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Leveraging Predictive Analytics to Identify At-Risk Students in Secondary Mathematics: An Intervention Framework for Urban and Rural School Districts

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Abstract- Predictive analytics in education has come widely in focus as a mechanism for identifying at-risk students and structuring interventions that are yet to make academic failure a foregone conclusion. This paper explores how predictive analytics can support the secondary mathematics education system that will identify at-risk students with an intervention regulation to be applied in the school districts (urban and rural). With the combination of data on academic performance with behavioural factors and socio-demographic variables, predictive models can provide information on those students who may fare poorly in mathematics. Relying on the results obtained in multiple fields, including corporate governance and risk management, this paper creates a broad intervention plan that serves the specific needs of students in different settings. A particular focus is on equal access to learning resources and proactive data utilization to reduce the risk and enable students to succeed.

I. INTRODUCTION

Secondary mathematics education is essential to determine students' future careers and academic growth. It offers a base for STEM disciplines, business and critical thinking, which is necessary for solving problems within different professions. Math is, however, a challenging field of study for many students. When they move on to higher concepts such as algebra, geometry and calculus in high school, they end up lagging when they get out of elementary arithmetic. This poses an academic deficit that might extend even after school life to the learners' career prospects and personal growth. This is a big challenge to overcome so students can succeed academically and professionally.

It is essential to establish students who are likely to lag. With early intervention, these students can be prevented from failing to become proficient and demanding in their abilities. Predictive analytics is a tool with much potential in detecting at-risk students. Predictive analytics denotes applying the data-driven quantification technique to generate the anticipated future results by considering history. Predictive models can be used to identify students who may have trouble with math by considering the background information of various students, such as academic achievement, behaviour, and socioeconomic status. Such insights enable teachers to intervene earlier, supporting the students before their problems become entrenched.

Predictive analytics is just emerging in terms of use in secondary education, specifically mathematics. Although predictive models have been frequently used in other sectors, such as finance and corporate governance, the same has not been the case in the education sector, particularly in predicting academic risks in mathematics. In this paper, this gap is endeavored to be filled in the description of a framework to be put in place using predictive analytics to determine at-risk students in secondary mathematics education. It will be framed to suit both urban and rural districts in schools, with consideration given to the challenges and opportunities presented by their realities. The aim here is to help intervene early on for students who are at risk, offer support through predictive models, and eventually improve the performance of the students and prevent failure in mathematics classes.

II. THE ROLE OF MATHEMATICS IN SECONDARY EDUCATION

Mathematics is one of the most essential disciplines in secondary education, and acquiring the quantitative skills necessary in STEM areas is obligatory. It also develops critical thinking and problem-solving skills, which are helpful in other non-STEM careers. The high need for workers who possess good acquisitions concerning mathematics in areas such as data science, finance, and engineering is an example of why it is necessary to excel in the field of mathematics in high school. Good mathematical education not only certifies students to enter college but also provides them with critical underlying skills necessary to perform in various professional activities in the long run and secure a career (Mupa et al., 2024).

Math is one of the subjects that most students have many difficulties with, particularly despite its importance. These disabilities are worsened as students move on to higher concepts in mathematics. Whereas some simple arithmetic is likely to have been learnt at primary school, more serious challenges, like algebra, geometry and calculus, may arise. Students go through high school, and the pressure becomes even more and the material trickier. A lack of understanding of the foundation often results in a snowball effect situation whereby students who perform dismally will not be capable of handling superior material. Such a collective nature of mathematics implies that initial problems in academic work may adversely affect future learning and that students are not successful in more advanced topics. To reduce these adversities, it is essential to help a student immediately as they may be a challenge to a successful experience in mathematical concepts (Shiraishi & Mupa, 2025).

Predictive analytics presents a compelling solution to determining which students might be at risk early. By ensuring that students who are at risk are identified adequately at an early stage in their academic schooling, the schools will be able to provide timely interventions and ensure that they do not perform dismally in their studies, which will have adverse benefits on their performance in mathematics. As the research findings in other fields, i.e., the areas of corporate governance and risk management (Netshifhefhe et al., 2024b), have demonstrated, early intervention measures as applied can be pretty effective to mitigate risk and enhance overall success, provided that applied adequately. The given paper seeks to apply these ideas in teaching, to be more specific in secondary mathematics since early prevention could play an enormous role in this sphere.

III. THE KNOWLEDGE OF PREDICTIVE ANALYTICS IN EDUCATION

Forecasting analytics in education involve application of information to envisage the performance of the students in future. The initial one will be to establish which students are perhaps on a risk of low grades or and may fail in their studies in order to intervene early. No surprises are obtained in this regard as these models use different data to get their data and generate a prediction, such as previous academic achievement, attendance rates, behavioral rates, and socioeconomic characteristics. Through this interpretation of the data points, prediction models can detect trends and directions that are not evident at first glance due to traditional observation. This enables teachers to make sound decisions on which students should get extra attention so that they can strategically direct their resources and take the kind of interventions. Predictive analytics can help assist in advance, thereby increasing the chances of student success and eliminating the failure to attain academic success.

Predictive analytics has been instrumental in helping to recognize those students who might fail in certain areas, such as mathematics. Predictive models allow for assessing students' future success by evaluating their past performance and patterns of absenteeism, as well as indicators of behaviour. For example, a student who has been showing weak performance in lower-level algebra courses and has never shown good attendance records may also be projected to perform poorly in subsequent mathematics courses. Such an early diagnosis enables teachers to provide early intervention with the needed support before the student gets behind, which would prove challenging to help the student catch up (Shiraishi & Mupa, 2025). Such data-based measures may result in more effective and focused responses.

The essence of predictive analytics is asking one simple question: How can we determine whether a student would become successful or fail using existing data? The question here is fundamental when the concepts have a dependency on mathematics. Students who lag behind early topics fail to learn later material, making the situation worse. Through predictive analytics, schools can deploy interventions on students early enough. These interventions may include extra tutoring, individualized learning plans, and social-emotional support. These active initiatives assist students in covering those particular matters and, in doing so, enable them to be on pace and thrive in their academic studies.

Early identification of risks in the broader context of corporate governance has been a proven and documented case. As an example, the topic of risk management in corporate environments covered by Netshifhefhe et al. (2024) points out that anticipating risks and solving them before they become larger will allow for avoiding bigger problems in the future. In the same way, academic risks in education can be identified early to enable schools to prevent the issue before it gets too late and the students get too far behind. Similarly to how companies achieve financial success due to early detection, schools may apply real-life predictive analytics to identify troubled students early to provide timely interventions and guarantee successful learning.

IV. DATA COLLECTION: THE FOUNDATION OF PREDICTIVE MODELS

The most basic and most crucial stage of the successful deployment of predictive analytics is data collection. Under conditions when there is no accurate, comprehensive data, predictive models cannot keep up. Schools are to collect data and information from various sources to form a whole image of a student's academic and behavioural profile. The most critical data to construct the predictive models in secondary teaching of mathematics comprise:

1. Academic Performance: Grades, standardized tests, homework and project performance. The mentioned data points give a clear picture of a student's level of mathematical knowledge and competence.
2. Behavioural Data: Indirect measures of academic engagement and risk include attendance, classroom participation and behaviour in school. Chronic absenteeism, in particular, can be associated with poor grades, especially in classes where knowledge is cumulative and related to prior knowledge (Netshifhefhe et al., 2024b).
3. Socioeconomic: These factors may include the following: family income, level of awareness, and the educational resources of parents, which may have a significant effect on the performance of the student. Students in lower-income families might not have access to resources such as tutoring or a quiet campus where students can work on their studies, limiting their mathematical achievements.
4. Psychological and Emotional Data: The emotional issues that might greatly affect a student and his mathematical skills are anxiety, stress or lack of self-confidence. These variables may be incorporated in predictive model using data provided by a school counsellor or self-report assessment data.
5. Demographic Data: There is also a possibility that it will consist of age, gender, ethnicity and home language as well which can influence the performance of a student. In perspective, even well-developed numerical skills cannot help students whose second language is not English to cope with language-intensive mathematical tasks (Mupa et al., 2024).

Predictive models can be developed on such data points to learn who among the students are at highest risk of not doing well in math. The models are able to predict certain students that could have some issues with learning mathematical concepts based on such factors such as previous performance, attendance, behavior and demographic data. These models also provide essential insights that can empower educators to make informed decisions, which would, in turn, empower them to develop and implement interventions specifically designed to address the specific needs of any particular student. Such specific interventions allow for mitigating the causes of struggles and providing support at the right moment and pace to enhance academic performance.

V. BUILDING PREDICTIVE MODELS FOR AT-RISK STUDENTS

When the data has been acquired, either through machine learning or statistics, modelling techniques are used to predict relationships between data points such as performance, attendance and behaviour. These models can describe patterns and make accurate predictions of new data. The aim is to detect at-risk students early and make them available with specific help.

Several different algorithms can be used to build predictive models:

1. Logistic Regression: Logistic regression is applied in binary classification (i.e., in predicting the outcome of whether a student passes or fails their course) because education is an easy-to-understand domain, and it is not complex enough to use other algorithms. It also offers understandable, implementable ideas, a practical option among educators without intensive technical knowledge.
2. Decision Trees: Decision trees contribute to risk categories for students by formulating a set of decisions using data. They are graphically comprehensible and thus easily explicable. The decision trees can deal with numerical and categorical figures; this makes them suitable for use with mixed data in education.
3. Random Forests: Random forests are a slightly more complex form of decision trees, and they are usually used to understand complex data that have numerous variables; random forests are a set of trees, and they use more than one tree so that all the trees can enhance prediction accuracy and avoid overfitting.
4. Support Vector Machines (SVM): SVMs effectively discover complex patterns in high-dimensional data to be applied to complex data sets with many variables.
5. Neural Networks: Neural networks are intended to work with extensive data and complex structures since they mimic the human brain to pick complex relationships. Hence, they can be applied in massive predictive analysis in education.

Once constructed, the predictive model is calibrated using the previous school data to find patterns of student achievement and failure. The model is taught how to connect data points to passing or failing. It is made to run on new data after training to assess its accuracy, and you can rest assured that it can be used to predict future outcomes.

VI. DESIGNING INTERVENTIONS FOR AT-RISK STUDENTS IN MATHEMATICS

The next essential step is developing and administering particular interventions after predictive models have identified students likely to perform poorly. Individualization of such interventions is necessary so that they consider the specific academic needs of these students (i.e. knowledge gaps in early learning) and non-academic needs (i.e. emotional, behavioural or deficiency of understanding at home). Academic ones may include tutoring, individual lesson plans or adaptive learning technologies. Still, the non-academic ones may be counselling, social-emotional learning courses or the possibility of being a mentor. Personal approaches to individual needs, in the case of considering not only academic needs but also emotional ones, enable students to get out of their experiences and become successful in their education.

VII. TARGETED ACADEMIC SUPPORT

For most students, the primary intervention is academic support. This may include:

- Tutoring: Tutoring or small groups of learners may offer individualized therapy in areas where the learner is weak. It enables individual attention, corrects particular areas of misunderstanding, and drills into complex topics for the student. The selective assistance makes sure that students are given a chance to correct their mathematical abilities.
- Adaptive Learning Technologies: These are tools that provide a more customized learning experience that considers the student's needs and may ease or increase the difficulty of a lesson depending on the student's performance. They may be especially effective when used with students who experience problems with other approaches to teaching, as they

allow more customized approaches, and students can learn independently, developing confidence and understanding of concepts.

- After-School Programs: Giving those behind in school extra time to be taught other things through programs outside of the school can help them get up to speed. The programs also provide increased flexibility in learning as the students can go over the lessons again, practice more, and strengthen their knowledge base over mathematical concepts in an amiable setting.

VIII. MENTORSHIP PROGRAMS

Mentorship schemes can also help vulnerable students, as well as educational schemes. Mentor role models give emotional and academic counsel to students. They also provide personal advice, encouragement and positive criticism, which boosts the degree of motivation and confidence of students. By maintaining regular contact with the students, mentors enable students to improve their study habits, time management, and attitude to study. This mentoring relationship makes students feel secure enough to share themselves, talk about their problems, and become resilient. Mentorship programs also influence the student's improvement by infusing confidence and trust in them, pushing students towards academic progress in their grades. As mentors help students surmount problems and issues, they also help students learn critical life skills to help them succeed in school and in life. Finally, the problems of mentorship programs also foster personal growth and academic achievements, enabling the students to succeed in all spheres of their lives.

IX. SOCIAL-EMOTIONAL SUPPORT

Social-emotional learning (SEL) curriculums and counselling options are essential to students experiencing emotional or psychological hardships. They enable the students to control themselves regarding emotion, stress, and resilience. With such skills, students become stronger athletes when it comes to academic stresses and challenges in life. SEP programs scientifically foster emotional development and educational success by concentrating on focus, self-esteem, and relationships, which encourages that. Together with SEL, guidance counselling provides individual counselling, which takes into consideration the causes of emotional issues among students whose priorities are placed on their mental health. Cumulatively, the two interventions result in a healthier and more humane school environment, eventually making students reach their academic and personal potential.

X. PARENTAL INVOLVEMENT

Striving to involve parents in the educational process is essential to the performance of weak students. The role of parents in providing a good learning atmosphere at home is critical. They make their children grow up, create good study habits, and organize them by assigning regular study time to their children. Homework that is actively done gives the student a sense of pacing when the going gets rough, and his knowledge and confidence are improved. The school attendance factor is also imperative because regular attendance in school guarantees that the students do not miss vital lessons, and this factor has direct implications for the learning process. Parents would be able to practice the emphasis on regular attendance in school. Open communication between teachers and parents also leads to collaboration and student success. It is a collaboration that creates a possibility to customize strategies to the needs of every student, making sure that they are targeted in order. When collaborative, parents and teachers will ensure that students achieve their potential despite their academic difficulties.

XI. EQUITY CONSIDERATIONS FOR URBAN AND RURAL DISTRICTS

Predictive analytics and interventions greatly differ in urban and rural school districts, so there should be a special approach to each situation. The frequent challenges associated with urban districts are overcrowded classrooms, limited budget, and high teacher turnover, which could affect the success of the selective interventions. They, however, have increased access to high technology, the resources in the community, and outside support programmes that can assist in reducing such risks. Conversely, the students served in rural schools are usually smaller and have limited resources, including access to technology and special education. Nonetheless, there are advantages of using rural schools as close communities that help strengthen and personalize the relationships between learners and teachers. In designing predictive models and interventions, it is essential to consider such differences so that all students (irrespective of their backgrounds and schools) get equal opportunities for educational aid and resources. This will encourage equity in education, giving all children a chance to succeed.

XII. CHALLENGES IN URBAN DISTRICTS

The population of urban schools is huge and mixed; along with it come problems and the scope of providing quality education. There is a tendency not to be able to give individual attention, particularly to struggling learners, due to overcrowding in the classroom, shortages in resources, and teacher turnover being very high. Due to such systemic obstacles, they hinder the appropriate capacity to address the unique needs of different children. Nevertheless, urban schools have more progressive technologies, outsider aid units, and an outstanding community resource net (Shiraishi & Mupa, 2025). By doing so, such resources help bridge those knowledge gaps and provide some additional support even when the resources are limited. Smoothly exploiting these resources, urban schools can break through the constraints and enable students to receive progressively more personalized education, ultimately birthing successful learners despite their current adversities. It plays a vital role in allowing every student to perform well.

XIII. CHALLENGES IN RURAL DISTRICTS

The rural counties, however, are likely to have fewer students in general, which may cause a hard time allocating resources. Rural schools can also not afford newer technologies and specialist teachers like urban schools. However, rural schools enjoy small community structures, which results in more positive, stronger relationships between teachers and learners. This close-knit setting facilitates individualization, where the learning atmosphere is created in a way that exposes it to individualized education. The rural school might not as well be well equipped, but on the contrary, it should be in a much better position to provide focused support that tackles the unique needs of the separate student (Netshifhefhe et al., 2024). Such capability in personalizing learning allows for better performance among students by providing personalized assistance to address their academic dilemmas. Rural schools also have more flexibility since they have fewer resources required and, as such, have the opportunity to have student-based methods of teaching, which promote active learning and greater involvement in the subjects taught.

CONCLUSION

Predictive analytics can offer an excellent solution to secondary mathematics that can help detect at-risk students early enough; thus, early interventions are provided to avoid academic failure. They can give schools predictions of who will become low-achieving students using information on students' academic performance, behaviour, and socioeconomic background and intervening in their lives. This will assist teachers in tackling the problems before they get beyond control, and they will be able to offer specific help to solve the causes of academic underachievement. Although the application of predictive analytics in schools is still at an early stage in development, positive experience in the use of predictive models in other settings, including corporate governance and risk management, can be applied as guidance as to the relevance of predictive analytics to schools willing to pursue evidence-based methods of improving student achievement. These models emphasize the necessity of preparatory warnings about the threats and proactive steps. All students should be made to succeed in mathematics, and no student should be kept back through what happens in schools in the ways of releasing equity and giving the necessary support to its students to succeed in mathematics regardless of where they are located or the type of background they have so no student will be left behind. Student achievement and gap bridging will probably occur using this data-driven model.

REFERENCES

[1] Rikuto Shiraishi & Munashe Naphtali Mupa (2025). Valuation complexities in the energy

transition: A comparative study of traditional vs. Green Energy Firms in M&A Transactions. World Journal of Advanced Research and Reviews, 26(2), pp.767–774. doi: https://doi.org/10.30574/wjarr.2025.26.2.1652

[2] Shiraishi, R., & Munashe Naphtali Mupa. (2025). *Cross-Border Tax Structuring and Valuation Optimization in Energy-Sector M&A: A U.S.-Japan Perspective*. *8*(11), 126–135. https://www.researchgate.net/publication/391485061_Cross-Border_Tax_Structuring_and_Valuation_Optimization_in_Energy-Sector_MA_A_US-Japan_Perspective

[3] Khodani Netshifhefhe, Magalane Vivian Netshifhefhe, Munashe Naphtali Mupa, Artwell Kudakwashe, & Murapa. (2024). *Integrating Internal Auditing and Legal Compliance: A Strategic Approach to Risk Management*. *8*(4), 446–465. https://www.researchgate.net/publication/385318623_Integrating_Internal_Auditing_and_Legal_Compliance_A_Strategic_Approach_to_Risk_Management

[4] Khodani Netshifhefhe, Magalane Vivian Netshifhefhe, Munashe Naphtali Mupa, Artwell Kudakwashe, & Murapa. (2024b). *The Role of Forensic Audits in Strengthening Corporate Governance and Mitigating Compliance Risks*. *8*(4), 427–445. https://www.researchgate.net/publication/385318601_The_Role_of_Forensic_Audits_in_Strengthening_Corporate_Governance_and_Mitigating_Compliance_Risks

[5] Munashe Naphtali Mupa, Chiganze, F. R., Mpofu, T. I., & Mubvuta, M. (2024). The Evolving Role of Management Accountants in Risk Management and Internal Controls in the Energy Sector. *ResearchGate*, *8*(2), 859–881. https://www.researchgate.net/publication/384055180_The_Evolving_Role_of_Management_Accountants_in_Risk_Management_and_Internal_Controls_in_the_Energy_Sector

[6] Naphtali Munashe, & Mupa. (2024). *Corporate Governance and Firm Performance: A Study of Selected South African Energy Companies*. *2*(8), 294–310. https://www.researchgate.net/publication/383039611_Corporate_Governance_and_Firm_Performance_A_Study_of_Selected_South_African_Energy_Companies