



Using Data Analytics to Improve Educational Outcomes in Cameroon

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ABSTRACT

Data analytics has revolutionized various sectors, yet its potential in education remains underutilized in many regions, including Cameroon. This study explores how data analytics can enhance educational outcomes in Cameroon by leveraging the extensive data collected by educational institutions. Through case studies and the application of linear regression models, this research identifies significant factors influencing student performance and provides actionable insights for policymakers, school administrators, and educators. The paper discusses the challenges and opportunities of implementing data analytics in Cameroon's education sector, highlights successful examples from other regions, and underscores the importance of ethical considerations and data privacy.

Keywords: Data analytics, education, Cameroon, educational outcomes, linear regression, big data, predictive analytics, descriptive analytics, educational policy, data privacy.

Introduction to Data Analytics in Education

With the advances of breakthrough technological innovations such as the Internet of Things (IoT), big data technologies such as machine learning and data mining techniques have been successfully employed in commercial and industrial sectors over the past few years [1-6]. This has brought about great outcomes of technology innovation in these sectors. Now is the moment to apply these advances to find effective learning in education. Cameroon's educational institutions collect a considerable amount of data about students which generally remain under-analyzed [7]. These data are valuable resources for enhancing the educational environment of the students through various measures [8]. The educational paradigm has been shifted from standard teaching approach to student-centered learning, and the data analytics has a vital role in redesigning the educational environments accordingly [9]. The 21st century has embraced big data and data analytics to improve organizational performance. The growing impact that big data and data analytics is having on the corporate sector cannot be ignored [10-14]. From the education sector perspective, the successful implementation of data analytics can also help to understand student behavior in order to improve educational outcomes [15]. It is believed that the effective integration of education and data analytics is able to facilitate academic planning and policy making in order to ensure sustainable development [16]. Furthermore, it is also a way to motivate more fully the diverse changes vital for improving the learning and teaching in the 21st century [17].

Importance of Data Analytics

Topics and themes that can be addressed by making use of data analytics include class size, assessment of learning outcomes, teacher skills, the use of resources, the achievement of pupils, the education budget, the selection of teachers, the incentives for teachers, parents, and students, and the type of delivery [18]. In sub-Saharan Africa, the call for data analytics is getting louder, and the call is being accelerated by the Target 4.1 of Sustainable Development Goals (SDGs) proposed by the United Nations (UN) that states that there needs to be significant progress in the quality, equity, and relevance in education provision by 2030 [19-25]. Efforts and initiatives aimed at improving how schools are managed and how the provision of remedial extra tuition can help to address learning gaps have gained recognition over the years, yet significant quality deficiencies remain [12, 13, 16]. When data analytics is used in the field of education, problems can be detected, but more importantly, insight can be provided into what the issues are and why they happen [20-24]. Data analytics can also help to answer questions about educational systems, developments, policies, interventions, student achievement, and teaching effectiveness [25]. Data analytics makes use of several techniques and processes in order to take data, cleanse it, merge it, and summarize it into an understandable and informative form that makes it suitable for exploration, visualization, and application [26]. There are different types of data analytics, so the techniques and processes used depend on the type of data analytics to be performed [27]. The most commonly used data analytics are descriptive analytics that

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provide a quantitative and qualitative summary of the contents of a dataset in order to produce important knowledge and insight; diagnostic analytics that help to look for patterns and structures in reported issues; predictive analytics that build models that are needed to enable the forecasting of future events; and prescriptive analytics that use the existing data to recommend actions that can help to optimize business processes [28-33].

Current State of Education in Cameroon

Glaring disparities notwithstanding, there are indicators that cannot be glossed over. By 2011, more than 61 million children of primary school-going age were out of school. Other reports suggest Africa will account for the highest illiteracy rate in the world by 2015, with 20% of the projected 773 million illiterate adults residing in the region [34-38]. These studies often provide snapshots of educational performance for the continent and other regions within it at macro levels alone, thereby making them uninformative of the micro dynamics of educational development in the different countries and regions concerned. Similarly, available educational analyses often overlook the role that early childhood education can play in shaping educational outcomes as a whole in Africa [39-44]. The different socioeconomic disparities among different groups of students facing education often work against students of lower backgrounds, maintaining the status quo [31]. Furthermore, the quality of students in schools, which often leads to poor performance, is often overlooked [45]. The current state of education for Africa as a whole is well documented. Progress indicators highlight, for example, an increase in net enrolments for children in primary schooling from 60 to 77% between 1999 to 2011, with similar rates of increase for secondary education where there was a positive net rate of growth of 84% in 2011 [46]. However, educational gains are not homogeneously distributed. Regional disparities have been reported in Sub-Saharan Africa [38]. The report states that 80% of children entered primary school in 2011, leading to a 96% completion rate for local six years of primary education. The figures have risen from 52% in 1990 to the year under consideration, with higher attendance reported for children who have completed some form of preschool education [47-53].

Challenges and Opportunities

Administrative data on schools and individuals were collected from several administrative sources and merged [54-60]. In this paper, we provide a first stab at using advanced data analytics techniques in order to improve educational outcomes in Cameroon. Specifically, we use the rich administrative dataset collected in 2008 by the Ministry of Education. Our dataset covers all levels of education, including primary, secondary, and high schools [61-66]. Possible research questions include image processing of classroom overcrowding, school monitoring and standardization, identification of characteristics of teachers and students leading to better learning outcomes [56]. Rapid advances in data collection technologies in the form of administrative records and new data analytic techniques now allow researchers to utilize these new datasets in order to provide substantive insights and improved education. Cameroon, like many other developing countries, faces serious challenges in its education sector such as poor infrastructure, inadequate human resources, and lack of funding, among others [57]. These challenges often result in identifiable educational outcomes such as high school drop-out rates, shortage of trained labor, and low overall quality of education. Educational research often relies on survey and experimental methods and rarely uses secondary institutions data for deeper insights. Only a few studies have tried to analyze components of educational challenges in developing countries with administrative datasets [67-69].

Case Studies of Data Analytics in Education

Two Linear Regression Models of Test Scores in Primary and Secondary Schools The studies analyze large datasets collected by the Ministry of Primary and Secondary Education in Cameroon and apply multiple linear regression models to identify significant factors that influence aggregated scores in secondary and primary schools [70-75]. The dependent variable (overall performance score) in the secondary school model is the sum of all grades for each student obtained by multiplying the ABSGRADES by the CRSES (Coefficients) [76]. The model involves 9,333 students from 103 general secondary schools and the secondary model uses 217 general secondary schools and 20,078 students [76]. The explanatory variables include the dummy form1, classroom size, rate topic, teaching experiences, such matters in ANPROFSC value internal degree, sex, and financial supports, among others. The models help to identify areas that are of crucial importance to students' learning and provide recommendations to policymakers, school administrators, and parents [77-82]. The linear regression models provide information about the impact of specific policy actions on the economies of the educational factors. Evaluating and directly comparing the magnitude of the relationships between the educational variables, the former offers useful insights whereas the latter can play a crucial catalyst for interventionists' decision making [83]. Furthermore, the models also show that the student's parent degree has various impacts on the choice of career. This is an issue of vital importance since finding careers that are congenial to the students helps parents and teachers guide these students throughout their school experience, increasing the likelihood of these students obtaining decent jobs and contributing to their communities [84].

Successful Implementation Examples

Data was used: 1) To monitor access, completion, and learning and analyze learning losses due to crisis and conflicts, 2) To measure equity and learning and track and tell the story of out of school children, and 3) To analyze the value

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of school funding and compare education outcomes with spending. Successfully analyzing data has led to incremental advancements in some countries, monitoring educational outputs and outcomes that have contributed to improvements in educational achievement and policies. Success stories underline four key principles that countries should consider adopting while planning for improved use of educational data. These are: 1) Compatibility with similar data; 2) Flexibility to analyze extra information; collecting the necessary data that permit answering priority questions; 3) Upscaling efforts and experiences and using basic data; 4) Promoting a domestic learning effort [85-90]. There are numerous examples in which collecting and analyzing learning data lead to better education and improved learning outcomes [91]. The international community has demonstrated that it can collaborate around key challenges to increase learning opportunities, data access, and educational outcomes. Section 2.0 highlighted the potential benefits of the use of technology and data in implementing and tracking national reforms in the education system. We discussed challenges, potential questions to answer, and ways to exploit the data available [92]. The flexibility regarding the use of data offers opportunities to answer additional questions and improvement of the system [93]. We draw from good international practice and applied international experience to develop examples of data use to: 1) Improve the quality of education at the national and school level, 2) Maximize access to data and analyze; 3) Accelerate the generation and application of data for education [94].

Key Data Analytics Techniques for Education Improvement

Many aspects or functions are related to data analytics: data capture, data management, data visualization, data mining or analysis, information and knowledge extraction, data usage analysis, and data representation [95]. Especially at the analytical level, there are two types of learning: inferential learning (i.e., knowledge or insight extraction) to understand why educational outputs are what they are, and predictive learning (i.e., rules or models construction) to anticipate educational outcomes in the near future [88]. Depending on the data structure and research objectives, such modeling can vary. Data structure may take the form of a "trained-set" of data with labeled and input/output data which may be used for a supervised learning process after preprocessing, or a "being-explored or generalized" set of data with no output that is manipulated to extract the knowledge (or the model) [72]. In addition to assessing the quality of our input and output indicators, it is also important to understand the associations between them and use cross-sectional and time-series data analysis techniques to identify the factors contributing to them [79]. There are different techniques that can be used for such analyses. These include basic quantitative analysis, inferential statistics and modeling, forecasting, or prediction modeling [95]. Data analytics is an approach that deals with the qualitative and numerical descriptive and predictive views of education. The basic tools used for data analytics are graphs, tables, statistics and data analysis techniques such as inferential statistics, regression analysis, clustering, and classification to explain, analyze, and predict the qualitative and numerical data [96-98].

Descriptive, Predictive, and Prescriptive Analytics

Prescriptive analytics is the final phase of business analytics and encompasses several advanced capabilities such as business rules, predictive modeling, and forecasting, also with mathematical optimization. Prescriptive analytics basically tells you how to ameliorate decisions before the decision actually happened [76, 88, 56]. A prescriptive type of analysis basically takes the past and present data and gives any output that can be used as guidance toward a decision that has to be made [99]. The output can be a decision or a suggestion, a feed or input targets for advertising, sales leads, credit risk assessment, or anything that depends on the judgment or credibility category. It has to be mentioned as output towards solving a particular problem [87]. It sometimes doesn't serve anything quite like a decision matrix. Predictive analytics model uses data collection to assess the likelihood of future outcomes. It is the creation or use of a model using various statistical, data mining, and algorithms to analyze current and historical facts to make predictions about future, or otherwise unknown, events. Predictive analytics model is used in science, economy, and history [89]. Descriptive analytics is a statistical method describing the main features of data. Descriptive statistics tend to be simple quantitative summary of a dataset. With descriptive statistics, one is simply describing what the data shows. It can provide a brief summary describing the views of a population for a particular question. It reports the average of a sample, i.e., the sample mean [100-102].

Ethical Considerations and Privacy Issues in Educational Data Analytics

It is a fact that we live in a business and capitalist society, and education is big business [103]. However, the authors of this paper are mindful that the potential commercial gain from the data-mining of educational data can result in the inappropriate use of data analytics results. Furthermore, educators may inappropriately use the data to manipulate student performance and class outcomes [89, 67, 66]. For example, data mining student interaction with a learning platform, such as a MOOC, can be analyzed to help create a customized education for all involved. Data, such as length of time spent on readings, quizzes and exams, answers to test questions, posts, and surveys are readily available, in real-time, for both individual and groups of students [104]. Fundamental ethical issues concerning data privacy, and the psychological and physical well-being of these learning individuals have been often overlooked. The roles and responsibilities of educational institutions using data analytics are still quite unclear, and there is an ongoing concern about the use of data-driven methods in the education process [100]. It should go without saying that the internet and social media have increased access to educational opportunities that might not have been

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available to students otherwise [86]. Technology has made the exchange of ideas and collaboration much easier. Educators can access a wide range of resources and publications [105]. The ability to collect, store, and analyze class performance and student achievement on high-stakes tests, and the potential for significant social pay-off, are innovations in the educational process [97, 88, 102]. However, concerns about the inappropriate use of modeling results and data generated through educational data analytics, to manipulate student performance and class outcomes, should give educators reason to pause in their implementation of data-driven instructional methods. Educational data should be used to maximize student success, while fully protecting the privacy of educational records and class performance [105].

CONCLUSION

The integration of data analytics into the education sector in Cameroon offers a promising avenue for addressing existing challenges and enhancing educational outcomes. By utilizing advanced data analytics techniques, educational institutions can gain valuable insights into factors affecting student performance, thereby enabling more informed decision-making and policy development. The case studies presented demonstrate the practical applications and benefits of data analytics in education, such as identifying key determinants of success and optimizing resource allocation. However, it is crucial to address ethical considerations and ensure data privacy to protect students and maintain the integrity of the educational process. Overall, the strategic implementation of data analytics in Cameroon's education sector has the potential to foster significant improvements in both teaching and learning experiences.

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