Enhancing Academic Management Through Data-Driven Insights: The Evolution and Impact of Educational Dashboards

[1] Umar Sathic Ali

[1] University of Technology and Applied Sciences, Oman
Corresponding Author Email: [1] umarsathic@gmail.com

Abstract— Higher education institutions are increasingly struggling to deal with large influx of data from multiple sources. This leads to the administrators at academic institutions looking for a software tools which provides an insight into data through the prism of data visualization. An institutional dashboard is an interactive data analytic application that assists university administrator's in capturing, tracking, and consuming data in a meaningful and useful manner. This application incorporates a bunch of data visualization tools to depict the range of administrative activities such as degree program enrollment, course registrations to find the overloaded courses, analyzing the students' grades at the end of each academic semester, tracking student movement inside the campus, instructor's outcome and much more. This study involves the development and deployment of analytical dashboard which facilitates the user to interact directly with the real world data and uses visualization elements such as chart, graph or table with the click of a button to provide quick insights into the data.

Index Terms— Data Visualization, Dashboard, Business Intelligence.

I. INTRODUCTION

The proliferation of digital data from internet devices and technologies coupled with the advent of cloud based storage and computing makes it possible that storing and analyzing the huge volume of data is relatively much easier than ever before. (Buckingham Shum 2012). With the compulsion of online learning and teaching due to the recent pandemic also pivot our academic services to contemporary digital formats. This has led to enormous increase in the quantity of educational data that we generate, store and process such as course enrollment, offerings, and other administrative records. (Long & Siemens 2011).

Though the data that resides in this new formats is useful in itself, but the insights that is derived from these sources excite and astonish the educators at large. This data driven insight offer a novel platform for administrators at academic institutions to enhance the teaching learning process, organizational efficiency and strategic policy making (MacNiell et al. 2014).

Academic analytics is the discipline where the strategic decision making at educational institutions is driven by the adoption of business intelligence methodologies (van Barneveld 2012). This study focus on simulating the academic analytic process and effectively use data-driven decisions for the purpose of bridging the vacuum between the administrator and student. (Howlin 2013). The proposed system incorporates all elements of the management process such as tracking student movement inside the campus, degree enrollment, course registrations, analyzing the distribution of students' grades, instructor's outcome and much more.

Moreover, this paper details the contributions to academic analytics that has been integrated in the proposed dashboard. Data is the key element and play a significant role in making an informed decision making.

The proposed system constantly acquires about each student progress, tracking attendance and movement, course registration and grade analysis. Thus it provides a more personalized and adaptive administrative experience of each individual student and instructors. In addition, the platform uses number of widgets and charts to generate illuminous illustrations which goes far beyond the conventional way of depicting the data. The system acquires data from multiple data sources and integrates its usage from different perspectives, and do the necessary analytics into the administrative process to infer meaningful insights and experience.

At any point in time, the system has complete access to student and instructor's data that an institution might require and dive deep into the data by performing higher level operations such as drill down and mashup. This offer gaining of new insights and patterns, proven relationships between data points at any level, from the individual staff or instructor and institutional level analysis. The major theme of this study is that we will illustrate the academic analytics on specific course along with the required visualizations representing the insights. The sample data was collected over the past successive instances of the course offerings and enrollments and includes around 20000 enrollments which spread across different campuses.

II. BACKGROUND

A dashboard is a business intelligence tool that contains numerous widgets and charts to depict the data in order to accomplish organization objectives (Pauwels et al., 2009). Higher education institutions are highly regarded as places where in data and knowledge are disseminated. However, the surge in the amount of data influx at these institutions cause a bottleneck for the academic management. (Roberts, Chang, & Gibson, 2017). Many higher education institutions recognized the need of adopting technological platform for continual pedagogical transformation and teaching. In this connection, many studies have been already explored to analyze the data generated from the educational sources and converting such data into visually insightful dashboard using business intelligence tools. (Baker & Inventado, 2014). Higher education institutions have witnessed a massive surge in the development of such tools in the recent years. These tools look into many aspects of educational process such as course enrollment, grade distribution, student retention, tracking movement etc. Educational dashboard development is complimented by the fact that the data is more adaptive and quantifiable than other sectors like business. (Shelton, 2010). Many programs offered in the educational domains have relatively simple metrics such as students enrollment, dropouts, registration, grade point average and degree awarded. These matrices are easier to gather and manipulate than the metrics in other domains. (Alcorn et al., 2006).

This study explored the myriad of issues in design and development of dashboard framework in academic institutions. (Sarikaya, Correll, Bartram, Tory, & Fisher, 2018) . The issues are ranging from data loading, specification of matrix used in the dashboard, interaction of data within the dashboard in order to optimize its architecture and fine tune the responses generated for the user interaction. (Sujaritha & Kavitha, 2020)

III. METHODOLOGY

An institutional dashboard plays a key role in monitoring and gauging the institution's educational resources for optimal performance. In this study, we are attempting to introspect the following key performance indicators (KPI) through dashboard technology in order to identify and rectify the potential problem areas in academic management.

- Percentage of undergraduate students admitted in different programs
- Percentage of graduating students relative to the total number of admitted students
- Analyze the grade distribution of all courses offered in any particular semester.
- Tracking the movement of students and groups inside the campus.
- Performance level of students who comes from the different regions of sultanate.

Though, we understand the process involved in the construction and deployment is a complex and time consuming in nature. However, the successful implementation depends on carefully crafted methodology or step-by-step procedures. We followed the following steps in the implementation and ensured that each step performs the intended purpose in logical sequence.

- Plan
- Requirement gathering
- Design
- Build and validate
- Deployment

In the planning phase, we defined the scope and objectives of our proposed dashboard. This step involves identifying the key indicators of the primary customers, data sources and defining the roles of the key stakeholders and setting the realistic goals in order to balance the expectation and affordability.
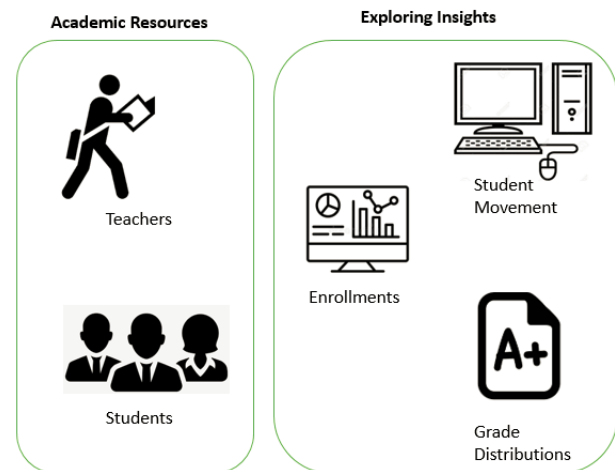

Fig 1. Overview of tasks in the proposed system

In requirement gathering, we interviewed the concerned stakeholders and collected their requirements and mapping of their requirement to the pre-established KPI within the scope of the dashboard construction. We explored the available tools and technologies for dashboard development and incorporating them well in the project prototype to meet the user expectations. We leverage the python based software library called plotly as our tool to implement dashboard construction and deployment.

The next major step in the development cycle is design phase, wherein we incorporated the following design aspects.

- Design and refine the appropriate user interface and data influx
- Establish the required data sources for each data element
- Define the data retrieval queries for each data element
- Determine filters, drill paths, slicing and data mashup.

The design phase is followed by build and validate phase, in which actual implementation process begins and involves the following steps.

- Front-end development – build the appropriate user interface screens with the required chart and graphs. Trade off the right kind of chart to best fit the data and doing aggregation of data if possible for cross analysis of data.
- Query implementation – creating the necessary queries which are identified in the previous phase. in order to check the right data is retrieved for the given task.
- Configure query and security – To ensure the content of dashboard is fresh, established queries ne dot be configured and executed frequently. Also ensuring data sources remains intact during query execution without violating integrity and security constraints.
- Dashboard validation – The final step in life cycle is validation which ensures the dashboard operation meets the expectation of primary and secondary stakeholders within the scope of the project.

IV. IMPLEMENTATION AND EVALUATION

The final version of the dashboards is implemented in the participating educational institutions. Training sessions are conducted to ensure that users are familiar with the dashboards and can effectively utilize them.

The study acknowledges potential challenges such as participant recruitment, ensuring data privacy and security, and addressing the diverse needs of different user groups. Additionally, the study's scope may be limited by the specific educational contexts and institutions involved, which may affect the generalizability of the findings.

By employing a rigorous mixed-methods approach and focusing on user-centered design principles, this study aims to develop educational dashboards that are both effective and user-friendly, ultimately enhancing educational outcomes and supporting data-driven decision-making in education.

V. RESULTS AND DISCUSSION

The evaluation of our proposed system reveals several key findings, these key findings are summarized as follows:

User Satisfaction: The majority of users report high levels of satisfaction with the dashboards. Educators particularly appreciate the ability to track student progress in real-time, while students find the dashboards helpful for managing their own learning.

Usability: Usability testing indicates that the dashboards are generally user-friendly, with most users able to navigate and find the information they need without difficulty. However, some areas for improvement are identified, such as the need for clearer labeling of certain features and enhanced interactive elements.
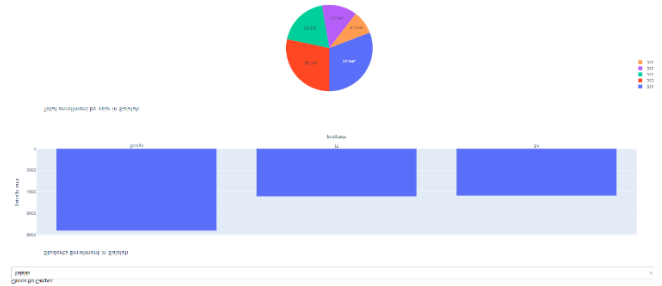

Fig 2. An use case showing the admission trends in various governorates

Educational Outcomes: Statistical analysis of student performance data shows a significant improvement in grades and engagement metrics post-implementation. Retention rates also show a positive trend, suggesting that the dashboards contribute to keeping students engaged and motivated.

Comparison with Existing Solutions

Compared to existing solutions, the developed educational dashboards offer enhanced features and better usability. The integration of advanced analytics and user-friendly design principles sets them apart from traditional dashboards that often focus solely on basic data reporting. The use of artificial intelligence and machine learning for predictive analytics provides a significant advantage, allowing educators to identify at-risk students and intervene proactively.

Implications for Practice

The findings have several important implications for educational practice. First, the positive impact on student performance and engagement highlights the potential of educational dashboards as powerful tools for enhancing learning outcomes. Educators can use these insights to tailor their teaching strategies to meet individual student needs more effectively. Additionally, the high levels of user satisfaction suggest that such dashboards can foster a more data-driven culture in educational institutions, encouraging both educators and students to make informed decisions based on real-time data.
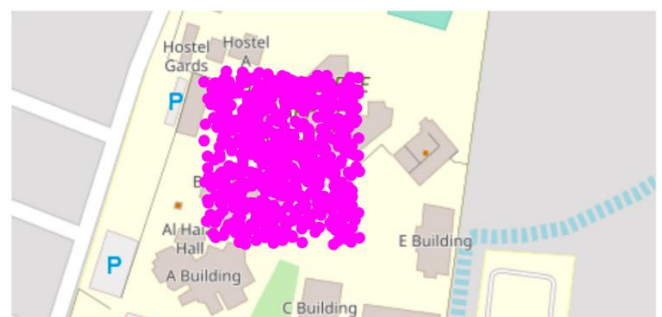

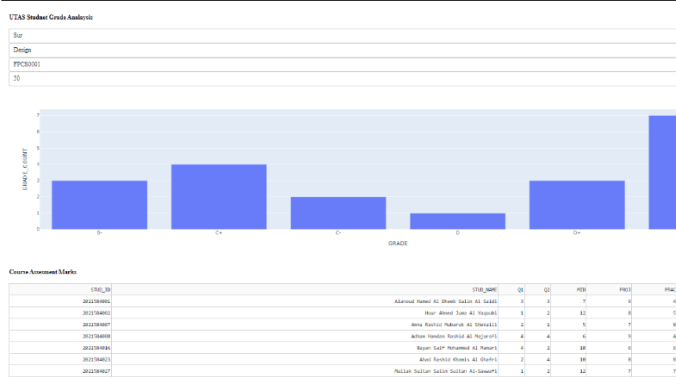**Fig 3.** An use case showing the movement of people inside the campus

Fig 4. An use case showing the grade distribution

Limitations: Despite the promising results, this study has several limitations. The participant sample, while diverse, is limited to specific educational institutions, which may affect the generalizability of the findings. Additionally, the evaluation primarily focuses on short-term impacts; long-term effects on educational outcomes and user engagement remain to be explored. The potential for data privacy concerns also needs to be addressed, particularly as the dashboards handle sensitive student information.

VI. CONCLUSION

Data visualization tools such as dashboard offers a high level data driven insights into the large influx of organizational data. Higher education institutions cater its needs such as course enrollments, degree awarded, grade distribution through dashboard either building on its own development tool or use an off-the shelf software packages. In either case, the approach would offer an edge over the conventional way of handling and depicting the data. Detailed data analysis on any academic activity can be quickly done and reported with adequate visualizations. In addition, the dashboard increases the robustness by adding capabilities such as drill down and data mashup to identify the potential problem areas in educational process. In conclusion, the development and implementation of educational dashboards represent a significant advancement in the use of data-driven tools in education. By focusing on user-centered design and leveraging advanced technologies, these dashboards have the potential to greatly improve educational outcomes and foster a more informed and responsive educational environment.

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