current works.

An early work n AI in education was a book by Lawler and Yazdani (1987). The book is an outcome of an international conference on the subject at Pittsburgh, USA in 1987. Papers deal with two different approaches to AI in education. Intelligent tutoring systems and computer-based learning environments. Computer-Assisted Instruction (CAI) introduced in the 1950's formed the basis of the first approach. ITS and Intelligent CAI systems were developed to solve some limitations of CAI. Knowledge presentation technology of knowledge engineering community developed SOPHIE as a predecessor of expert systems. This was followed by a few early developments in application of AI in education. A book by Claude and Gauthier (1990) deals with intelligent tutoring systems with more or less similar contents.

The current progress and future prospects of AI in education were discussed by McArthur, Lewis, and Bishary (2005). Three research models of AI in education were discussed by Baker (2000). The models were: as scientific tools, as components of educational artefacts and as bases for design of educational artefacts. But the author does not go beyond computer-based learning for any of these models. AI is much more than just computer-based learning as was seen above.

According to Devedžić (2004) web-intelligence (WI) related AI in education (AIED) consists of web-based intelligent tutoring system (ITS) (a topic discussed by Lawler and Yazdani (1987) also) is exemplified by the development of ELM-AR, PAT Online of the late 1990's. Educational gateways like GEM of US Department of Education is a teacher-oriented facility for to access teaching materials and lesson plans used in other countries. Use of WI in personalised

learning comprises web-learner interface activities. WI-enhanced web-based ITS is possible by employing intelligent Web services. This goes beyond XML/RDF infrastructure of web pages. Web services can be enabled by intelligent systems technology. Learners, teachers, and authors will be able to see the web as a collection of educational resources, each with well defined interface to access its services. Based on this possibility, an intelligent educational servers' architecture was proposed by the author is reproduced in Fig 2. The variety of services this structure can provide to teachers, learners and authors is indicated in the diagram. Web-mining, when automatic processes are used, is also an application of AIED. These are just some possibilities, which may become realities eventually.

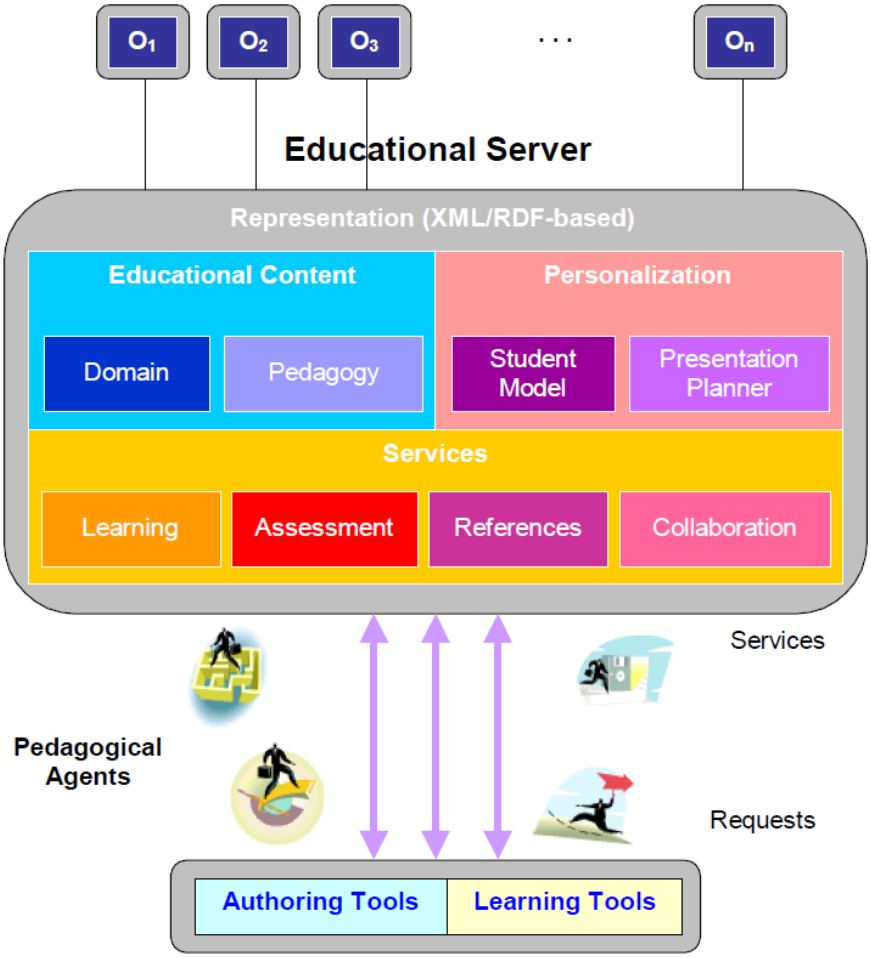

Figure 1: INES architecture inside an intelligent educational server (Devedžić, 2004)

The possibility of using augmented intelligence/knowledge-based system (KBS to develop distance learning applications to support curriculum was conceptualised by Crowe, LaPierre, and Kebritchi (2017). A KBS system allows both data management and assist in creating tools and curricula by instructional designers to generate meaningful applications. An exploratory study conducted by the authors to develop a KBS software for scholarly writing was discussed as a proof of the applicability of this concept.

A detailed framework of a conceptual smart classroom using and integrating various AI applications at various levels was proposed by Aguilar, Valdiviezo, Cordero, and Sánchez

(2015). The system proposed uses a multi-agent systems paradigm. Each agent and each system is described with regard to its properties, tasks performed and expected outcomes. The authors discuss two examples of applications of these two frameworks in a device and a software of a smart classroom and an example of the conversations occurring in a classroom session.

Applications of AIED

Many applications of AIED in different educational contexts have been researched. Conceptually, all applications are similar. The following brief review is indicative of the various types of applications of AIED.

Noting the inadequacy of traditional, remedial intelligent tutoring systems approaches for tutoring in domains that require open-ended thinking, Holland (1989) tested two manipulation tools to encourage and aid music composition by musical novices, particularly those without traditional musical skills. In one using Harmony Space, novices are allowed to sketch, analyse, modify, and compose harmonic sequences simply and clearly by moving two-dimensional patterns on a computer screen linked to a synthesizer. Studies using small sample of subjects showed considerable reduction of the prerequisites required to learn about, sketch, analyse and experiment with harmony. These activities are normally possible only with high level of theoretical knowledge or instrumental skill. A knowledge-based tutoring system was in the developmental stage. This system was meant to help novices to use an interface to compose chord sequences.

In a detailed work, Graesser, VanLehn, Rosé, Jordan, and Harter (2001) evaluated three AIED applications: AutoTutor, Atlas and Why2. The concept that students learn best if they construct knowledge themselves was proved. Finite state networks are used in all three tools. Authors need to enter the dialogues in natural language. All three projects use robust natural language–understanding techniques. Thus, LSA is used for AUTOTUTOR, CARMEL for ATLAS, and a combination of the two for WHY2. In all these projects, the initial step consisted of data analysis from human tutors. All were using evaluations with human students throughout their design cycle. The three tools have their tasks and knowledge in different subject domains like computer knowledge, mathematics and physics and are qualitative. Class-specific domains may be the future development.

The utility of Sketch Worksheets and Design Buddy as educational software tools of CogSketch was evaluated by Forbus, Usher, Lovett, Lockwood, and Wetzel (2011) in a geology class, students might be asked to highlight a fault on a photograph or draw the layers of the Earth. Sketching is a valuable way of learning spatial relationships. With pencil-and-paper sketching, feedback is delayed, and assessment is time-consuming and difficult. Immediate feedback leads to better student learning. Cogsketch can provide sketch worksheet of students and that of the instructor. The instructor sketch is hidden till evaluation for feedback to students, which can be used for corrections. Design Buddy helps engineering students to learn design and communication before they learn CAD for actual designing practices. In this case also, the works of the students can be compared with that of the instructor for feedback and corrections. Systems developed by others for similar purposes have also been discussed by the authors.

A second language reading application was designed, used and evaluated by Furtado, Hirashima, and Hayashi (2017) for its potential applicability in transforming foreign language narratives comprehensible communication to initiate and maintain interest. Short narratives in foreign language were combined with dialogue construction tasks. The software was found to be useful

in improving reading comprehension facilitated by its design in guiding user behaviour. However, some students were not very optimistic about its use for learning purposes.

Having examined some general applications of AIED, how such AIED tools performed in actual educational context is discussed in the works below through evaluation studies.

A conceptualised vision of AIED in future suitable for younger generation was discussed by Nye (2015). Currently, advanced learning tools are entering actual learning contexts. When this happens, it is essential that AIED follows the recent trends in development of tools for various services. This means, AIED platforms will be broken into distinct services consisting of different platforms like web, mobile, etc. Such a system will essentially be a distributed and integrated one across many systems. This will make learning platforms to become ecosystems of interactive learning tools.

In their work, Timms (2016) visualised a future in creating technologies designed specifically for learning and teaching, which combines the power of AIED with advances in robotics and in the increased use of sensor devices so that our surroundings and actions can be monitored. Although some form of schools will still exist, and teachers will be required, educational cobots will assist the teachers in classrooms. Smart classrooms will use sensors to support learning as AIED will be embedded in them.

Evaluation of AIED

There had been many experimental evaluations of educational tools developed based on AI. The tools include virtual learning games, tutoring or logic development facilitators. Some of them were standalone and other were supportive of classroom teaching. Improvement of motivation, increased engagement due to the tool, increased effectiveness of education through improved performance, especially those of poor performers was noted by Virvou, Katsionis, and Manos (2005) and Lanzilotti and Roselli (2007). Positive results were obtained by Aldahdooh and Naser (2017). Faster efficiency gains were reported by Aleven, McLaren, Sewall, and Koedinger (2006). The AIED tool was easy to learn, comprehensible and enjoyable and thus with high usability in the evaluation done by Mitrovic and Ohlsson (1999) and Robertson, Good, and Pain (1998). The tested AIED tools were useful for the teacher in the studies of Robertson, Good, and Pain (1998). Rosé, Moore, VanLehn, and Allbritton (2001) and Giraffa and Viccari (1999) compared two tools and established the superiority of one over the other for specific attributes. Improved student engagement, precise and serious work on the assigned tasks were carried out by students in a disciplined manner in the evaluation study by Lanzilotti and Roselli (2007), Higher and more efficient output with better performance leading to higher grades was noted in the work of Stamper, Eagle, Barnes, and Croy (2013). The scope for use of mobile tools for authoring by teachers for teaching purposes was examined by Virvou and Alepis (2005) and usefulness of robots for AI learning was demonstrated by Kumar (2004).

Problems of slower speed and software problems, lower utility of feedback messages and their contents, lower level of learning, sometimes no advantage of using the tool over conventional teaching were encountered variously in the above researches.

Conclusion

The past had been rich in development of software applications for diverse needs of learning inside and outside classrooms. Artificial intelligence was used mainly for tutoring, problem solving and logic development applications. Evaluation of these applications produced

encouraging results to carry on and further advance the concepts and frameworks for innovative development of artificial intelligence in education. Some of these concepts are far-fetching and may appear to be distant dreams.

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