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Big Data in Education- Applications and Challenges

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Abstract

Data is presumed to be the next oil. Unless it is refined, it is of no value. But once it is refined and presented in the required format, is equivalent to gold. Education is also no exception. Big Data has found its way deep into the realms of education and is transforming the way education is delivered and consumed. This work is an attempt to explore the ways Big Data is transforming education and what are the challenges that beset this transformational journey. Some noteworthy tools that have attracted quite an ample amount of prominence are also discussed and how the conventional tools of education are being transformed or replaced by the tools powered by analytics and artificial intelligence are making way into the mainstream. The advantages of adopting the data driven technologies also find mention in this work. Ethical and moral questions have also been raised as analyzing the data generated by someone through digital interactions are always a shady area. There is no clear black or white to it.

Keywords: Big Data, Education, Education Technology, Analytics and IoT

Introduction

Imagine a situation where the teachers had the power to:

- Initiate the academic year with a complete knowledge of her class by tapping into information and generating various performance reports about her class and students from a single source. (Julien, H., & Barker, S. 2009)
- Use their time in the most optimum manner for the entire year by working on micro level reports with actionable insights about her students. (Mattingly, K. D., Rice, M. C., & Berge, Z. L. 2012).
- Craft targeted learning experiences on-the-fly with confidence (Bonk, C. J., & Graham, C. R. 2012)

Such a scenario is not a work of fiction from any sci-fi Hollywood movie. This has become reality and many companies are working assiduously on making education more cognitive and more personal. Big Data has become a buzz word in today's scenario, but it is not just restricted to e-commerce or allied industries. The not so glamorous field of education is also smitten by the Big Data bug and the fever is running high and in our opinion it is rightly so.

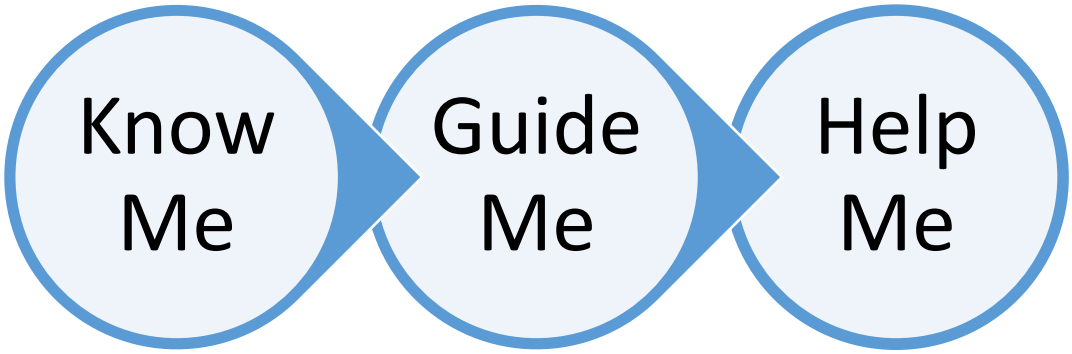
Research Methodology

The said is a review based article in which several articles were gleaned from various data bases. This study examines the work done in the field of Big Data with respect to Education from 2000 till January 2020. A comprehensive online search was conducted using "ISI Web of Knowledge" and "Google Scholar". This resulted in 54 relevant articles. The keywords that were used were "Big Data in Education", "Education Technology", "Education Analytics", "Learning through Analytics". The studies were disperse across various journals and conferences. The predominant journals were "*OLC Online Learning Journal*", "*British journal of educational technology", "Evaluation review", "Journal of Educational Technology & Society", "Journal of Academic Librarianship".* The keywords used in all the articles were noted and they too were used in identifying new studies in this domain, so that the latest body of knowledge could also be incorporated.

The Advent of Online Content

Online and software-based education is gaining prominence and this is gaining unprecedented acceptance among the educator communities (Misra, P. K. 2014). The obvious reasons for such acceptance could be that the evaluation becomes easy and unbiased (Chen, H. T., & Rossi, P. H. 1983). Benchmarking becomes easy and teachers have more time to train the students rather than spending time on the mundane tasks such as setting the question papers and evaluating the answer scripts (Martin-Kniep, G. O. 2000). Such extensive use of digital platforms have not just made the task of the teachers easy (Jacobsen, M., Clifford, P., & Friesen, S. 2002). Several schools and educators are adopting the power of IBM Watson Enlight to train their students to be equipped with skills required for the next generation (Isaacs, S. 2011). IBM Watson Enlight is a high-end technological innovation powered with strong cognitive computing capabilities along with cloud computing technology to store data in a secure manner and provide key student insights and academic content for teachers (Ferster, B. 2014).

IBM Watson Enlight works on three guiding principles:



Know Me: This principle empowers the teacher with a complete access to each student's micro level data and to understand the strengths and weakness of each student and how this could be used to curate a road map for the holistic academic growth of the students..

Guide Me: This principle provides actionable insights to teachers in order to help them hand-hold the students and lead them to academic success.

Help Me: This principle emphasizes on supporting teachers with customized and personalized content and academic activities and tasks.

When Big Data is integrated into the classroom, what ensues is an atomic level analysis of student skills and ability to provide targeted and customized help to each student in order to maximize the academic performance of each student (Shepard, L. 2001).

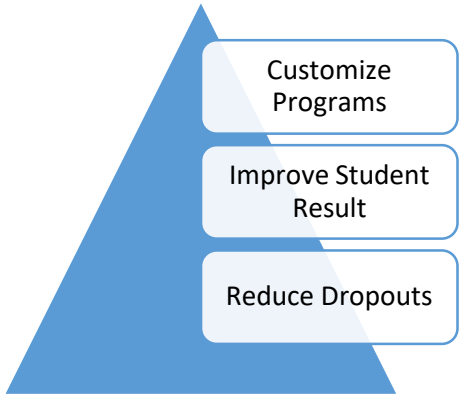
Several tools such as the IBM Watson Enlight, gives enormous power to the educators in order to transform the entire learning experience. Such tools are transforming education in a big way and the cognitive capabilities which are coupled with data are transforming the way education was delivered and the way education is consumed. The process of learning is getting personalized (Dietrich, B. L., Plachy, E. C., & Norton, M. F. 2014). The cognitive systems help educators delve deep into the learning styles and patterns and aptitude of the students and provide deeper understanding to the educators. This allows educators to curate custom-designed learning pathways for their students and can guide them through the lifelong journey of learning (Nisbet, J., & Shucksmith, J. 2017).

How is Big Data Transforming Education?

Big Data is revolutionizing the way we manage education in schools. It is also offering numerous benefits to the education sector which were a far flung dream in the not so distant past. It is empowering the educators to instruct in new ways which were unheard of. It gives a deeper understanding of students'

education experience and thus help the educators provide customized learning solutions for the students (Ary, D., Jacobs, L. C., Irvine, C. K. S., & Walker, D. 2018).

Three immediate ways in which Big Data is set to transform education are as follows:



The most important idea for applying Big Data within education is to enhance student academic performance. In the conventional sources, students' academic performance is measured by his or her ability to answer questions in an exam or an assignment. But in reality, a student leaves plethora of data trail of his or her individual learning abilities. All the bread crumbs of information such as how much time a student takes to read a question, how often a student skips a particular type of question or even which sources they use or prefer for their exam preparation helps understand the unique personal learning behavior of a student. When such data is integrated into the learning of a student, this definitely creates a personalized learning environment for him or her, thus improving the academic performance. With the help of Big Data, it is now possible to capture every minute aspect of the students' learning behavior and create a customized learning path for them (Daniel, B. 2015).

Each student can be given a customized and personalized learning path, based on her learning style, learning patterns and aptitude. This can be materialized through blended learning models – a judicious mix of both online and offline learning (So, H. J., & Bonk, C. J. 2010). This provides students with an opportunity to follow classes as per their interest and they can also learn as per their pace, while still enjoying the benefit of offline support from their teachers.

As Big Data helps in the academic performance of students and also helps in pacing their learning as per their requirements, the students will get attached to their academic subjects and thus reduce drop outs (Bettinger, E. P., Boatman, A., & Long, B. T. 2013).

Table for online content leading to big data

Factors	***Citations***
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Power	Selwyn, N. (2014). Crossley, M. (2014). Williamson, B. (2017). Daniel, B. K. (2019). Attaran, M., Stark, J., & Stotler, D. (2018). Gillborn, D., Warmington, P., & Demack, S. (2018). Prasad, S., Zakaria, R., & Altay, N. (2018). Salajan, F. D., & Jules, T. D. (2019). Clayton, M., & Halliday, D. (2017). Johanes, P., & Thille, C. (2019). De Rosa, R. (2017).
Hierachisation	Selwyn, N. (2014). Manolev, J., Sullivan, A., & Slee, R. (2019). Mau, S. (2020). Tuxen, N., & Robertson, S. (2019). Fuller, K. (2019). Waters, J. L. (2018). O'Connor, P., Martin, P. Y., Carvalho, T., Hagan, C. O., Veronesi, L., Mich, O., ... & Caglayan, H. (2019). Van Poeck, K., & Östman, L. (2018). Michelsen, S., Vabø, A., Kvilhaugsvik, H., & Kvam, E. (2017).
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Education Gets a Make-over with Big Data

While considering today's learning, it can be stated without doubt that students have more options than ever (Liu, N. F., & Littlewood, W. 1997). They are not bounded by the walls of the classroom. They can pursue with their learning from the comforts of their home or of a coffee shop (Schmoker, M. 2006)

E-Books

The heavy backpack full of books is quickly getting replaced by slim smart phones. This is not that awe-inspiring. What is amazing is that these e-books are becoming highly interactive, collaborative and updated for accuracy in real time (Allen, M. W. 2016).

In the words of Greg Fenton, CEO of Redshelf (the digital textbook company), "There is plenty of information available on students' habits of reading and the amount of time they spend for studying. With online textbooks, publishers and professors now have access to information that shows exactly how, when, how often and why the students use textbooks (Hernon, P., Hopper, R., Leach, M. R., Saunders, L. L., & Zhang, J. 2007)."

Such data is contributing to the editorial process significantly. Such data also helps teachers to improve their instruction based on students' learning habits (Prince, M. 2004). Digital textbooks provide ample opportunities to the publishers to update them automatically, the assignments or homework sections can be evaluated and graded in real time, audio and video clips can be placed at appropriate locations and thus enhance the whole learning experience Fulton, K. P. 2014).

IoT

IoT integration is quite useful for higher education as it obviates the hardware costs (Costa Pereira, V. 2014). Most of the students have devices connected to the internet and it creates an academic infrastructure devoid of the conventional barriers such as geographical location, language, specialized learning needs etc (Darling-Hammond, L. 2015). Books in their digital forms can be instantly distributed and made available to all students irrespective of their locations and the number of copies to be distributed. Unlike the traditional libraries, books in their digital form obviates all the traditional barriers in real time and can in time make the traditional libraries redundant. (Martin, K., & Quan-Haase, A. 2013)..

Big Data Helps in Enrollment Decisions

Big data helps both the students as well as institutes make smart enrollment decisions.

Predictive Analytics tools help students short-list schools, colleges and universities that best fit their profile (Kelley, L. A., Mezulis, et.al 2015). Such decisions are made with the help of numerous data points and can help the applicant to reach those colleges and universities which are a perfect match for their profile (Nilson, L. B. 2016). Social Media has gained enormous popularity to guide them to make a perfect choice when it comes to selecting the colleges and universities (Perna, L. W., & Titus, M. A. 2005).

Big Data is helping both educational institutions and Education Technology Companies to understand things that were almost impossible (Ferguson, R. 2012). Big Data coupled with powerful predictive analytics algorithms help the educational institutions prepare analytical databases which empower the institutional administrations to take quick data-driven decisions assisting educational institutions and companies to understand things they could not have previously understood. Such databases help the administration take smart enrollment decisions and using powerful Optimization Algorithms (Prescriptive Analytics), they can optimize both the faculty time and the financial resources. This has raised the enrollment rates of several institutions in the near past. Education Technology companies such as edX and Coursera are making use of Big Data to determine what kind of courses should be conducted in an online mode and which courses are apt for a physical classroom. This also optimizes quite a number of resources for institutions and organizations (Rabah, K.(2018).

The Challenges of Big Data

With so much of data available at the disposal of the educators, there is a rush to mine gold out of so much of noise in the data. But the question is, "are the educators using this data for the best interest of the students?"

Most of the institutions make retaining students as their top-most priority and they use data to identify the possible students who have the maximum tendency to churn out. So big data is used in a big way to plug such churns by taking timely interventions and help such students stay on track and stay in the system. Now the question arises whether the data was used in good faith for the students. (Allen, I. E., & Seaman, J. 2014).

For institutions who are novice to big data and the entire data sphere, they could simply be numbed by the complexity the data handling poses. The reasons are simple. Data comes in various forms and structures and also it is stored in various platforms and various formats and one format could be incompatible with one application. Cleaning the data and making it compatible across all the applications requires high-order data science skills, which the novice institutions may be lacking and thus harnessing the true power of the data available with them could be elusive if not impossible.(Guillochon, J.,et.al (2017).

It also becomes pertinent for institutions to fix their priorities for using Big Data. Aligning the institutions broader goals with the Big Data applications and to integrate Big Data into the vision of the institution becomes an important task. So it cannot be condoned that Big Data must be aligned with broader institutional goals and priorities. There could be several questions that the institution need to ask before joining the bandwagon of Big Data such as: (1) Should student retention overpower all other priorities? (2) Is providing students with additional support and help them flourish should be set as the paramount objective? Answering such questions define the pathway for the institution to plunge into the journey of Big Data Analytics and determine the framework for applications of the gold mine of data at their disposal.(Daniel, B. 2015).

Ethics also plays a major role. Is the privacy of students getting compromised? Is the data being used exclusively to supplement the student learning process? To answer such questions, it becomes pertinent

to obtain the students' consent and the algorithms are designed in such a way to provide ethical interventions and contribute to student academic progress. (McGuire, A. L., et.al 2011).

The over exuberance with this entire Big Data gold rush had side lined the actual learning of the students and that is posing the greatest threat. Understanding the implications of each click generated by students generates lot of information of the student's behaviour and deciphering it and generating student-centric learning analytics is the real challenge. But the question is to what extent these clicks and the subsequent data generated is a real indication of the student learning? How does this data translate into information about the student's cognitive evolution? What educators need to delve deep into is the intention and the thought process behind each click a student makes. If this is not being tracked and analyzed then the entire exercise may turn out to be futile. (Eagle, N., & Greene, K. 2014).

Closing Words

In order to harvest the true power of analytics and Big Data, educators need to answer the most pressing and pertinent questions raised. These answers must be bolstered with strong analytics frameworks which have groundings in Educational Theories and with the help of such theories, activities and assessments must be designed to help the students. The rush to exploit data and to fancy the new tool should not obscure the true intention and nature of education.

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