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Codesigning A Big Data Analytic Tool for Girl Child Learner Drop Out from Eastern Cape Province - South Africa

Research Paper

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ABSTRACT

Developing sustainable solutions is critical for adoption of digital solutions. As the high number of learners dropping out of school continues to increase, it is critical to find innovative ways of predicting and preventing high drop out. Current literature has documented a number of factors that influence learner drop out. Innovative ideas, techniques and activities have been undertaken to motivate learners to stay at school. It is unfortunate that most of the initiatives have not helped to avoid drop out of learners. The study is based on a mixed approach that was used targeting female learners from Oliver Tambo District in the Eastern Cape Province of South Africa which consists of face-to-face engagements and community codesigning approach. A variety of factors were presented as drop out reasons. These factors represent large data sets that are available to affect learners. A big data analytic tool was co-designed involving key stakeholders in education since they also have an influence on learners. Emerging technologies such as machine learning and big data analytics were applied to produce the presented tool.

Keywords

Big Data, Artificial Intelligence, Learner drop out, smart learning, co-design, participatory design, personas.

INTRODUCTION

The performance of girls has generally been reported to be lower than boys especially in relation to Science, Technology, Engineering and Mathematics (STEM) (Musau et al., 2013; Mashavave & Vhurumuku, 2018). Some of the reason for this gender disparity favoring boys are parental discrimination against girls which result in girls being given more workloads at home; social pressure where society expects girls not to behave as boys hence girls then tend to choose careers that are humanity based which are not usually chosen by boys; and lack of empowerment for girls reducing their morale and motivation (Mashavave & Vhurumuku, 2018).

In addition to gender disparity in the access to education, there is a significant digital gender divide in relation to digital technology. Digital literacy offers vast opportunities in access to education. These gender differences include affordability, gender exclusion and inherent societal biases (OECD, 2018). This part of the review will investigate technologies used in teaching and learning as well as those used to monitor girls. However, lack of motivation has been cited as one of the major causes of poor performance (Raponso et al., 2019). Some of the problems emanating from lack of motivation manifested as ill-preparedness for class, incomplete homework or sleeping during lessons (Godzicki, et al., 2013). There is gender disparity that has been observed especially in the field of Science, Technology, Engineering and Maths (STEM). Lack of opportunities, achievement and choice have contributed to reducing motivation of women in enrolling in STEM resulting in their low numbers.

This study proposes a proactive approach and tool that could be used to predict that one is likely to be a school dropout by engaging different stakeholders. The female learners within OR Tambo District in the Eastern Cape Province of South Africa were considered for this study. The study has a long-term goal of being able to cover most of the Eastern Cape in future, to extend the positive impact envisaged from this initial start. From its conception, the study is an engaged community project in collaboration with the OR Tambo Department of Basic Education, schools, learners at risk of school dropout, communities, and school management body. The study focussed to achieve the following:

- a. Evaluation of the current data sets mainly focusing on factors contributing to school dropouts within OR Tambo District
- b. Co-designing a Big data analytic tool that predicts a girl child is likely to be a school dropout with mitigation measures to prevent the possible dropout.

The study is a multidisciplinary research that brought together faculties of social sciences, computer science and education. Additionally, the study was a collaborative effort by various researchers from multiple South African universities, namely Walter Sisulu University (WSU), University of South Africa (UNISA), University of Kwazulu-Natal and Sol Plaatje University. The meeting of different researchers and educational actors has consolidated the common design principles and the choice of technologies to be used. Therefore, the co-creation was guided by all the key stakeholders involved during the project. Although the main target group was female learners, there is a consensus that these learners also rely on other stakeholders. Therefore, it is also important to consider the role played by different stakeholders in co-creating. The paper therefore presents how different stakeholders contributed to the design of the big data analysis tool and which critical features should be considered for such a tool. The paper consists of several sections such as literature review, methodology, key results, architecture of big data analysis, discussions and conclusions of the paper.

RELEVANT LITERATURE

This section discusses the literature considered in this study. Women and young girls around the world have experienced harmful cultural and traditional practices. According to Msuya (2020), the minimum age for marriage in Africa is under 18, making it one of the continents with the highest rate of child marriages in the world. Nevertheless, this practice is still widespread in many African countries, where many young girls are married off to older men without their knowledge or consent. A student is more likely to drop out of school or perform poorly in their studies if their parents are not actively involved in education (Amadi, Role & Makewa, 2013). It is easy for a child to get the attention from their parents by attracting the student's attention, passing when the parent shows an interest in studying and dropping out when the parents display no interest in studying since parents are usually the most important role models and factors influencing the background of their children. Based on the DHS, MICS and other nationwide research, UNICEF (2021) assertions that sub-Saharan Africa has the highest dominance of forced marriage. Similar allegations have been made by Amadi, Role, and Makewa (2013), who claim that when considering the status associated with pregnancy and marriage in African cultures, the moment a girl is pushed into marriage has a negative one impact on their participation in school.

Despite the young girls' awareness, but with their parents' consent, older men in rural areas pay lobola for young women (Msuya, 2020). The connection between the two families is created once the bride's lobola is paid, and the position of the women is changed to that of a prospective partner (Commission for Gender Equality, 2012). Hence, when the lobola is deemed acceptable, the woman is considered the as the wife and is expected to do wifely duties including caring for the home, the husband, and having children. Thus, going to school and acting like a child is no longer a free choice or acceptable practise for a girl (Commission for Gender Equality, 2012; Rembe et al., 2011). Marriage is really uncommon in South Africa, however "ukuthwala" appears to be rising in some rural groups regardless of falling rates elsewhere (Radebe, 2019).

Learner Drop out factors

Soares, Fernandes Nbrega & Nicolella (2015) identified some factors for school dropout like difficulties with subjects, wanting to go to another school, perceiving better job opportunities after graduation, and school choice. Thus, a contradiction between internal and external aspects school dropout happen to apparent. In addition, Stearn and Gleinne (2006) confirm that these factors can vary by age, grade, and socioeconomic group of students. External factors include the workplace, social inequalities, pregnancy, and the need to take care of family members, while internal issues like the language employed at school, teachers' attitudes, school leadership characteristics, and the educational program (Soares et al., 2015). According to Boyaci's (2019) double logistic regression, being married, a job, living in a village, and living away from father or in a divided family are the top sociodemographic issues leading to early school leaving. Similarly, Ussif, Ussif & Yussif (2020) show that features like school-related, community-related, societal reasons, economic factors, or individual reasons influence the school dropout students. Furthermore, Mohlouoa (2014) found that some students dropped out because they were orphans, while others dropped out after being absent for several weeks. It has also been found that mainstream classrooms encourage early school leaving because educators are not adequately trained to deal with the problems that learners with disabilities bring into the classroom and a lack of parental involvement causes learners to leave school (Mohlouoa, 2014). Due to poor financial circumstances, learners drop out of school and are forced into

child labor to improve the living conditions of their families. Joram (2021) found that low socioeconomic status, poor school performance, drug and substance abuse, peer pressure and poverty leading to financial problems were also alluded to as reasons for dropping out.

Technologies in Learning

Hershkovitz and Ambrose (2022) attained that member valued the prediction and it's timing overall and came up with several behaviors that might explain the non-thriving, most notably motivation and commitment, and proposed additional data that might predict background information, academic engagement, and study habits. According to Boyaci (2019) cox proportional hazards regression models were anticipated to identify possible correlations between in-school and out-of-school factors and early school dropouts whereas the PNAD database model was valued to verify non- school dropout rates secondary schools. Cele (2021) noted that universities need to set up big data analytics systems to support learning and teaching practices by considering vital changes in higher education such as the need for institutional awareness to student learning desires. Moreover, Rienties, Cross and Zdrahal (2017) contend that the biggest challenge for learning analytics research and practice is still ahead, using learning analytics modeling to find out what types of interventions positively affect attitudes, behavior and affect learner cognition. Rienties et al., (2017) also conversed how a Learning Analytics Intervention and Evaluation Framework (LA-IEF) utilising principles of design-based research and evidence-based research is being implemented at the Open University UK.

Codesigning with Females

Liang, Lim, Park, and Mendoza (2023) emphasised on discovering and conferring how ICT-enabled learning can expand the educational ways and prospects of female students for inclusive and equitable education through ICT-enabled learning. The authors summaries major ICT-enabled learning approaches together and present them which consists of new technology-based learning, digital game-based learning, mobile learning and computational learning. Liang, Lim, Park and Mendoza (2023) propose several strategies for developing an inclusive learning setting enabled by ICT for the educational pathways and opportunities of female students, thus enhancing inclusivity and equity in education. Similarly, predictive analytics has been used Rahman and Keseru, (2021) to determine the risk level of individual students who drop out of science, technology, engineering, and mathematics (STEM) classes. Additionally, co-design is a method for designing and delivering interventions that consider contextual factors, enable ownership of interventions, and motivate adoption and user satisfaction (Ludlow, et al., 2021). The choice of processes and methods is guided by the following co-design principles set out by Blomkamp (2018), where the results are focused, inclusive, participatory, respectful, and adaptive. The predominant goal of the study was to help design a big data analytic tool for school dropouts. However, several stakeholders were involved in the design process, directed by their distinctive knowledge, opinions, and encounters. It was recognised that each group has a role in terms of school dropout. Therefore, a community-based co-design methodology was employed to the development of the co-design of the analytic tool architecture.

METHODOLOGY

The study employed a mixed method. Both qualitative and quantitate data was considered. Participatory design with the female learners was implemented. The specific methods comprise of Participatory design and Community-based co-design (CBCD). Additionally, Personas were used to explain and describe the different experiences.

The specific data collection tools and methods include:

- Online questionnaire
- Workshops
- Participatory design
- Focus groups
- Interviews
- Experiential and prototype design
- Surveys – online & face to face

Though the paper does not present all the data from different methods used, only data from workshops, online questionnaire, participatory design, and interviews was considered. The study collected data on female learners from schools across the OR Tambo district in 2021 and 2022. Over 600 girl child learners were engaged. Questionnaires were distributed to learners systematically and randomly selected from 10 schools within OR Tambo District. The project describes the entire study sample across demographic, socio-economic, and other factors. The presented findings were derived from the qualitative questions.

Overall, a community-based co-design (CBCD) using agile methodology was applied to the development of the co-designing of the Big Data Analytic tool. The agile project approach enabled collaboration and cooperation with the participants. The community governance structures and the technologies to be integrated into the tool and has been established based on long-term development collaborations with BCM and the university. This is based on principles of participation as promoted in participatory design, participatory rural appraisal and participatory action research among much similar research and development approaches. Thus, education stakeholders were project partners rather than being just informants or service providers and later receivers only. CBCD follows a series of steps which can be adapted to a specific context. These series are the same for the abovementioned technologies as well as the benefit sharing and income generating solutions.

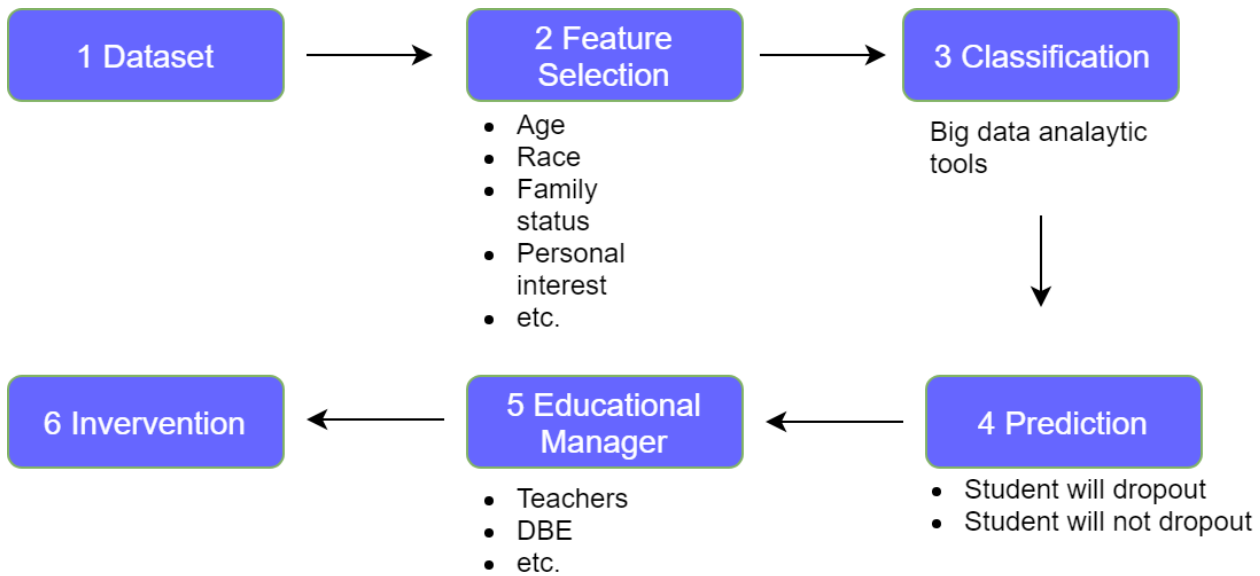
Agile methodology within co-design was adopted. There were several technologies considered, including MongoDB & Express for Backend Technologies, this was selected mainly because it is an open-source platform, which also provides easy to learn capabilities and user-friendly interfaces. ReactJS for Front End was selected due to its good maintenance services which helps to keep an application working quickly and dynamically. ReactJS has built in components which enables easier design of complex user interfaces with less effort. Big data Analytic technologies and Machine learning Plugins are critical in order to ensure that the system is able to do the prediction through using the available big data. Wordpress is the main software for the interface design of the big data analytic tool.

RESULTS

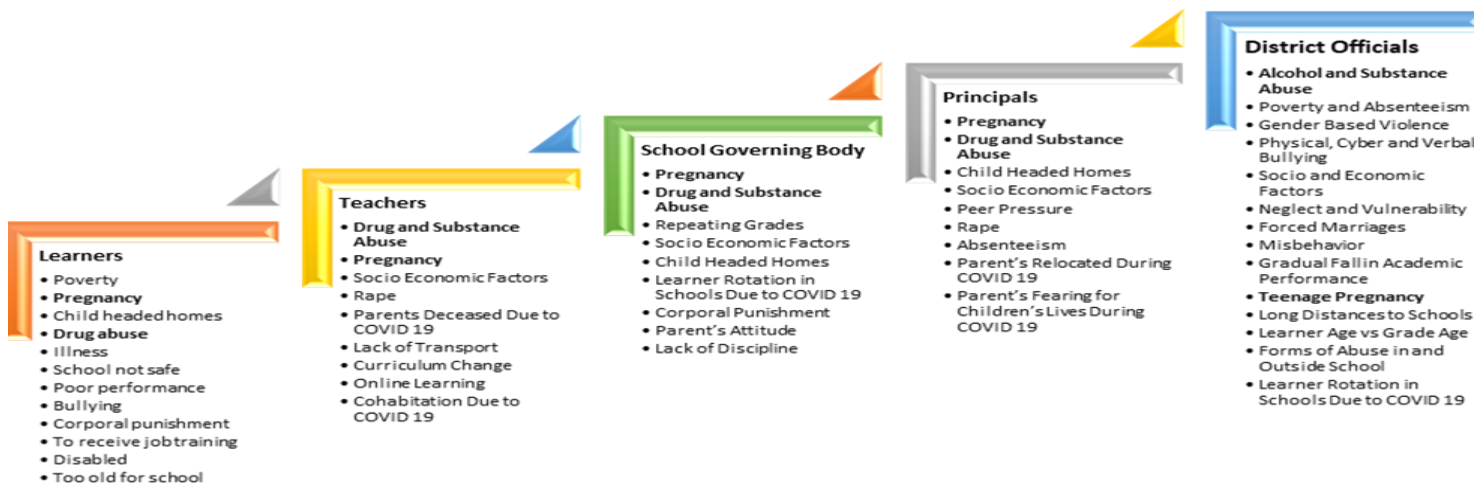
Results from both quantitative and qualitative findings were collected. However, this study focuses more on the qualitative results. Figure 1 shows how the codesigning was informed by the participants who were in the forefront on highlighting the factors that lead to drop out and how they would want the tool to look like.

Figure 1

Big Data Analytic Tool Architecture



Below are the main factors that were indicated as the main causes for drop out.



These factors were extracted during different engagements with the participants. Mixed methods were used to get these drop out factors from different participants. The summary of the highly rated and common girl child drops out factors were:

- Pregnancy
- Drug and substance abuse

Of course, all the other factors mentioned were equally important and there is need to consider all in co-designing the big data analytic tool.



Qualitative – all stakeholders – focus groups, work, and in-depth interviews – focus more on causes of school dropout factors.

Data was collected from 10 selected schools. 5 Schools were from inland and 5 from Coastal region of the OR Tambo District. Principals were engaged through one-on-one interviews. The rest of the stakeholders were engaged through focus groups and workshops.

Principals

Learner drop-out has always been a challenge in schools, especially in rural areas where access to resources and the school itself is difficult. Interviewed school principals in the Eastern Cape have identified the following factors as leading problems to the girl-child learner school dropout. Teenage pregnancy has been identified as the leading cause of girl child drop-out as many schools mentioned it as the leading cause of girl children dropping out during pregnancy and not returning after giving birth. One principal quote:

Teenage pregnancy has risen to a number that we cannot even measure, especially during the year 2021 although there are Learner Support Agents (LSA's). These learner support agents are there to provide support and to educate through awareness campaigns and counselling, how learners should conduct themselves in relationships and when to say yes and no”.

Alcohol and drug abuse

This has also been identified as a factor that has increased girl child school dropouts during the pandemic. Over the years, boys were the ones getting involved in alcohol and drug abuse but there has been a shift and both genders have been identified as abusers of alcohol and drugs. One concerned principal states:

“Teenagers smoke dagga, benzine, drink alcohol, and experimented a lot during COVID-19 because of the free time they had so when there are disciplinary measures once they are caught, they do not show up for them and eventually do not come back to school and rather look for work”

The teachers were asked to share their opinion on what causes the school drop-out of the female children. They have alluded to a series of factors contributing to the girl-child school dropout. They have mentioned that the predominately contributing factor is teenage pregnancy followed using drugs and alcohol. They think that female children have been exposed to substance abuse especially dagga as it is easily available. Another noticeable trend was teenage pregnancy caused by the teachers. At times the teachers are usually the suspects, and, in the process, they deny the pregnancy and/or pay off the parents of the child not to lay criminal charges for statutory rape. They promise to cover all the costs. Rape was also mentioned to be one of the extrinsic factors precipitating the girl drop-out. They remarked as following:

“Drugs especially dagga, and alcohol are the main causes of school dropout here in our community”.

“Pregnancy is one of the factors that cause school dropout, when girls are pregnant their parents do not encourage them after giving birth to go back to school”

School distance – school being far

The distance of schools in some communities is a problem and a reason for late age entry to school. For example, parents would wait to send their children to school till they reached an age that allows them to walk such long distances to and from school. The issue of school transport is not even a matter here because there are no roads, for such, hence walking is the only means to get to school. There are two scenarios of school access and school dropouts- there is one with no roads and no learner school transport – these start school very late and feel too old to continue with much younger children and school dropout. The second scenario is a school with a possible learner school transport available but the process of approving the learner transport takes too long and such schools even if they have roads but without the means of transportation, then learners will not be able to attend school. These are schools that can only be reached through learner transportation for instance, they must walk 20 Kilometres which makes it hard for a grade R learner to travel 20ks to school. Such communities now, instead of letting their children go to school, would wait for some years. Instead of letting the learner go to school at the age of 5, they would wait till the learner is 10 years, so they can travel the distance to school. They get to the lower grades at such old ages, and they would drop out because of being the only older learner in class.

Family responsibilities – looking after siblings, sick member of family, child labour, child headed households, raising their children, children feeding themselves.

The issue of extended families also has an impact on how the girls are treated maybe by family members. If a family member is not well and need someone to stay with, the girl child gets to be the one sent to attend to the needy family member. Online learning was strange and new to them, and life was hard for them. The online resources were not available for them as well. WIFI was introduced with lockdown, but the service was soon no more, and we do not know what happened to the service provider, but that resulted in the learners being designed and then dropping out.

Not interested to school for any other reason including class rotation due to covid

The issue of class and attendance rotation made most learners lose interest as they could not follow the learning process. This was also worsened by the fact that the learning methods and the online platform were things they were not used to and couldn't cope with. There is redness to provide learning under covid regulations was a problem because there were schools without the required infrastructure to manage learning and covid at the same time and learners lost interest as there was no learning.

Cultural and social challenges- like forced or arranged marriages and male initiation

There are communities in our Pondoland who target wealth through cows. Arranged marriages by parents while the learner is supposed to be schooling. The learner cannot even go to high school because Parents will not encourage schooling because they want to have cows paid when the girl is married. There should be a way to equip the parents on the importance of schooling by engaging our community members. The parents would not even encourage the learner for schooling as they expect cows through her being married. This is just the way things are done in some communities – it's the culture of such communities, hence interventions are needed to educate parents about the importance of schooling and their children. There are community members who are just ignorant about schooling and even engaging their learner about school and schoolwork.

Summary of findings

Intrinsic Factors – factors related to individual disposition, behaviour or personal choices of learners, which lead to dropping out.

Student individual-related: qualities students possess independent of demographics such as drug abuse, trouble with the law, and pregnancy.

Push out: school-related factors that are experienced by learners as exclusion from school. These included both

- unintentional and deliberate endeavors by educators or school management to limit the number of learners who write grade 12 examinations to the ones who are most likely to pass.
- Grade repetition is a major predictor of school dropout.

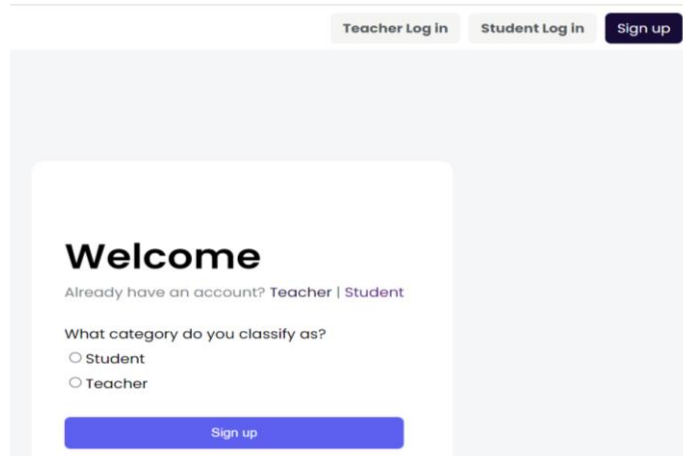
Extrinsic: barriers that exist at home or in the community that has resulted in a learner dropping out of school

The Web-Based Big Data analytics tool is designed for girls in high schools across the Eastern Cape province with the goal of connecting the capabilities of Big Data to predict the likelihood of school dropout encountered as a result of the COVID-19 pandemic. The tool can be utilised by the various stakeholders in the Department of Basic Education to predict the dropping out of a girl child. Users of the tool within the various schools include Principals, Teachers, and Girl Learners.

The big data analytics tool was developed through the data collected within the selected schools for this study. The tool will assist in identifying potential trends in behaviours of the girl child, thus assisting in the formulation of situation specific intervention strategies.

To access the big data analytics tool, a user enters the following web address:

System Manual



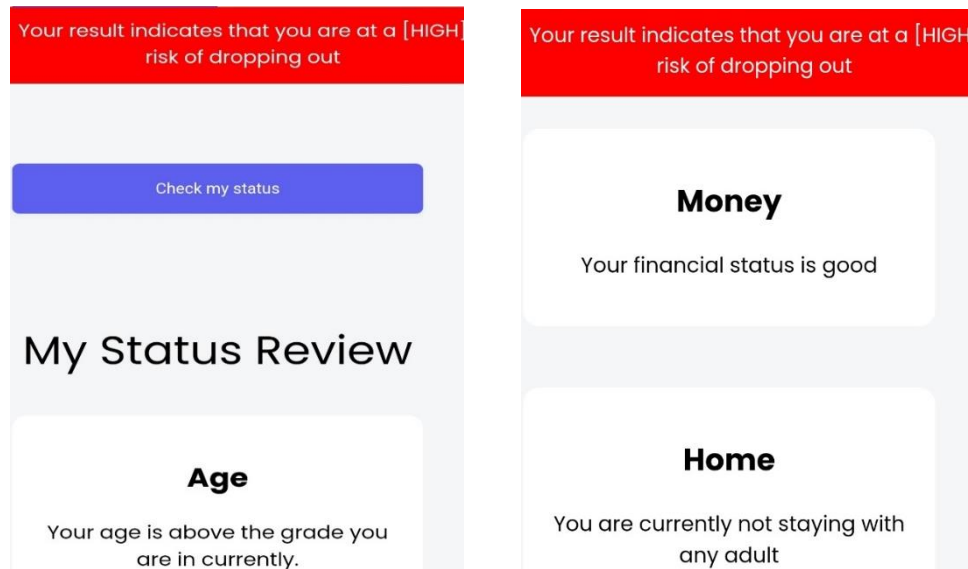
After the selection of the category and the sign-up button is clicked, the user will then need to fill in all the relevant details required.

After filling in all the details, the user can then click on the [register] button, the questions page is then shown.

There are several questions asked to the learner in order to acquire more details on the challenges, living arrangements, financial status, and various social issues applicable to a learner.

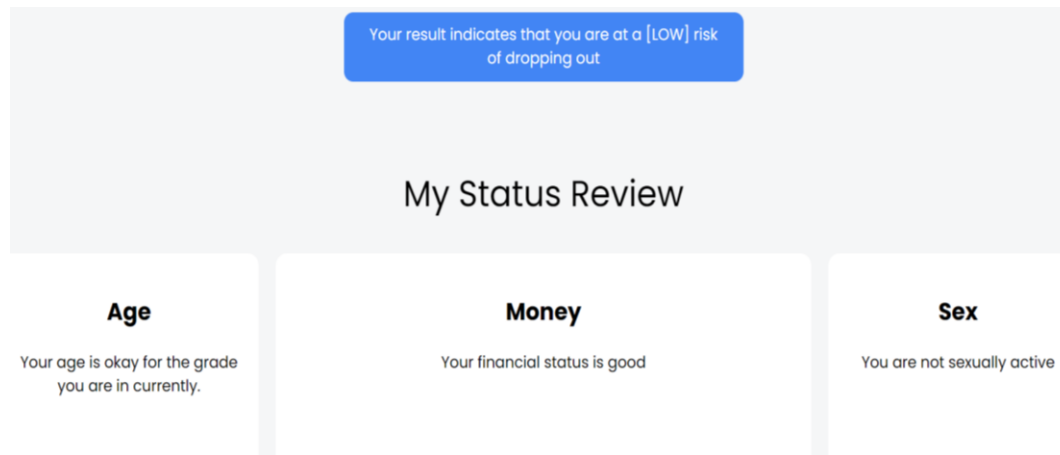
Due to the type of personal questions learners are asked, the tool makes provision for privacy controls to protect the learner's rights to privacy. Teachers and principals are unable to see the learners' responses to all the questions asked on the system.

All questions asked on the tool are rated as per the results from the data collected within the schools, ratings from the Department Officials as well as literature consulted. After answering all questions asked, the learner can click on the [check status] button, and their results will be displayed.

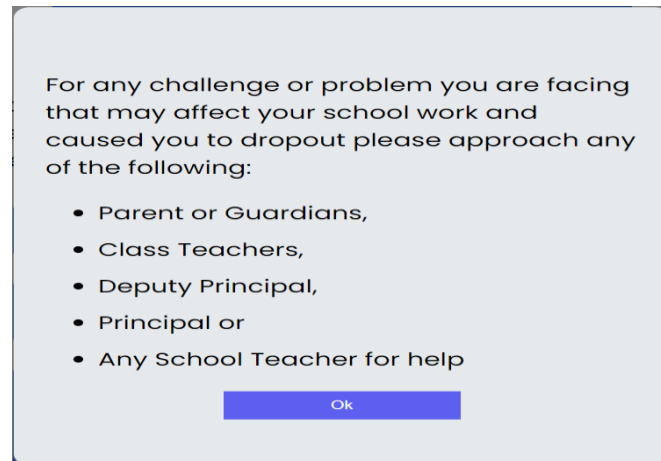


The status review page will display a summary of the key areas used to give the prediction results for the learner. Depending on the factors or responses from the learner, the tool can produce the level of school dropout risk a learner falls under.

The tool provides results to the learner showing if they are a high or low risk school dropout.



The tool is able to provide a list of people who can best assist a learner with any issues related to their results.



The tool allows the teacher/principal to utilise the tool mainly for information or report-based purposes. After a teacher signs up on the tool, they have only view permissions of the student's final prediction results. The teacher can only view the level of school dropout risk for a learner. The learner's personal details and responses are visible to them only. The big data analytics tool provides numerous benefits to its users and other relevant stakeholders within the education sector.

DISCUSSION

Unlike other studies that focuses on school dropout only based on factors from one group of users and not infusing emerging technologies, the paper is unique in the approach and how machine learning techniques were implemented. The paper considers the critical factors and places the participants who are not familiar with the proposed solution, but wanted to be involved in seeing a solution that works for them. Different views and suggestions were proposed and these contributed to the interaction of how the design would be. District officials stated that being vulnerable and neglected also contributes to dropping out. A student is more likely to drop out of school or perform poorly in their studies if their parents are not actively involved in education (Amadi, Role & Makewa, 2013). It is easy for a child to get the attention from their parents by attracting the student's attention while dropping out if the parents are not available hence, teachers indicated that some learners lost their parents due to COVID-19. Both learners, teachers, principals, and district officials indicated that pregnancy is the main challenge for drop out and this is like Amadi, Role, and Makewa (2013) who claimed that when considering the status associated with pregnancy and marriage in African cultures the moment a girl is pushed into marriage has a negative one impact on their participation in school.

Furthermore, both participants highlighted that drug/substance abuse also contributes to drop out. This corresponds with Joram (2021) who found that low socioeconomic status, poor school performance, drug and substance abuse, peer pressure and poverty leading to financial problems were also alluded to as reasons for dropping out. According to Boyaci's (2019) a job, living in a village, and living away from father or in a divided family are the top sociodemographic issues leading to early school leaving which is like what some of the learners have stated. However, bullying, corporal punishment, being disabled and being too old were also common features for dropping out among the learners.

CONCLUSION

Various challenges were stated as the main factors for dropping out like poverty, drugs, distance, and early pregnancy. However, learners opted to be on the forefront in the designing of the data analytic tool architecture. Co-design principles were crucial in the study in the sense that it seeks to meaningfully involve potential user groups (learners) in the design of tools and interventions, depicting on their lived experiences to ensure outcomes are modified to their stated needs and preferences, and with systems and accessible resources. The community design procedure was developed based on long-term development cooperation with learners and is based on the principles of participation as promoted among many other similar development approaches in participatory design and participatory action research. As a result, learners and community members were project partners and not just informants or service providers and later just recipients.

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