The A.I in Education

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LIS 3353: IT Concepts for Information Professionals

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April 29, 2021

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Artificial intelligence is an interdisciplinary subject that combines the fields of natural science, technical science, and social science to create computer systems that exhibit behaviors similar to that of human intelligence (Fu, 2020, p. 263). Thus, it is not surprising that the ideas presented in this relatively novel field could have an impact on the field of education. This is compounded by our rich information society which not only incentivizes these solutions but provides a great platform in which they can be implemented. These technological innovations, however, are not as colorful as those of its mechanical cousin (the A.I who controls Atlas -the Boston Dynamic robot). Thus, these innovations don't get the same media attention as these robots which might be considered a competitor to their human counterpart. Nevertheless, the intersection of these two fields and the improvement of these algorithms could have great ramifications on an institution that is a cornerstone of society. Thus, I think is of importance to mention ways in which this change could be accomplished.

One of the ways in which artificial intelligence could influence the field of education comes from advancements in the field of text mining. More specifically, the use of algorithms to classify different types of data. One article that covers one of these algorithms is titled *Persian Text Classification via Character-level Convolutional Neural Networks*. This paper, which was co-authored by Saeideh Ghasemi and Amir H. Jadidinejad, faculty members of the Computer and Information Technology College of Islamic Azad University, presents the use of deep convolutional neural network algorithm to make this process more efficient. Unlike other text classification algorithms which use words as their basis for analysis, this algorithm uses characters text to perform this task (Ghasemi & Jadidinejad, 2018, p.1). This allows them to overcome the issue of having extra knowledge of the semantic and syntactic structure of a language that plagues the aforementioned algorithms (Ghasemi & Jadidinejad, 2018, p.1). This algorithm, by its very nature, also overcomes a second problem common to these algorithms which is having someone features that must be selected manually (Ghasemi & Jadidinejad, 2018, p.1). The Persian language corpus was used as the experiment's dataset and its efficiency was compared to other well-known learning algorithms, such as SVM and Naïve Bayes on parameters such as precision, recall, accuracy, etc. (Ghasemi & Jadidinejad, 2018, p.4). This model's performance was comparable to its counterparts when the datasets were small but achieved better performance when these were large (Ghasemi & Jadidinejad, 2018, pp.4-5). I mention this technology because of its potential to be in future educational applications. Although this algorithm is not extraordinary by any means, it is important to note that it is capable to classify Persian texts regardless of the language, the meaning of its words, or concepts associated with these sentences (Ghasemi & Jadidinejad, 2018, p.5). Thus, it is not hard to imagine, that an advanced version of these types of algorithms could serve as a tool to help students to learn about languages.

Another way artificial intelligence could aid education is by serving as a reliable way of testing the performance of students in the classroom. Take for example the article titled From *Human Grading to Machine Grading: Automatic Diagnosis of e-Book Text Marking Skills in Precision Education*, a study that measured the effect of student's markings on student's comprehension. Although the primary objective of this study was to measure the relationship between student makings and learning performance, this study, by necessity, had to find the best way in which to rank these scores. To perform this analysis, the researchers compared the performance of three learning algorithms that extracted key concepts from the student's learning material (Yang et al., 2021, p.167). These algorithms, named TextRank, Rake, and Bert were compared to each other and their human counterparts based on predetermined metric systems and instructor making references (Yang et al., 2021, p.168). It is important to note that the BLEU, a precision-based measure for evaluating a hypothesis translation to a reference translation, and Meteor, a recall-centered metric, were used to test the performance of these algorithms (Yang et al., 2021, p.168). In the end, the researchers decided to use the BERT algorithm to perform their analysis since it was able to outperform the other two in all but one category (Yang et al., 2021, p.168). This algorithm's reliability was compared to its human counterpart by using Cohen's kappa coefficient (Yang et al., 2021, p.168). The result indicated that the algorithm was good at indicating bad markers when the coefficient had a value of 0.2 and was less efficient when these were above 0.8, so they decided to cross-examine these results with a human instructor (Yang et al., 2021, p.169). This algorithm was later used to test the performance of 130 Taiwanese students enrolled in a 12-week accounting course that used an online e-book system, called Book Roll, for the aforementioned purpose (Yang et al., 2021, p.166). I will abstain from talking about the results of the paper since it there are not relevant for our purposes and they are consistent with similar research on this field (Yang et al., 2021, p.172). Nevertheless, this study shows that is not only possible to create a grading algorithm that tests the performance of students accurately and precisely, but that in some circumstances it is better than a human. Thus, it is not illogical to think that in the future algorithm-assisted learning can be accomplished.

Another way in which algorithms are making strides in the field of education is in their potential to substantiate pedagogical agents, intelligent agents design to support learning, to aid engineering students to learn in a virtual world. Such a scenario was presented by the article titled *Implementing Intelligent Pedagogical Agents in Virtual Worlds: Tutoring Natural Science*

Experiments in OpenWonderland and was coauthored by Mohamed Soliman and Christian Guetl. Although this article is a little bit outdated (being published in 2013), it still presents an interesting perspective on how this task could be accomplished. The authors decided to use Open Wonderland, an open-source java-based virtual world environment, as the domain in which to implement this tool (Soliman & Guetl, 2013, p.783). The reason for their decision was that this platform has been utilized to conduct virtual physics experiments in the past (Soliman & Guetl, 2013, p.784). The authors also decided to use a character module to represent the agent, an avatar for the learner, a multi-modal communication module for conversation (Soliman & Guetl, 2013, p.784). Although the article is explicit on how this tool was implemented, I will not cover these details in this paper as they are not necessary for this topic. However, it is important to note the capability of this tool. For example, this tool is able to add a voice feature using Mary TTS, a text-to-speech system that has been developed independently from this paper (Soliman & Guetl, 2013, p.786). In relation to its capability, this tool is capable of simulating the experiment or device operations, propagating events from the IPA to avatars where they can select to control the experiment or a value, allow the IPA to control the experiment internally, and provide an ability to intervene the operation of if the student chooses the incorrect allowable operation (Soliman & Guetl, 2013, p.786). Some of the questions asked to the student can include "*What experiments do you have?*" and *What is a capacitor*? (Soliman & Guetl, 2013, p.786). It is important to note that this tool is customizable, and the IPA can be trained to have a larger database (Soliman & Guetl, 2013, p.787). Although the options provided by this proposal is limited due to its age, the fact that it exists demonstrates the potential of this technology of providing a virtual environment in which the student can learn concepts and experiment with them in a safe setting.

This potential is collaborated by a study with a similar topic that explored the impact of these tools on the student's learning experience. This article titled *Examining the Impact of Pedagogical Agents on Students Learning Experience in Virtual Worlds*, and written by multiple authors, attempted to evaluate the effectiveness of pedagogical agents on 3D virtual environments. To enable this experiment, they first created the world using the Open Simulator platform, wrote the scripts using the Linden Scripting Language, and created simulations in which the students could manipulate (Grivokostopoulou et al., 2018, p.603). The researchers also created practical exercises, tests, and quizzes to go along with these hands-on experiences (Grivokostopoulou et al., 2018, p.604). The pedagogical agents were also designed and incorporated into the world in order to assist the students (Grivokostopoulou et al., 2018, p.604). This was done in preparation for the experiment which was design to answer the aforementioned question. In this experiment, 42 undergraduate students (males and females), with prior experience in using 3D educational environments, were randomly selected into two groups which differed on the level of engagement of their pedagogical agent (Grivokostopoulou et al., 2018, p.605). The first group had a pedagogical agent with complete functionality in which it accompanied the students and provided assistance to them when needed. The second group, in turn, only interacted with this agent at the beginning of the experiment and never saw it again. If students needed assistance with the experiment, they could interact with the assistance message platform provided by the program. The students were allowed to study in this environment for two weeks and were given questionnaires upon the completion of this program (Grivokostopoulou et al., 2018, p.605). The first questionnaire was based on the five-point Likert Scale and contained 10 questions, while the second one was based on the System Usability Scale (Grivokostopoulou et al., 2018, p.605). The Cronbach's alpha metric was used to test the reliability of the results (Grivokostopoulou et al., 2018, p.606). Consequently, the article found that the group with the agent had a better experience in the environment, the students found the learning activity to be more attractive and had a better engagement with the subject (Grivokostopoulou et al., 2018, p.606). Although greater study must be conducted in this area, these two studies demonstrate the potential and benefit of having a teaching agent, fuel by A.I algorithms, to aid with the learning process of students.

The greatest demonstration of the potential of A.I is the article, titled *Improving reading and comprehension in K-12: Evidence from a large-scale AI technology intervention in India*, which reported on the use of an A.I based framework to improve literacy in schools in India ((Srinivasan & Murthy, 2021, p.1). This A.I framework, which is called ReadToMe, is created to provide a multi-sensory experience to students (Srinivasan & Murthy, 2021, p.3). This framework consists of an online tutor (A.I program) that teaches itself the curriculum of the textbook that is given (Srinivasan & Murthy, 2021, p.3). This textbook content is, then, converted to a proprietary multisensory structure by the RightToRead A.I Engine (Srinivasan & Murthy, 2021, p.3). This experience includes adding knowledge such as localization of pronunciation strings and attaching images of different words (Srinivasan & Murthy, 2021, p.3). It is important to note that humans can change various aspects of this software including reading speed, accents, pronunciation strings, context, intonation, etc. (Srinivasan & Murthy, 2021, p.3). This framework has an automated assessor that examines the learner's performance and compares it to a normative benchmark to provide insights into this performance at a word, sentence, and passage level (Srinivasan & Murthy, 2021, p.4).

It is important to mention that this RightToRead platform was implemented across schools in India from 2013 to 2016, encouraged by the success of the program (Srinivasan &

Murthy, 2021, p.4). Consequently, this program covered 1 million students in 5000 government schools as of 2016 (Srinivasan & Murthy, 2021, p.4). The implementation of this program consisted of training the program on the class textbook, integrating this software into the school timetable for regular English class or digital lab period, and training the relevant teachers on how to use the application (Srinivasan & Murthy, 2021, p.4). In order for this program to be implemented seven steps had to be undertaken to satisfy government approval. These steps include that the program acquires school demographic data, that infrastructure and system audits of the schools were created, that the program acquired the school textbooks necessary, that these textbooks integrated into aforementioned A.I platform, that this program was deployed and properly installed with the assistance of the school's personnel, and that the relevant school personnel and teachers were trained to use the program (Srinivasan & Murthy, 2021, p.4). After this initial implementation, the program was monitored using different methods to ensure the effectiveness of the program.

In order to test the effectiveness of this program, a research study was conducted on a population of 33,000 students across four states in India (Srinivasan & Murthy, 2021, p.7). This population, which included kids from grades 3 to 7, was separated into two categories. The first was given access to this technology while the second was not. This population was sampled using randomization methods, and the population was given a test at the beginning and the end of the academic year to test student performance (Srinivasan & Murthy, 2021, p.7). The results were that the first group saw a 17 percent improvement in English scores in grades 3-5 as opposed to a 4 percent decline by the second group (Srinivasan & Murthy, 2021, p.9). Similar improvements were seen in grades 6 through 7 which saw improvements of 30 percent in the first group and 10 percent in the second (Srinivasan & Murthy, 2021, p.9). It is important to acknowledge that this improvement represents the whole student population, and this result varies depending on where the students are located. It is also important to note that a subsequent study was conducted the following year in which the study was repeated for students in the states of West Bengal and Maharashtra (Srinivasan & Murthy, 2021, p.13). This study found that the first group achieved between 21 and 22 percent more improvement in scores than the second group (Srinivasan & Murthy, 2021, p.13). Although further research in this area is a necessity, I mention this study because it demonstrates that a curriculum with artificial intelligence tools seems to lead to higher student performance. This student's proficiency increases as the program are presented to the student in their subsequent education.

In conclusion, throughout this article, I have presented different experiments and propositions that display how the fields of artificial intelligence could interact with education. These interactions usually come from improvements from other fields, such as in the example of text mining, which presents an innovative way in which to distill and teach ancient languages. However, other innovations come from attempts to fuse these two fields. A prime example of this is the use of pedagogical to teach students in the virtual world. Unfortunately, these tools are in their infant stage and will not become mainstream for a few decades. Nevertheless, as the experiment of India demonstrates, there are benefits of making this technology a reality.

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