Chapter 4
Predictive Analytics in Education

4.1 What Is Predictive Analytics?

By examining trends in past data, predictive analytics can estimate the likelihood of upcoming events (Judge 2021). Figure 4.1 represents a conceptual view. Although the data might look complex, the method itself is easy.

Organizations and institutions use predictive analytics to find trends in historical data and make informed decisions about the future (Judge 2021). Through this method, we can establish reliable standards for our data and develop models to foresee better and comprehend any dangers. Businesses can foresee the effects of a decision by understanding the connection between datasets and results.

4.2 Examples of Predictive Analytics

As with many other forms of cutting-edge technology, predictive analytics is often seen as futuristic. Actually, no. It has a long history of use across various organizations (Judge 2021). Data collection is used in most businesses for product logistics, financial transactions, or academic success. Companies can anticipate the behavior of comparable customers by identifying trends in existing data.

It can be used in healthcare to predict whether a patient will show up for an appointment or in the insurance industry to aid in detecting and preventing fraudulent claims. Another sector that may benefit from such a system is the banking sector, where it would be helpful to determine whether a loan applicant is likely to repay the loan based on specific qualities that the system will request at application time. It uses "big data," or large and complicated datasets that might be difficult to manage and manipulate by hand. That is why companies employ BI tools to make predictive analytics more accessible. By providing a visual representation of the
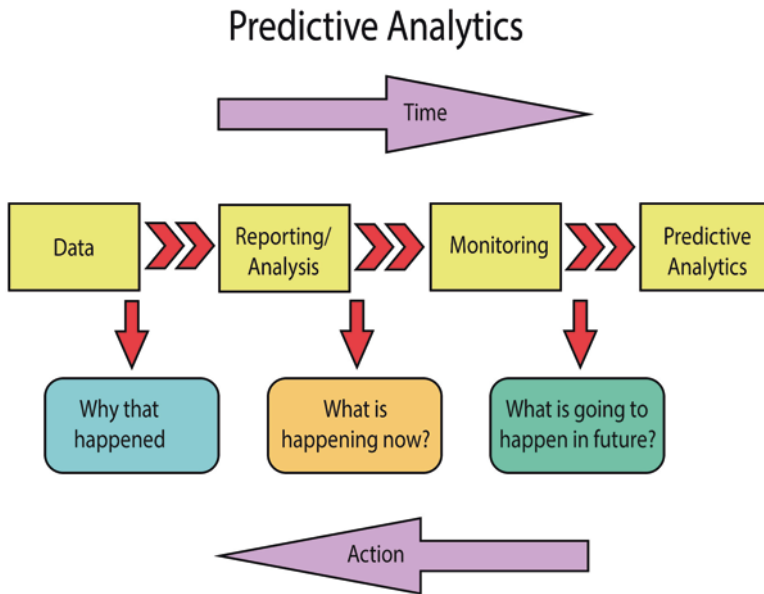
Predictive Analytics

Fig. 4.1 A conceptual view of predictive analytics

data, these technologies make it easier for institutions to share and analyze their data (Judge 2021). Because the technology eliminates the need to manually construct technical scripts and algorithms, decision-makers now have easier access to this information and can make more educated decisions.

4.3 The Evolution of Predictive Analytics in Education

The fields of digital technology, marketing, finance, and healthcare are generally the first that come to mind when discussing big data analytics. Institutions increasingly turn to predictive analytics to promote systemic improvements in the education sector by drawing on historical student data to understand better how their students will perform in the future (Judge 2021).

The education industry has always placed a premium on accurately forecasting student outcomes, and as a result, K-12 institutions, colleges, and universities have traditionally relied on data connected to exam scores and attendance records. Previously, records were compiled and examined manually, necessitating human involvement in the event of a discrepancy. That means the information was probably kept in silos inside individual divisions, and responses might have lagged.

Today, there is an exponentially more significant amount of data collected in the classroom than ever, thanks to the widespread adoption of digital learning and educational technologies. This information has grown increasingly intricate as our

institutions and technologies have advanced. The vast amounts of data available today allow for extracting a wealth of relevant information, opening up new avenues for boosting student outcomes and informing prudent business decisions.

Students can interact with data on campus and through various online platforms. In addition to traditional academic information, schools will keep track of students using digital learning tools, library resources, and extracurricular activities in their student information systems. This "big data" can be used by predictive analytics to reveal patterns and examine the whole picture of an organization's success (Judge 2021).

4.4 Reasons for Using Predictive Analytics in Higher Education

The higher education sector uses predictive analytics to address many of the same commercial and operational difficulties other social service industries face. Universities are using this tool for three primary reasons (Ekowo and Palmer 2016):

- In order to pick out the students who would benefit most from counseling.
- Creating personalized adaptive learning content.
- Enrolment management.

Predictive analytics has enabled universities to identify potential donors among their alums. As a result, many businesses have teamed up with USA Funds, a non-profit that used to insure federal student loans against default, to use analytics to anticipate which students are most likely to stop making their loan payments (Ekowo and Palmer 2016). There is a wide variety of alternative applications for these tools.

Targeted Student Advising Universities sometimes fail to provide their under-graduates with enough access to counselors. The "median caseload of advisees per full-time professional academic adviser nationwide was 296:1," a recent National Academic Advising Association (NACADA) survey stated. However, at community colleges, that ratio skyrockets to 441:1 (Ekowo and Palmer 2016). Because of this, it is difficult, if not impossible, for most universities to provide each student with the individualized attention they require and merit. Early-alert systems help find students at risk of academic trouble, and program recommender systems help students choose courses or programs. The institution can meet a student's essential needs when early-alert and program recommender systems are in place.

Adaptive Learning Using data mining and other forms of predictive analytics, universities can create adaptive learning courseware that adjusts a student's path through a course based on their use of the technology. These systems use student information to judge course material, assessment methods, and how these elements should be presented to students.

Teachers can better address students' individual learning needs and provide instruction that works best for them with predictive analytics implemented into adaptive learning platforms. This resource can help students learn faster by skimming over material they already know and diving deeper into concepts they struggle with.

Enrollment Management Predictive analytics has been a staple of university enrollment management strategies for quite some time. Universities use predictive analytics for more than just assisting students on campus. The data estimates the size of incoming and returning student populations. Moreover, they utilize it to focus their advertising and recruitment efforts on the students most likely to apply, enroll, and thrive at the school. Predictive analytics has also helped universities calculate the likelihood that an admitted or returning student will accept a financial aid package (Worcester Business Journal 2011).

The expense of recruiting might be high. There was a median expenditure of $2433 per incoming freshman at private four-year institutions, according to a survey done by enrollment management firm Noel Levitz in 2013. Public four-year universities pay $457 for each new student, while public two-year universities spend only $123 (Ekowo and Palmer 2016). Due to the high stakes, institutions try to maximize their strategic spending. Using predictive analytics, college admissions teams can provide an individual likelihood score to each prospective student, often on a scale from 0 to 10, that accounts for the possibility that they will apply, get admitted, and ultimately enroll. Colleges use factors including racial/ethnic background, where they live, where they went to high school, what they want to study in college, and how interested they are in taking a campus tour or receiving marketing materials to determine these grades. These ratings allow admissions officers to focus on the most qualified applicants aggressively.

Other Reasons for Using Predictive Analytics Colleges utilize predictive analytics for a variety of reasons, including improving student engagement and making better use of limited financial resources. Among these are (Ekowo and Palmer 2016):

- Rather than focusing on enrollment numbers, state financing is now connected to how well an institution educates its students. The National Conference of State Legislatures, a nonprofit that provides resources to state legislatures, reports that 32 states financially reward universities for increasing the percentage of their students who complete their programs within the required time frame. These incentives are designed to encourage schools to invest more time and resources toward the academic success of all their students. This is especially true for students from underrepresented groups and those from low-income families.
- Retaining as many students as possible to reduce tuition and fee revenue loss. If a college can keep a student enrolled there instead of having to find and enroll a new one, they will save money. If students stop enrolling, schools lose hundreds of thousands of dollars in revenue each year.
- The culture of institutions is changing. Higher education institutions increasingly use data to reflect on the past and inform the present. An organization's

commitment to a data-informed culture can be bolstered by using predictive analytics.

4.5   Predictive Analytics Significance in Education

Data is attractive since it is continually developing in exciting ways. By acquiring these insights through data modeling, schools, universities, and training providers can foresee potential future challenges and proactively deal with them to better the student experience while focusing on the bottom line (Judge 2021). The complexity of analysis, though, grows in proportion to the number of datasets. Core analytics models for understanding outcomes will automatically adapt and update based on any new data received by the institution once it has designed and built them.

For instance, a school that has already built a predictive analytics model to determine whether a student would pass or fail a course can add a new applicant's information to the model to determine the likelihood of success or failure.

To increase productivity across an organization, predictive analytics is crucial. Predictive analytics can boost student enrollment, productivity, and presence even in the face of resource constraints (Judge 2021). Predictive models can be fed data from several departments, providing a complete picture of the institution's context for the student.

4.6   How Is Predictive Analytics Changing Education?

Thanks to technological advancements, more data is being collected than ever in the current education industry. As a result, predictive analytics facilitates the organization and interpretation of these massive datasets and encourages a more evidence-based methodology in academic settings (Fisher and Mulroy 2021).

The educational system has long relied on and shown an interest in quantitative assessment. However, there is a danger that reports and insights will become compartmentalized, only capturing a subset of the entire student experience. The trend toward data centralization, which will benefit all decision-makers by making more information easily accessible, relies heavily on predictive analytics.

Schools can better meet their needs by identifying students' specific areas of struggle. Institutions can utilize predictive analytics to learn about the specific needs of each student through adaptive learning. Predictive analytics helps students' emotional health and well-being by providing a structure for early intervention. It can address education gaps by highlighting systemic concerns with the quality of modules or programs (Fisher and Mulroy 2021).

Various organizations use predictive analytics to direct and inform the development of their overall operations. Predictive analytics aid in the mapping and planning of further higher education's period of significant change.

4.7   How Does Predictive Analytics Help Higher Education?

Educational institutions are under growing pressure to retain and develop students as the emphasis shifts from maximizing semester enrolment numbers to boosting the rate of successful student graduations. State officials are driving this shift in strategy in response to rising expectations from students and their families, investing time and money into a higher education that may or may not pay off. Thus, students can utilize predictive analytics to gain insight into their academic achievement and take preventative measures in response to their development (McGavisk 2022).

4.8   Predictive Analytics Uses in Education

The following are the three vital uses of predictive analytics in education (McGavisk 2022):

- *Informed Student Advising:* Students who fall below the expected attendance rate can be flagged as early as the first semester using Early Alert Systems (also known as Flags), giving advisors and pastoral support teams ample opportunity to reach out offer assistance.
- *Accurate Enrolment Management:* Institutions and their departments can better accommodate returning students and revamp underperforming courses with the help of predictive analytics, which can determine which students are most likely to graduate based on their academic performance.
- *Adaptive Learning:* Educators can also benefit from predictive analytics. Lecturers and teachers with access to students' academic records can use this information to better tailor their lessons to each student's needs and learning styles. Teachers can take prompt action based on frequent feedback, leading to more engaging and purposeful learning experiences.

4.9   How to Use Predictive Analytics in Education

The provost and the chief academic officer are challenging to hold at any university. The extensive responsibilities of a provost, and the skill with which they must carry them out, may vary slightly from one institution to the next, but the job's difficulty remains constant. A provost's primary duty is to make educated choices about teaching and research at the university. To be more specific about their responsibilities, provosts are accountable for (Moraes 2018):

- Keeping them from dropping out.
- Maintaining a healthy growth in revenue.

- Participating in and coordinating meetings.
- Making preparations for the hiring of excellent faculty.
- Creating educational materials and instructional plans.

There is a delicate balance to be struck between the university's bottom line and the happiness and success of its students, and here is where most provosts run into their most considerable difficulties.

A recent study found that only approximately 50% of students who enroll in college end up graduating (Moraes 2018). Bill Gates, a multibillionaire in the IT industry, has voiced his concern over this matter. For example, Gates wrote on his blog,

"Based on the latest college completion trends, only about half of all those students (54.8 percent) will leave college with a diploma. Most low-income, first-generation, and minority students—will not finish a degree. They will drop out" (Moraes 2018).

This is a significant issue that provosts need to think about. New technology, however, has given provosts the tools they need to handle the situation. How? Utilizing predictive analytics in the classroom allows provosts to identify at-risk students accurately.

The procedure (Moraes 2018) is as follows:

Step 1: Establish the Requirement for a Predictive Analytics Model in Your Organization Refrain from doing what everyone else is doing. Instead, it is essential to have a firm grasp on the necessity of a predictive analytics model for your organization. Think critically about the problem of student attrition and any other problems of a similar nature by holding a brainstorming session with the university's key players. When all parties participating in the academic and administrative project have settled on objectives, it is time to begin formulating a plan to see that they are met. Constructing a predictive model may not be necessary to realize these goals; perhaps other approaches may be used instead. If not, plan how to construct a model using predictive analytics to get the desired results.

Step 2: Create a System that Can Adapt to Technological Changes To create a predictive analytics model in education, adjustments must be made to how things are done. As a result, provosts must ensure that everyone involved is prepared for the upcoming shifts. Stakeholders, including teachers, curriculum developers, and the dean, should familiarize themselves with predictive analytics models and be ready to incorporate them into their practices.

Step 3: Collect Reliable and Objective Information for Educational Predictive Analytics The first significant step in developing the inputs for the predictive model can begin if everyone provides the go-ahead. Students generate and leave a digital footprint as they go about their daily routines on campus. Information such as tuition, fees for extracurricular activities, food costs, grades, attendance records, motivation levels, and career aspirations is helpful. However, collecting data on the existing pupils for the model to make accurate predictions will not be sufficient. All information that can aid in the early detection of at-risk students must be gathered

to ensure accuracy. You need to collect dropout and graduation rates from the past in addition to current student data to create a reliable predictive analytics model for student retention. Avoid gathering unrepresentative data, which might lead to problematic classifications when fed into the model.

Step 4: Make Sure that Everyone Involved Understands Predictive Models Thoroughly Teachers or curriculum professionals who thoroughly understand how to use predictive analytics in education technologies should only use them effectively. That is why provosts need to plan and set up training sessions on using a predictive analytics program. Once data has been collected, it must be uploaded to an analytics platform.

Step 5: Inspect the Model's Development in a Series of Iterations Information is continually being created at an exponential rate. Therefore, a new result (with improved accuracy) is generated when this information is fed into the model. As a result, the predictive model may be updated with new information about a student as it becomes available, resulting in a more accurate and nuanced forecast of that student's future performance.

Step 6: Get Your Vendors from Reputable Sources It is challenging to develop a framework for predictive analytics in education and integrate it into the established systems of a university. Provosts are responsible for more than hiring technical specialists; they must also secure funding, construct necessary facilities, and instill the proper mindset in their staff. Moreover, thus, what are some potential solutions? It is safe to assume that many IoT and big data service providers will offer reliable products and support. Vendors are a reliable resource that universities can rely on to get things done.

4.10 Predictive Analytics in Higher Education: Guiding Practices for Ethical Use

Predictive analytics can be instrumental, but only if used ethically by institutions. Data collected from students could be used to hinder their education if proper procedures are not followed. Colleges will continue to use student and institutional data in novel ways, necessitating a periodic reevaluation of whether their ethical standards address current data practices and the corresponding need to examine the ethical use of data anew.

The ethical use of data is nuanced, and there is no simple solution. It does not solve every problem arising from institutional data usage and probable exploitation. This ethical framework is hoped to serve as a discussion starter for students.

The following are the five guiding practices (see Fig. 4.2) for the ethical use of predictive analytics in education (Ekowo and Palmer 2017).
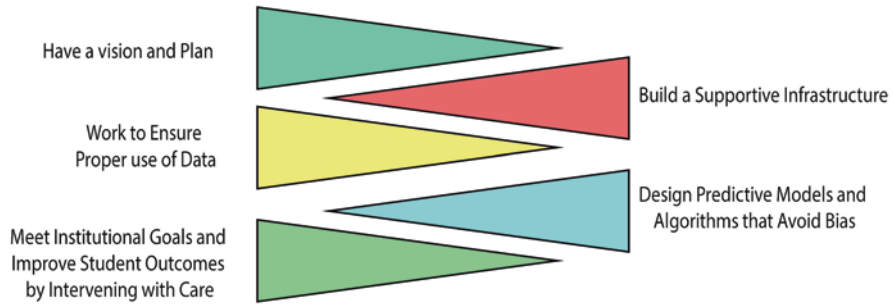
Fig. 4.2   Predictive analytics in higher education: guiding practices for ethical use

Guiding Practice 1: Have a Vision and Plan Establishing a strategic goal and plan for data application might assist in pointing the way for a predictive analytics project. Without proper planning, predictive analytics could be employed in a way that is counterproductive to student achievement, excludes essential members of the staff who should be included, and/or fails to define how success will be determined.

Here are some suggestions for developing a vision and plan:

Convene Key Staff to Make Crucial Decisions It is essential to involve and gain the support of key personnel and stakeholders as you formulate your plan. By involving them early on, you can ensure that predictive analytics is being used in a way that does not cause harm to the people whose information is being studied.

When formulating the plan, keep in mind the following three factors:

1. *The purposes of predictive analytics:* Both the questions you seek to answer and the outcomes you desire should be outlined in the plan. The group needs to make sure the information is not used for any bias. The paper must also consider the possible drawbacks of utilizing student and institutional data.
2. *The unintended repercussions of predictive analytics:* Your institution and its partners (including third-party vendors) should identify potential unintended outcomes and strategies for mitigating them in the strategy.
3. *The outcomes to measure:* Measurable goals for using predictive analytics should be outlined in the plan.

Guiding Practice 2: Build a Supportive Infrastructure By having protocols and other supports in place to aid the data endeavor and ensuring campus stakeholders are aware of and receptive to the benefits of predictive analytics, a campus may create a supportive infrastructure for the analytics to thrive.

Communicate the Usefulness of Predictive Analytics and Foster an Environment Where Its Use Is Encouraged Using information from students and schools, predictive analytics can prompt urgent action. The stakes of ensuring students graduate on time may be too high for many educational institutions to have expertise using data in this way, at this speed. Well-thought-out plans may not get the necessary

backing if the benefits of using predictive analytics to improve campus life are not communicated. It would be best if you took the initiative to inform your campus's administration, faculty, and students why predictive analytics is so crucial to the future of your school and your education. The VP of PR and marketing could be of use here.

Create Effective Change Management Processes Changes to workflows, reporting mechanisms, personnel, and collaboration partners, all of whom bring unique expertise, are common when introducing new technologies. When decision-makers gather to discuss data use, they may also ensure that the necessary infrastructure is in place to accommodate the ongoing transformation on campus. For those in charge of implementing predictive analytics on campus, this can lead to pandemonium or, at best, bewilderment.

Assess Institutional Capacity Evaluate how well predictive analytics can be implemented at your institution. Institution-wide data cleaning, sharing, and decision-making rely on the interoperability of many data systems; keeping this infrastructure in good working order is essential. It is crucial to have access to high-quality data and the necessary hardware, software, personnel, resources, and knowledge of how to analyze that data. The project's success could be increased by adding staff members who are experts in information technology, student data legislation, and contract drafting with vendors.

Guiding Practice 3: Work to Ensure Proper Use of Data Supporting enrollment efforts or assisting students in making academic progress requires data to develop predictive models (demonstrating how different data points are related) and algorithms. Moral development and use of these technologies require considering data quality, data interpretation, privacy concerns, and security vulnerabilities.

Ensure the Information Is Comprehensive and Accurate Enough to Respond to Specific Inquiries Having complete and accurate information about students and how the school operates is essential. Evaluating students thoroughly also entails taking into account any and all pertinent information about them.

Quality data is precise, exhaustive, and up-to-date, acquired from reliable sources through clearly established procedures, and easily understood by a broad audience.

Ensure Data Are Accurately Interpreted Data analysts need to keep the context in mind. Ensure that you have personnel familiar with your organization's data and can correctly understand the prediction models based on this data. It is crucial to educate teachers on how to use dashboards that show how students utilizing adaptive technologies are doing in their classes. Finally, even though they may be included in datasets used for predictive analytics, look for measures to preserve data integrity for reporting reasons. Imagine that analysts at a large institution have been tasked with gathering data for use in reports and conducting analyses for predictive analytics initiatives. If the information is being put to creative use on campus, then there

is no reason to doubt its veracity for reporting purposes. Your institution must maintain compliance with federal funding requirements, and predictive analytics should not compromise the quality of the data it reports.

Guarantee Data Privacy   Students, employees, and others whose data are gathered should be informed of their rights, including how their data may be used for predictive analytics and how long it will be held. Inform employees and students that their data will be used for predictive analytics and obtain their permission to utilize sensitive data like health records.

Take precautions to ensure your data is secure, as this will prevent it from falling into the wrong hands. It is also crucial to safeguard the personal information of students who are particularly at risk, such as those who are underage and engaged in college-level coursework while still in high school, undocumented, and disabled.

Furthermore, ensure that all policies regarding who owns what and who can access student and school data are communicated clearly.

Monitor Data Security   Unexpected security incidents often occur. Security becomes more of an issue as institutions gather and store more data on students and staff and as more gadgets that keep data on the teaching and learning process are utilized in classrooms. This highlights the importance of thorough monitoring of data privacy and security by educational institutions. Threats and dangers need to be tracked frequently. You and your vendors must implement security processes that comply with student privacy regulations and industry best practices to keep sensitive data safe.

Get the IT department involved in data security at your organization. Officers tasked with data security and privacy are invaluable to any organization. One of the most important things you can do to protect your data is to provide your IT and other employees with regular training on data security.

Guiding Practice 4: Design Predictive Analytics Models and Algorithms that Avoid Bias   Predictive models and algorithms can aid in deciding how much effort should be put into student support and recruitment. Therefore, it is essential that predictive models and algorithms are developed to minimize bias instead of amplifying it and that these models and algorithms are rigorously evaluated for efficacy. When developing models and algorithms, ensure that you work with suppliers willing to guarantee that they will not be designed to codify prejudice inadvertently and that their efficacy can be verified through testing.

Create Predictive Models and Algorithms that Reliably Deliver the Outcomes you Need   No classification of people should ever be the goal of an algorithm. The use of algorithms that create discriminatory results should be prohibited, and it is vital to eliminate bias in predictive models and assure the statistical significance of forecasts beyond race, ethnicity, and socioeconomic position.

Therefore, it is necessary to build or understand the process by which predictive models and algorithms are developed in order to guarantee the success of their vision and goal. If this precaution is not taken, unfair treatment may result.

Predictive Models Must Be Put to the Test and Made Transparent Before using predictive models in algorithm development, it is essential to evaluate their correctness, possibly with the help of an outside party. The predictive models should incorporate new realities and aims for the campus. You should try to ensure algorithms can be understood by those they will affect, and you may wish to restrict the variables used in predictive models to those that can be described. Such actions promote openness and simplify identifying and punishing those responsible for discriminatory consequences resulting from poorly conceived models or algorithms.

Choose Vendors Wisely If a university needs assistance developing models or predictive tools, it typically contracts with a third party. It would help if you were directly involved in or informed about constructing prediction models and algorithms to guarantee their soundness, transparency, and lack of bias. This may be more challenging if you opt to work with third-party vendors.

Some vendors make their models and algorithms transparent, giving universities more agency in the design process or letting them seize the reins entirely. However, not all sellers act in this way. Because of this tendency to treat models and algorithms as intellectual property, many institutions are either not participating in the design process or are actively excluded from it. The level of openness between you and the vendor should be high on your list of priorities.

Guiding Practice 5: Meet Institutional Goals and Improve Student Outcomes by Intervening with Care Predictive analytics' actual test is how your organization uses the information it gathers. Even if they do not see or understand how the algorithm-based judgments are produced, they will experience these actions or interventions firsthand. Even with modern aids, human beings are still necessary for most involvement. Therefore, it is essential to consider interventions in the context of other supports provided at your institution and spread information about them thoughtfully. It is essential to verify the efficacy of treatments after implementation and provide proper training to staff members who will implement them.

Inform Teachers and Students About the Change in Intervention Practices An institution's culture may shift if data-informed interventions become increasingly central after adding predictive analytics to the toolkit for student achievement. Faculty, staff, and students must be aware of the positive outcomes that can be achieved through implementing interventions that are informed by predictive analytics to achieve widespread buy-in for this shift.

Incorporate Predictive-Driven Interventions into Existing Programs Aimed at Improving Student Performance Predictive analytics is a valuable tool, but it is only one component of a more extensive set of resources, including first-year

orientation programs, that can guarantee students' and institutions' success. All your efforts to improve student achievement should be interconnected and build upon one another, so keep an eye out for ways to use predictive analytics to advance other initiatives.

Predictive-Driven Interventions Might Cause Harm If Not Handled with Caution There will always be room for error in decision-making, no matter how detailed an institution's data, models, algorithms, processes, and training are. For this reason, it is essential to fine-tune any treatments you take in response to predictive analytics to ensure no students are harmed. In response to student data and predictive models, educators may increase outreach to a specific student based on his predicted likelihood of enrolling, mandate a meeting with an adviser at the suggestion of an early-alert system, or modify the practice problems assigned to a student using adaptive technology.

Colleges must know the potential downsides of using algorithms for strategic enrollment management, early alerts, recommender systems, and adaptive technology. However, one must carefully consider the risks involved before employing such methods. Protecting students from damage might be accomplished by shifting our perspective from illness and lack to wellness and asset. In this model, each and every student is seen as having limitless potential. Furthermore, it allows for the possibility that a student's dropout risk may be affected by factors unique to the institution. Finally, it will be smart to determine how people will be punished for inappropriately utilizing or manipulating student and institutional data and how to restore trust after a damaging incident.

Here are some cautious applications of predictive tools:

- Early-alert systems.
- Recommender systems.
- Adaptive technologies.
- Enrollment management.

When Implementing Interventions, Make Sure to Keep Everyone Informed Communicate effectively and make the intended audience can reach sure of interventions. It is essential that the words you deliver do not discourage students and that the tactics you use to get the word out about interventions reach as many students as possible.

Educate Employees on Implicit Bias and the Limits of Data Confront implicit bias and learn to recognize the limitations of data. Intervention strategies for at-risk students may be hampered by staff members' implicit biases or a lack of complete data. They inadvertently hurt the pupils they are trying to help because of their prejudices or an unhealthy obsession with school data. Staff members who have received adequate training should gladly accept their responsibility to use student and institutional data to benefit their pupils.

Instruct Students on How to Make Effective Use of Their Data An example would be students using the data they produce in adaptive learning tools to figure out what works best for them as far as studying goes. Staff members may also seek to instruct pupils on properly using data to shape their time at school.

Evaluate and Test Interventions A successful intervention should not be declared before it has been tried and proven to work.

- *Which interventions are most effective, when, and why?* It would help if you evaluated how well your interventions are working. This evaluation can reveal whether or not these interventions have different effects on different groups, allowing for re-tuning. The research into the therapies' efficacy may also shed light on unforeseen outcomes.
- *Verify the claims made by tool vendors before making a long-term investment:* One of the biggest questions surrounding adaptive technology is whether or not the techniques are helpful. There must be a steady stream of new tools and validated claims in technology-enabled student learning. There is minimal third-party confirmation for many companies' claims that their solutions are adaptive and would boost student achievement. Demand that providers team up with objective academics to verify the efficacy of their products and services.

4.11 How to Implement Predictive Analytics for Education: Best Practices

Predictive analytics in classroom implementation is complex. However, there is a standard rule of thumb (Kyianovska 2022) you can follow to ensure success:

- Determine the metrics that data analytics should concentrate on after you have identified the bottlenecks in your operations.
- Identify relevant data sources.
- Methods for boosting students' grades should be digitized.
- Applying statistical methods to find some insights.
- Set up an automated system for gathering and analyzing data; create a system for getting notifications including the findings of this analysis; and establish rules for following up on these alerts.

Developing and implementing this new product into your business has potential pitfalls. The following best practices (Kyianovska 2022) can assist you in meeting these difficulties head-on.

Give Students Access to Their Data There may be privacy issues with implementing predictive analytics in the educational sector. That is why data collection needs to be as open as possible. Students should have the option to participate or not. Get their permission by explaining the value of opting in and being transparent about how you use their data.

Keep in mind that you do not need to provide any identifying information. Some universities collect information on entire classes to understand student behavior better.

Make Sure Your Data Is Safe   A school must ensure the security of its students' data if it gathers it in massive databases. If not, the information could be vulnerable to hacker assault. Predictive analytics can be used to enhance the educational experience of students and can also be used to strengthen cybersecurity.

More than that, schools should have rigorous guidelines for managing student data. Some employees may care only about attendance records in the workplace, while others would need detailed information on how often the library is used. Only a select few faculty members need access to all student information.

Search for Implicit Biases in the Algorithms   One common expectation placed on algorithms is that they will render fair assessments. However, their biases may be introduced by the people who made them. In order to achieve this, they can use biased information to teach the model. Therefore, the effect of a structural bias can be amplified by an algorithm.

It has been argued that the prediction model can become skewed if indicators such as secondary school, race, and zip code are included. For example, in the case of Georgia State University, these considerations are omitted on purpose.

4.12   Advantages of Predictive Analytics in Education

Predictive analytics has great potential to improve the educational experience for everyone involved, including students, parents, and teachers (Saranya 2020).

- Predictive models can help teachers anticipate academic difficulties and intervene with interventions like tutoring or supplementary classes for students who are at risk of falling behind.
- When applied to areas of the institution where problems have been identified, predictive analytics can aid administrators and educators in making positive changes, such as:
  - Identification of factors that lead prospective students to decide against enrolling.
  - Predicting which departments have the highest attrition rates and using that data to inform efforts for keeping enrollment consistent.
  - Keeping the school in a solid academic and financial position requires constant analysis of student feedback to determine what is working and what needs to be changed.

- Students' participation in sports and other forms of physical activity can be predicted and improved with predictive analytics. The same is true of schoolwork and extracurriculars.
- Predictive analytics can be used to spot patterns that improve accessibility and adaptability in the classroom, such as the increased popularity of weekend online classes and last-minute cram sessions before exams. Once a new teaching method is implemented, its effectiveness can be evaluated and tweaked to benefit all students.

4.13   Examples of Predictive Analytics in Education

If you are on the fence about whether or not the implementation of predictive analytics into the educational system is worthwhile, consider the following (Kyson 2021):

- *Causes of absenteeism can be identified:* It is well known that a student's level of attendance has a significant impact on both their salary and return on investment. The higher the number of students absent from class, the more critical it is for schools to investigate why this is happening, such as the student's health or financial situation, to accommodate these students better.
- *Promotes in-depth, individualized focus:* Every learner has a different learning pace and/or ability to grasp new material. You cannot judge their comprehension of your lesson from the looks on their faces. Neither hunches nor gut feelings have led them anywhere. You can figure out which youngsters require extra help by using predictive models. Foreseeing and preparing future issues through specific data metrics is now possible by deploying such measures and scheduling tailored seminars.
- *Helps reduce college dropouts:* US dropout rates for 16–24-year-olds are at a record high of 5.4%. The working class bears unemployment's social and financial weight, diminishing student return on investment. Should any division in a university see a spike in the dropout rate, predictive analytics can be a valuable tool. The data from these forecasts can be used to increase enrolment in that area year after year.
- *Competes effectively in retaining students:* Due to the high level of competition, universities and colleges are under significant strain to maintain and grow their student body and faculty. Instead of focusing on increasing semester enrollment, institutions should work to increase graduation rates, boost the quality of their studies, and make students more aware of their academic progress. By encouraging a proactive response from the student, predictive analytics aids retention and development.
- *Analyses of feedback from students and teachers:* The main issue with written or vocal comments is that they can easily get lost in the shuffle. Here is where the institution's operations may be fine-tuned with the help of technology, which can collect feedback from across the web and compile it into usable, well-structured

data. Finally, schools can modernize their academic and financial offerings to fill gaps and better serve their students and employees.

- *Encourages adaptive learning:* Adaptability in the classroom is crucial in today's ever-changing world. With everything documented, educators may spot areas for improvement in their lessons and adjust their delivery to reach their students better. Similarly, predictive analytics in education can use information about students' knowledge gaps to encourage institutions to develop more cutting-edge educational practices and create individualized curricula for each student. Therefore, in the end, adaptive learning provides a more fulfilling and well-rounded college experience.
- *Encourages participation in physical activities:* Many schools have a terrible reputation for misplacing students based on their athletic records and failing to recognize students' prior achievements. On the other hand, this technology uses past data to encourage students to continue their education and choose a career path. Predictive models and algorithms can be reused in the classroom and the real world.
- *Identifies emerging educational trends:* Like any other organizational practice, educational practices need metrics to measure their instruction's efficacy and impact on students' learning. Institutions must determine what is beneficial and what is not for their students. However, without concrete data, many organizations struggle to assess the efficacy of their systems. Good thing there is predictive analytics to help us find the most recent productive patterns and evaluate system responsiveness. You can use it to see if pupils are better off with a specific grading scheme or to compare the effectiveness of online and traditional classroom settings. After recognizing and implementing the recommended educational trends, you may evaluate your current teaching methodology to determine how it might be enhanced to provide the most beneficial learning opportunities.
- *In other ways, predictive analytics can be used in education:*
  - Specialized support for low-income students, ethnic minorities, and students of color.
  - A deep dive into KPIs with actionable recommendations for improvement.
  - Making wise choices during the learning process.
  - Improvements in student motivation and retention rates are vital to ensuring their success in the long run.

4.14   Case Studies

This section presents case studies (Ekowo and Palmer 2016) on various universities' use of predictive analytics.

Finding at-Risk Students at Temple University Temple University in Philadelphia, Pennsylvania, developed an early alert system based on statistical analysis to anticipate better which students are at risk of dropping out. Peter

R. Jones, the university's senior vice provost for undergraduate studies, was a crucial figure in the system's development. Jones had utilized datasets to make predictions before. For his previous employer, a criminologist, he employed such models to forecast which formerly incarcerated individuals would commit new crimes. Temple's "intrusive, or even forceful, advising," as Jones put it, is provided to students flagged as "at risk" by the university's early-alert system.

Predictive analytics at Temple is similar to the Global Positioning System at Georgia State. Predictive modeling helped Temple administrators discover surprising information about Temple's student body. For instance, they discovered that low-income students who got the federal Pell Grant at its whole reward level had a lower dropout rate than those who received a smaller Pell payment. The highest degree of education a student's mother attained is considerably more predictive of that student's odds of academic achievement than the highest level of education his or her father attained, as was discovered by Temple officials. There was also a significant disparity in the high school dropout rates between students who did and did not take 4 years of a foreign language.

Temple's retention and graduation rates dramatically increased after implementing the early alert system.

- The percentage of students who came back for their second year of high school increased by 12%.
- There was a 24% boost in the university's 4-year graduation rate.
- The percentage of students who complete their degrees within 6 years at the university increased by 11%.

While the initial investment in an early-alert system may seem high, the return on investment is often more than justified, as was the case at Temple University.

Helping Students Select Courses at Austin Peay State University Degree Compass is the course recommendation system used at Austin Peay State University (APSU), a public 4-year university in Clarksville, Tennessee. The program analyzes current students' transcripts against those of previous students (almost 100,000) to provide advice tailored to each individual. Based on the success of streaming services like Netflix, Amazon, and Pandora, Degree Compass helps existing students find the right major and coursework.

The algorithm ranks the courses based on how they will help the student complete her program, using information such as grades and enrolment. The following criteria are taken into account while making course recommendations:

- The suggested order of courses for completing a given degree.
- Their potential for academic success and significance to the university's overall curriculum means they may count toward graduation requirements in more than one major.

To help students choose classes where they have the best chance of succeeding, Degree Compass calculates the likelihood that they will receive a specific grade.

According to university data, students' success at APSU has improved by five standard deviations since the implementation of Degree Compass. For instance, students who receive the federal Pell Grant have had their chances of graduating college improve by 4%.

My Future, introduced in the 2012 academic year, is an additional resource for students deciding to major at APSU. Using Degree Compass's predictive analytics, My Future identifies the majors where students have the best chance of succeeding based on their courses, including courses for all of Austin Peay's majors.

My Future guides fields of study and career outlooks for students who have previously declared a major. Students who have not declared a major might use My Future to see which fields they would be most successful in.

More than 40,000 students have had access to Degree Compass since its debut at Austin Peay University in 2011.

Adaptive Learning at Colorado Technical University Career Education Corporation, a publicly traded company, owns Colorado Technical University (CTU), making it a for-profit institution. It focuses on providing online education at all levels, including undergraduate, graduate, and doctoral programs in business, nursing, and information technology. In 2012, CTU began testing adaptive learning in introductory-level science and mathematics classes. The university claims that its intellipath adaptive learning system evaluates what students already know, predicts what they need to learn, and provides them with that knowledge as rapidly as possible.

To create intellipath, CTU collaborated with Realizeit, a leader in adaptive learning. Intellipath leverages CTU faculty-created personalized content and Realizeit's Adaptive Intelligence Engine to tailor instruction to each student's strengths and weaknesses. The Adaptive Intelligence Engine at Realizeit utilizes machine learning to learn individual students' skills and thought processes as they interact with the tool.

Officials said using intellipath led to higher test scores, more active class participation, and higher student retention rates. They claim that by using intellipath, an additional 27% of their students successfully finished Accounting I; 95% of those who enrolled in the course ended up taking it, and the average grade earned by those students increased from 69% to 79% (a very high C). Furthermore, the passing and staying rates in Accounting II and III increased.

In 2015, CTU had 63 courses and over 34,000 unique student users of intellipath. Over August 2016, over 30,000 and 28,000 online students used the technology. CTU trained students, staff, and almost all faculty on intellipath. This process did not happen overnight. According to Connie Johnson, chief academic officer, and provost, it took about "four years to reach 15 percent of its total course offerings" at CTU.

Proprietary Predictive Modeling at the University of South Florida USF (University of South Florida) has been committed to student achievement since 2010, dramatically increasing its retention and graduation rates through several

initiatives. By 2012, most of the reforms and new policies had been implemented, and progress had halted, with retention and graduation rates being around the same.

Interest grew in utilizing data to foretell first-year student persistence as a means of moving the needle. Student Affairs professionals have been using an in-house strategy to identify at-risk student populations, coordinating interaction with them through its staff and student employees like Resident Assistants, and developing specialized programming to pique their interest.

Following the success of in-house modeling, USF officials realized the value of using data to learn about the patterns and habits among the student body. In 2014, the institution contracted with Civitas Learning, a leader in the field of higher education technology, to implement a predictive analytics platform that would create predictors of persistence for all students to broaden its programs and increase its retention rates.

Using data from the university's student information and learning management systems, Civitas' cutting-edge predictive analytics modeling software identifies at-risk students in real-time, allowing the institution to assist them better and keep them on track for academic achievement.

4.15 The Benefits of Predictive Analytics in Higher and Further Education

The ability to quickly access and understand data on outcomes and accomplishments is crucial to the strategic planning of any educational institution, and this is where predictive analytics can be a powerful tool. Although predictive analytics results are not immediately apparent, their value cannot be understated. Improvements in quality across the board are an undeniable outcome of a more comprehensive and methodical approach to data use.

There is little doubt that higher quality control throughout the organization is driven by a more comprehensive and methodical approach to data use. Predictive analytics' many advantages in postsecondary education include the following (Fisher and Mulroy 2021):

- Providing stakeholders with the data they need to make educated decisions at the strategic level.
- The process of distilling data into understandable evidence, reports, and dashboards for dissemination to decision-makers.
- Contributing to overall institution-wide performance management planning.
- Monitoring academic progress and increasing awareness of potential dangers allows for early, well-informed intervention.
- Building models to learn how different factors contribute to students' final grades.
- Finding and helping students in danger of dropping out or not performing up to their potential is a top priority.

- Bringing attention to underserved areas by analyzing broad patterns of student achievement and speculating on where further resources are needed.
- Gaining a deeper familiarity with usage patterns might help you run your services more effectively.
- Consolidating funding and improving services to enhance the educational experience for students.

4.16 How Colleges Should Go About Selecting a Predictive Analytics Vendor

Universities use models more frequently to forecast student behavior and implement corrective measures. Because of this, it is more crucial than ever to pick the best vendor to work with on projects that require a collaborative effort. Using predictive analytics through a partnership with a vendor is no different from buying any other technological product. However, the complexity of the algorithms and the forecasts they provide adds another layer to the decision-making process.

Today, many colleges select vendors through informal networks. Colleges can learn about the vendors' client retention rates by talking to other colleges about their experiences. However, colleges must also weigh some moral weights in this age of big data.

The best predictive analytics services will promote responsible data use across the educational spectrum. Vendors who check that data are comprehensive and integrated correctly can reduce the likelihood of incorrectly identifying students. They can be open and honest about their algorithms and conduct experiments to determine whether they disproportionately affect specific student populations. When protecting students' personal information, they can be lenient with permits and employ acceptable security methods. They can aid in assessing programs to ensure that no subsets of students are harmed. Further, they can educate employees on correctly understanding data and the perils of unconscious bias.

Of course, not all vendors operate in this manner. Some researchers have claimed that their algorithms and models are unique. Regarding data integration, many people only accomplish the bare minimum. Some people do not care about students' right to privacy and safety. However, many oppose both assessment and development.

This section (Palmer 2018) intends to equip administrators with the knowledge to examine and evaluate predictive analytics vendors effectively. It will ensure that vendors ethically use early warning systems and other forms of predictive analytics.

Do Your Analytics, or Hire a Vendor? Once colleges have determined their data-use capabilities, they should proceed with the following steps:

- *Cost:* Does your college set aside funds specifically for this?
- *People:* How well do your various offices (registrar, financial assistance, academic advising, registrar, and IR) work together? Can we expect college administration to back efforts to alter institutional culture to better use data?

- *Level of analysis:* In what ways have data analytics been explored thus far? Can you effectively connect with other colleges using analytics and ask about their experiences?
- *Institutional capacity to act on the data:* If your college cares about student performance, how much experience do you have using data to make decisions?

You Have Finally Settled on a Vendor Partnership *Colleges have varying requirements based on their aims and profiles when looking to work with a predictive analytics vendor. These requirements, too, will evolve with time. Schools must consider technological and ethical factors to guarantee that the vendors' data and tools are adaptable enough to meet those requirements. Please ensure the data and tools can be adjusted to fit your need*s.

- Determine the degree of tool integration.
- Assure true interoperability.
- Determine data needs.
- Set goals for the future.
- Check the interface.
- Ensure that these tools are easily accessible.
- Plan out the implementation timeline.

Ensure Transparent Use of Data For colleges, one of the most challenging parts of selecting a predictive analytics vendor is being unable to inspect the inner workings of the vendors' algorithms. The system's administrators are interested in learning more about the prediction process but are unsure of the types of answers to expect. Administrators without a technical background may be particularly confused by salespeople who do not fully understand the system and do not know what questions to ask to get the information they need about the algorithm. Due to a lack of shared knowledge between the vendor's technical personnel and the university, missteps are more likely to be made. There should be some accountability for the algorithms colleges use, so knowing how they function is an ethical obligation. There are a few things universities should require their vendors to disclose about their algorithms:

- Inquire about the data that was utilized in the prediction.
- Enquire about training data.
- Inquire about the model's effectiveness.
- Ask that vendors do tests on their algorithms.
- Request for a Disparate Impact Analysis.
- Inquire about what factors cause the prediction.
- Inquire about the frequency of algorithm updates.

Concerns with Predictive Analytics Vendor Agreements Colleges, like any vendor, should check that any contract with a predictive analytics firm adequately safeguards student privacy and keeps college ownership of collected data. It is crucial when dealing with vendors who rely on cloud services. Even though FERPA sets a floor for compliance, additional factors must be considered when selecting a

vendor. There are a few things that administrators should bear in mind, even if institutions' legal and IT departments likely know what contracts with vendors should look like. This is not an all-inclusive checklist, but it covers some essential points:

- Who owns the data after it has been cleaned, after it has been reused, and after it has been created as a byproduct?
- The practice of changing vendors.
- Vendor bankruptcy, closure, or acquisition.
- Using external suppliers.
- Disaster mitigation, recovery, and breach plan.
- Commitment to service standards.
- Security.

Ensure Security and Privacy   Ethical data use and vendor selection depend on the presence of privacy and information security safeguards. Typically, CIOs and IT teams are aware of the criteria that must be met by vendors in order to gain access to student information. The Higher Education Cloud Vendor Assessment Tool has over 300 data security and privacy questions that vendors must answer. However, non-technical decision-makers should have a few considerations in mind. All concerns about a vendor's administrative, technological, and physical security and privacy protections should be answered. It may hint that they must further investigate their security and privacy procedures if they have trouble responding to these questions.

- Administrative safeguards.
- Technological safeguards.
- Physical safeguards.

The Promotion of Research and Evaluation Efforts   Colleges that use predictive analytics will consistently work to enhance their intervention procedures. However, the tools themselves require verification from the outside world through studies.

- Check the product's research base.
- Assist with intervention design and evaluation.

Facilitating the Growth and Application of Professional Skills Among Employees   Implementing a new tool into the daily routines of academics and staff can be challenging. Consider how the vendor will aid in deployment and troubleshooting to determine if they can be trusted to help you overcome this obstacle.

- Implementation consulting.
- Technical support.
- Communities of practice.
- User training.

4.17   Using Predictive Analytics in eLearning

Predictive analytics may sound like a complex and arcane field of study, but its core idea is straightforward. Below, we will discuss how predictive analytics can be applied to eLearning (Edly 2022).

The rising popularity of distance education has contributed to the demand for predictive analytics in educational institutions. Monitoring student progress in traditional classrooms and online learning environments is crucial to guarantee that everyone is learning what they should be.

- *Implementing adaptive learning:* The advantages of online education lie in its adaptability and individualization. Top-notch online education programs recognize that each student learns uniquely. Predictive analytics, which examines historical student data to identify the material, assessments, and learning paths most likely to be successful for an individual student, enables schools to construct adaptive learning measures in this way. Predictive analytics in adaptive learning also enables teachers to identify and swiftly fix their student's weaknesses. Courses can be designed more effectively for individual students by considering their preferred learning environment, assessment methods, and study speed. Learners are also afforded a degree of agency through adaptive learning strategies. Students can select their courses of study, quickly moving beyond the material they already know and focusing on areas where they need more practice. Students are more invested in their education when they have a hand deciding what will be covered in class.
- *Recognizing strengths and interests:* Institutions of higher learning can better cater to their student's individual needs by analyzing data from previous enrollments to identify common areas of interest and academic achievement. The use of predictive analytics in this approach greatly aids targeted academic advising. A student's probable success in future classes can be predicted by analyzing the types of grades they received in their previously taken classes. With this data, schools can better guide students in selecting electives and majors that best serve their professional goals.
- *Addressing performance issues:* Data on student achievement gives schools a rare chance to pinpoint those students most likely to struggle academically. Colleges can use predictive analytics to properly assess whether a student is on track, at risk, or performing moderately by using large amounts of student data. Purdue University's "Signals" project implements this idea; it uses visual cues reminiscent of traffic lights to convey information about a student's performance in a specific course. In another illuminating example, analytics alerts have been used to significantly increase graduation rates at Georgia State University by intervening with students early on.
- *Managing enrollment:* The number of students enrolling in universities consistently rises each year. Institutions need to be sure they are making informed enrollment decisions in light of the high demand for courses with low enrollment caps. Predictive analytics help the pupils and the school as a whole. Predictive analytics can estimate the total number of incoming students, the proportion of

those applying to specific colleges, and the cost of meeting individual students' financial aid requirements. It is also helpful for colleges and universities since it allows them to focus their recruitment and marketing efforts on the students who are most likely to be interested in the programs they provide.

4.18   The Future of Predictive Analytics in Education

Predictive analytics in EdTech is a part of the more significant shift occurring in the educational industry. Let us examine a few current tendencies (Kyianovska 2022) that are likely to have an impact on the market soon:

- The development of tailored education will be aided by predictive analytics. As a result, the trend in education is away from a universal curriculum and toward individualization. In contrast to the latter, which considers each learner's unique characteristics and circumstances, the former was developed with the average student in mind. Teachers and lecturers can better anticipate their students' performance and intervene at the correct times by analyzing their learning habits. Consequently, the learning outcomes for students and teachers will increase thanks to personalized education. The need for flexible learning platforms and adaptable pedagogical resources is only expected to increase over the following years. In addition, these resources will have to cater to the needs of students with special needs, such as those with dyslexia. Individualized education will be almost instantaneous when meeting each student's needs.
- COVID-19 will hasten the spread of data analytics programs at universities. The pandemic highlighted the adaptability of digital teaching methods. These tools, which may include predictive analytics models, can be sufficiently robust to implement distance learning rapidly. Teachers can gain knowledge to assist their students better, while executives and administrators can use the information to make more informed decisions. The educational system was not immediately transformed by COVID-19.
- Nonetheless, it highlighted the importance of digital resources and online education. Using data analytics tools has become increasingly popular in pre-schools, schools, colleges, and universities because it helps them use their resources and create better learning results. As a result, the foundations for a new education model are becoming more apparent.
- As with every technological advancement, predictive analytics will focus on the user experience. There will be a further honing of the algorithms. However, they are insufficient for fully realizing analytics' potential benefits. The administration's reaction to the data discoveries is also crucial to the project's outcome. Increased student retention rates result from using predictive analytics in higher education. This is because universities can better tailor their student assistance programs. In other words, setting up a program to notify the student automatically that "you have earned a low grade in..., you should do..." is not the answer. As part of this effort, the institution should "design" its campus culture so that fac-

ulty and staff are more likely to proactively engage at-risk students and introduce them to available resources.

4.19   How to Prepare for the Future of Predictive Analytics for Education

As institutions become more data-led when making strategic decisions, and as the findings, reports, and insights gained from predictive analytics become more available, many organizations will naturally use predictive analytics.

As more people inside an organization access data, predictive analytics are becoming increasingly important in various settings. Decisions can be made swiftly and efficiently based on evidence, allowing for early action and resolution of issues as soon as they are recognized.

Furthermore, in the future, students may have direct access to the results of reliable predictive analytics. In their education, it might help them make informed decisions by revealing, for instance, the likely employment outcomes of completing specific modules or programs.

Predictive analytics will be crucial in bringing about meaningful change by integrating predictive models into the strategic decision-making process. Predictive analytics is expected to increase in the education sector, leading to the deeper and more precise analysis of student performance data. Predictive models and the data they use to make predictions will develop over time better to suit the specific context of each educational institution.

Predictive analytics is the future, and universities and colleges can get ready for it (Fisher and Mulroy 2021):

- *Intuitively knowing what you want to accomplish:* Think carefully about the information you must collect and analyze to help achieve your organization's strategic goals and improve the student experience.
- *Gathering the right data:* To ensure the success of your predictive analytics models, you will need a reliable and safe internal database to store all of the necessary data.
- *Guaranteeing the optimum data quality:* High-quality data is crucial for reliable analysis. To avoid needing to clean or reformat the data later, you should ensure that everyone in your organization responsible for data collection and input enters the correct data values in the specified format.
- *Selecting the best predictive analytics approach:* Educational institutions can use readily available predictive models that provide quick and straightforward access to their data.
- *Evaluate your predictive model at regular intervals:* The predictive model should be evaluated and validated regularly to ensure it is error-free and to identify and fix any potential problems. Having faith in your organization's prediction models will let you make smarter business choices.

4.20   Conclusion

Opportunities abound for academic institutions in the realm of predictive analytics systems. Institutions of higher education continue to benefit from the improvements in graduation rates made possible by predictive analytics. They can foresee students' results, identifying those at a higher risk of dropping out. Schools can prepare for the future by knowing which pupils require extra support. An individualized training program for educators could help to raise motivation levels. Thereby, universities and colleges can boost their retention rates, student satisfaction, and financial gains.

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