

Students' performance evaluation in higher education using data visualization techniques

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Abstract

Assessment is a process that produces information for educators that they may use to make decisions regarding students' learning. Nowadays one of the great difficulties that educational institutions face, is the increasing growth of educational data and the use of it to improve the quality of making decisions in regard to education. Data visualization methods help to create useful and valid analyses from higher education databases. They also ensure students maximize their academic output. Here we present the evaluation of students for different subjects, graduation levels, student enrollment and by the use of data visualization techniques we make an analysis of the study results. We show the importance of data visualization in data analysis which has a significant impact on the accuracy of the predicted results.

Keywords: *Data Visualization, Higher Education, Knowledge Discovery.*

Introduction

Nowadays by increasing the importance of information in all sectors, illustrating data in an interactive way helps those who make decisions understand and analyze effectively and big amounts of information in no much time. Students are the main assets of higher education Institutions. Student outcomes play an important role in producing the best quality graduates and post-graduates. They will become the leaders and workers of their countries, and thus they will be the source of their country's economic growth and social development. Academic results are one of the main factors that employers use to recruit workers, especially in the case of recent graduates. Thus, students must place great effort in their studies to obtain good academic results to fulfill employer demands. Information coming out of visualization, as a way of presenting different data types in a form that is easier to take in, is growing increasingly in various areas (Zentner et al.,

2019) and one of them is higher education. Some visualization techniques involve plots or graphs, tables, diagrams, or multidimensional renderings. Data is always increasing in quantity and becoming integrated into our daily lives that makes visualizations more and more necessary. For higher education institutions whose purpose is to contribute to quality improvement, the success of human capital creation is the subject of ongoing analysis (Zentner et al., 2019). The purpose of this study is to use data visualization for student assessment, enrollment and graduation. Also to see how this visualization affects the decision making by professors, administrators or leaders of the educational institution. In order to do this we do the visualization of student data regarding their assessments in various subjects, their graduation in years and their registration in years. From year to year there are changes and thanks to the visualization pedagogues, management, etc. take action to improve the situation. Pedagogues in order to increase the students' performance intervene in the curriculum and also administrators improve marketing campaigns, based on legislation or guidelines of the relevant ministry. This paper has the following sections: Section 2 describes the relationship that exists between data visualization and higher education. Section 3 contains the description of the dataset and the methodology. Section 4 contains the results of the application of methods of data visualization. In section 5 the conclusions are discussed.

Data visualization and how it is used in higher education

The primary purpose for data visualization is to assist people with processing large amounts of information. Data volumes are large and human cognitive capacities to remember and understand data are limited (Mohd et al., 2010). Data visualization should be made to simplify visualization as much as possible to help people make more effective decisions. Put simply, data visualization is a method of producing an output so that all problems and solutions can be clearly seen by domain expert (Donohoe et al., 2020). In general, visualization techniques are great tools that can assist people to understand information. Visualizations can help make difficult relationships more easily understood and can stimulate visual thinking (Shabdin et al., 2020). Clearly defining academic success is important for predicting academic success in higher education. Klein et al. (2019) have carried out a case study. This included research done at a public university in the mid-Atlantic region of the United States to examine undergraduate use of learning analytics dashboard (LAD) interventions. The results show that student understanding is connected with data relevance, accuracy and context. One

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conclusion of our study is that the material after the interventions that have been made in the curriculum has affected the result of students understanding, a result that is realized through visualization. The study of Akanmu and Jamaludin (2016) included findings regarding the meaning of HEI current data management practices as well as the elicitation of domain policy-makers' explicit knowledge preferences. The data dimensions also assist with making the choice of visualization, interaction and analytic techniques. Starting from the latter in relation to the dimensions of the data we were focused on data related to student assessments, graduation and their enrollment in different academic years, which are numerical data. Information visualization techniques that give the benefits of visual perception are considered as tools for presenting data through the conversion of tracks into visual information (Zotov et al., 2021). One of the visualization techniques used in our study as in (Zotov et al., 2021) is a chart which graphically presents information about students. Information related to their evaluation in various subjects. By using data visualization we can make a better analysis of student assessments. We can also make decisions to improve their performance, to inform students more effectively of their performance on a subject or different subjects of an academic year using visualizations of up to date assessments, comparisons with the average results of the class as a whole, and projections of potential future outcomes. In turn, this might make students change their behavior for the better, based on their observations of the graphs.

Data and Methodology

This study presents the visualization of the evaluation data of the students of the Informatics Applied study program at Logos University College. Microsoft Power BI was used to visualize the data. Microsoft Power BI is a Data Visualization platform that has a focus on the creation of a data-driven business intelligence culture in all modern organizations. In order to carry out this role, it provides self-service analytics' tools, which can be employed to analyze, aggregate and share the data in a useful manner (Ferrari & Russo, 2016).

The data are extracted from the Edu Page system. It is traditionally presented in a tabular format showing the student's score on each subject. There are some benefits of visualizing numerical data in a graphical format and one of them is a more efficient and clearer interpretation of the data (Eberhard, 2021). Based on the extracted data, data sets in excel format are created and through visualization a detailed analysis is made. This analysis aims to make decisions regarding the quality of teaching or interaction in the curriculum. The data that will be visualized

are data that represent the evaluations of students of Applied Informatics. The evaluations are for each subject of this study program.

In this paper are used some data visualization techniques such as charts, graphs and maps.

CHARTS

What is the easiest method to display how one or more data sets develop? It is a chart, of course. Charts have a variety of forms, such as bar and line charts, which may show relationships between items over time. Pie charts can show how the elements or portions relate together within a whole.

A line chart is created by connecting data points within a data series using line segments. Line charts are frequently employed for showing trends in data that vary continuously over a period of time or range (Gandhi & Pruthi, 2020).

MAPS

Maps are another popular technique. They are used for data visualization in a variety of business fields. They help locate elements of relevant objects and areas on geographical maps, building plans, website layouts, etc. Some of the most popular forms of maps are heat maps, dot distribution maps and cartograms (Besançon et al., 2020). Maps are types of visualization used to show what differences are in data through variations in color, size, position, space etc. These charts use color to show values in a way that makes it easier for the viewer to quickly identify trends. Maps are often used for representing topographical and geographical information but they have been used in such way that can exhibit very useful data (Balla et al., 2020).

GRAPHS

The use of graphs provides a general means to transform the data and their relationships into an abstract view for showing complex relationships and improving data comprehension. Meanwhile, graphs can also be adjusted flexibly to answer specific questions based on the distinctive characteristics of the data (Fisher et al., 2021). We demonstrate the effectiveness of graph-based representations by applying them to our data.

Data visualization can improve the use of data in higher education. A variety of different types of stakeholders in the higher education community routinely use data to make decisions. Pedagogues look at student performance data to identify knowledge, gaps, and then adjust syllabi according to instructions. Administrators look at registrations to determine courses and create schedules. Some of the scenarios used in this paper are exam results, graduation levels and student enrolment.

Data visualization- experimental results

Logos University College is a non-profit private academic institution. Logos University College is accredited as an institution and through its organizational structure offers accredited study programs in the first and second cycle. Its study programs are in line with the needs of society and inspire knowledge, innovation, research, practice, employment in the labor market, promotion of human values and culture. Currently Logos University College consists of three faculties: Faculty of Applied Sciences, which has three departments: Department of Medical Sciences; Department of Applied Informatics and Statistics; Department of Health Sciences and Social Welfare; Faculty of Economics with three departments: Department of Finance and Accounting; Department of Management; Department of Agribusiness; and the Faculty of Humanities and Linguistic Communication with three departments: Department of Languages and Literature; Department of Theology and Culture; Department of Pedagogy and Psychology. The institution has about 100 employees, of which 75 are academic staff, including management staff such as rector, deans, heads of departments, etc., and 25 are part of the administration such as learning/teaching secretary, finance sector, human resources sector, etc. Logos University College is dedicated to equip students with individual and professional perspective, extracurricular activities, internships, international nobilities, and career mentoring, as it was based on the Foundation's vision and the Decision of the Senate and the Board of Administration.

In this paper, as we have pointed out in section 3, we are focused on the Department of Applied Informatics and Statistics and on the programming of this department, that of Applied Informatics. To conduct this study we used Power BI software based on the approach and familiarity with its use.

Figure 1. Student Performance Report 2017-2020

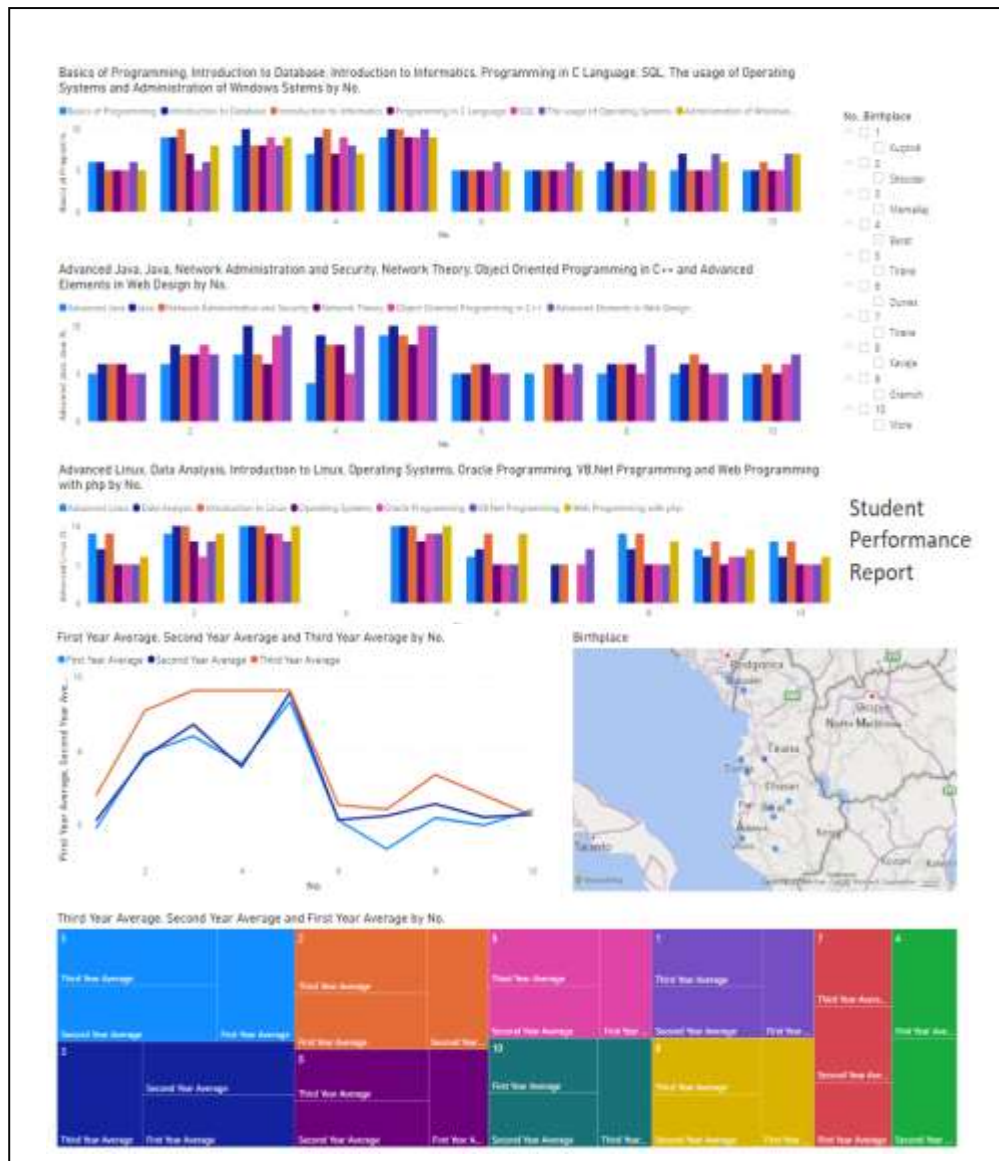


Figure 1 presents the evaluation report for students who have attended studies in the period 2017-2020. The report presents the evaluation for the special subjects that the students have attended in the first, second and third year of studies. The average of each of them in the three academic years is also presented. As can be seen in the figure, the evaluations for the student with code 4 in the third year of studies are missing, because this student did not participate in any exam of that academic year. The map also shows the birthplace of each student.

Figure 2. Evaluation report for the student with code 9 (2018-2021)

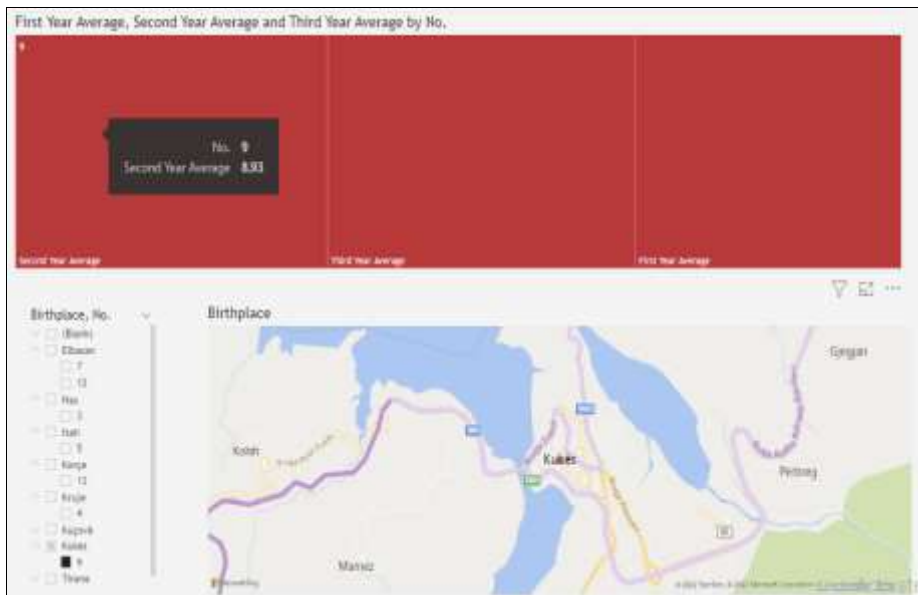


Figure 2 presents the evaluation report for the student with code 9, who is from Kukës and has an average of the second year of studies 8.93. His birthplace is visualized through the mapping technique.

Figure 3. Evaluation report for the student with code 5 (2017-2020)



Figure 3 presents the report for the student with code 6, who is from Durrës and in the course Introduction to Linux, the course developed in the third year of studies is evaluated with a grade of 9.

Based on the visualization of student evaluations for the periods 2017-2020 and 2018-2021 we make an analysis of these visualizations and data regarding

students' evaluation. In the period 2018-2021 the results of students for special subjects and in general are higher because the lecturers of the subjects have made improvements to the syllabi in the following year and these improvements reflect the higher results of students in these years, compared to previous years.

At all levels of education system “dashboards showing student grade histories and status classification points can be useful visualizations for identifying students who appear to be doing well or to be at-risk in particular or general course content areas. Student progress in the past and during the current school year can provide teachers, advisors, and academic coaches with empirical information for action-oriented decision making and timely educational intervention at the individual level.” (Lacefield & Applegate, 2018, p. 5)

Figure 4. Report of enrolled students

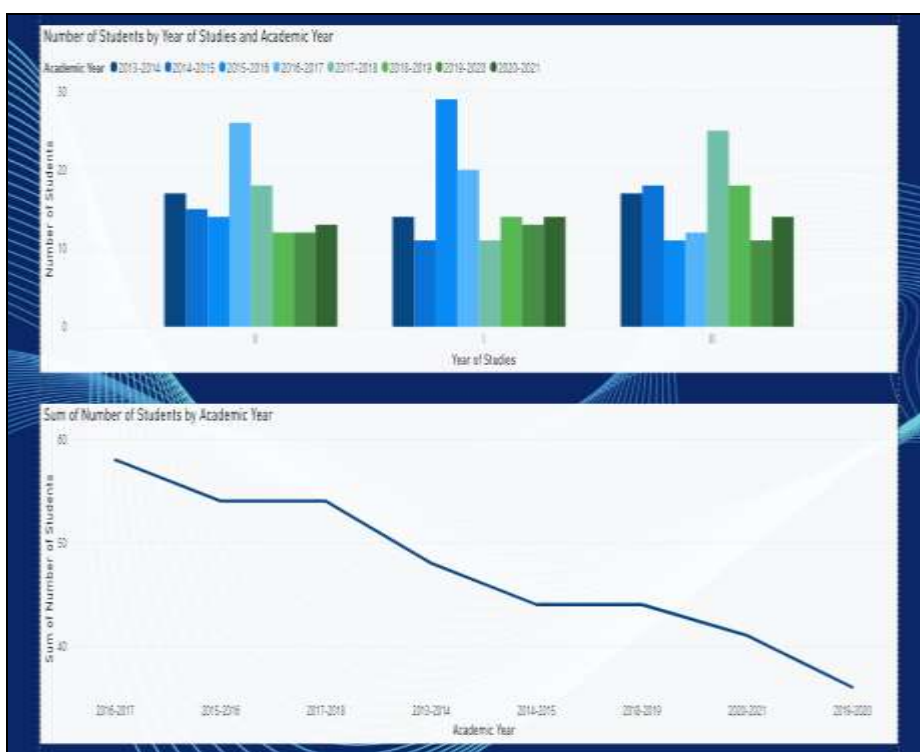


Figure 5. Report of students enrolled in the academic year 2016-2017

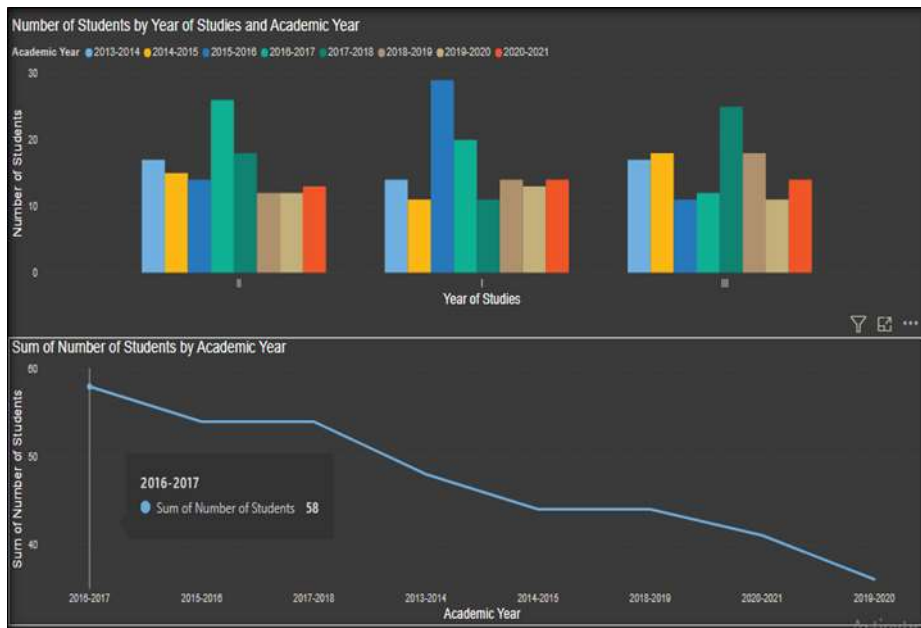


Figure 4 and Figure 5 present the report of student enrollments in the Informatics study program applied in different academic years starting from the academic year 2013-2014 until 2020-2021. Figure 4 presents a detailed enrollment report while figure 5 specifies the number of enrollments for the 2016-2017 academic year which is 58 students divided by years, first year 20 students, 26 students in the second year and 12 students in the third year. It is noticed that over the years the number of enrolled students is declining. There are several reasons for this and an analysis is done for this. One of the reasons is the establishment of the average in high school where graduates who finish with an average greater than 6.5 have the right to continue higher education. This is set for the academic year 2017-2018 and onwards. Another reason is the smaller total number of graduates who compete for higher studies and a part of whom continue their higher studies abroad. This is an analysis of the change in student enrollment in different academic years.

Figure 6. Graduate student report

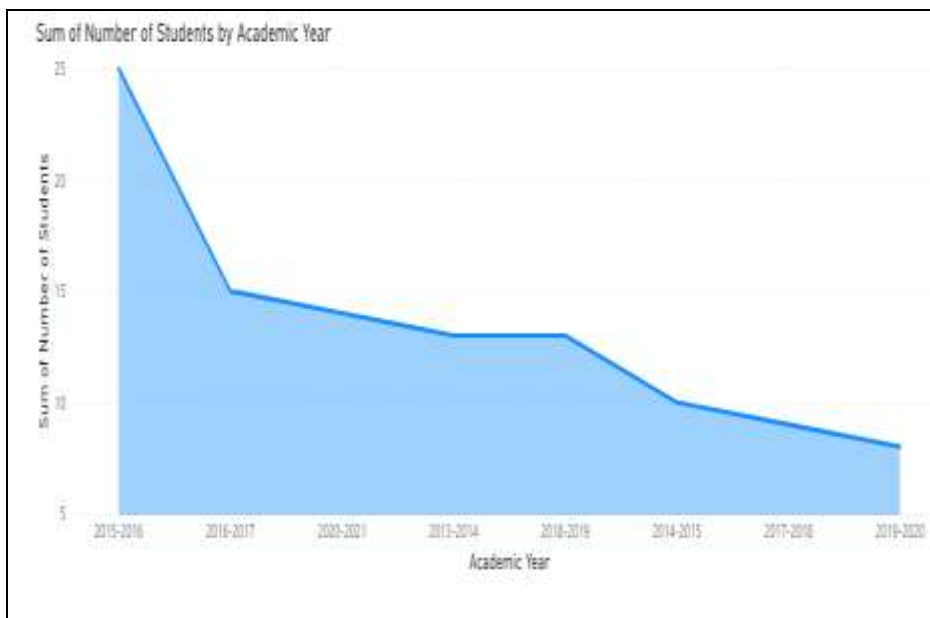


Figure 6 presents the ratio of graduate students in the Informatics study program implemented in different academic years, starting from the academic year 2013-2014 to 2020-2021. It is noticed that the number of graduates depends on their evaluation during the three academic years, as there are students who as a result of poor results have not managed to close the 3-year cycle and graduate at the end of this cycle. This is more clearly evidenced in Figure 7.

Figure 7. Enrolled and graduate students in the 2018-2019 academic year

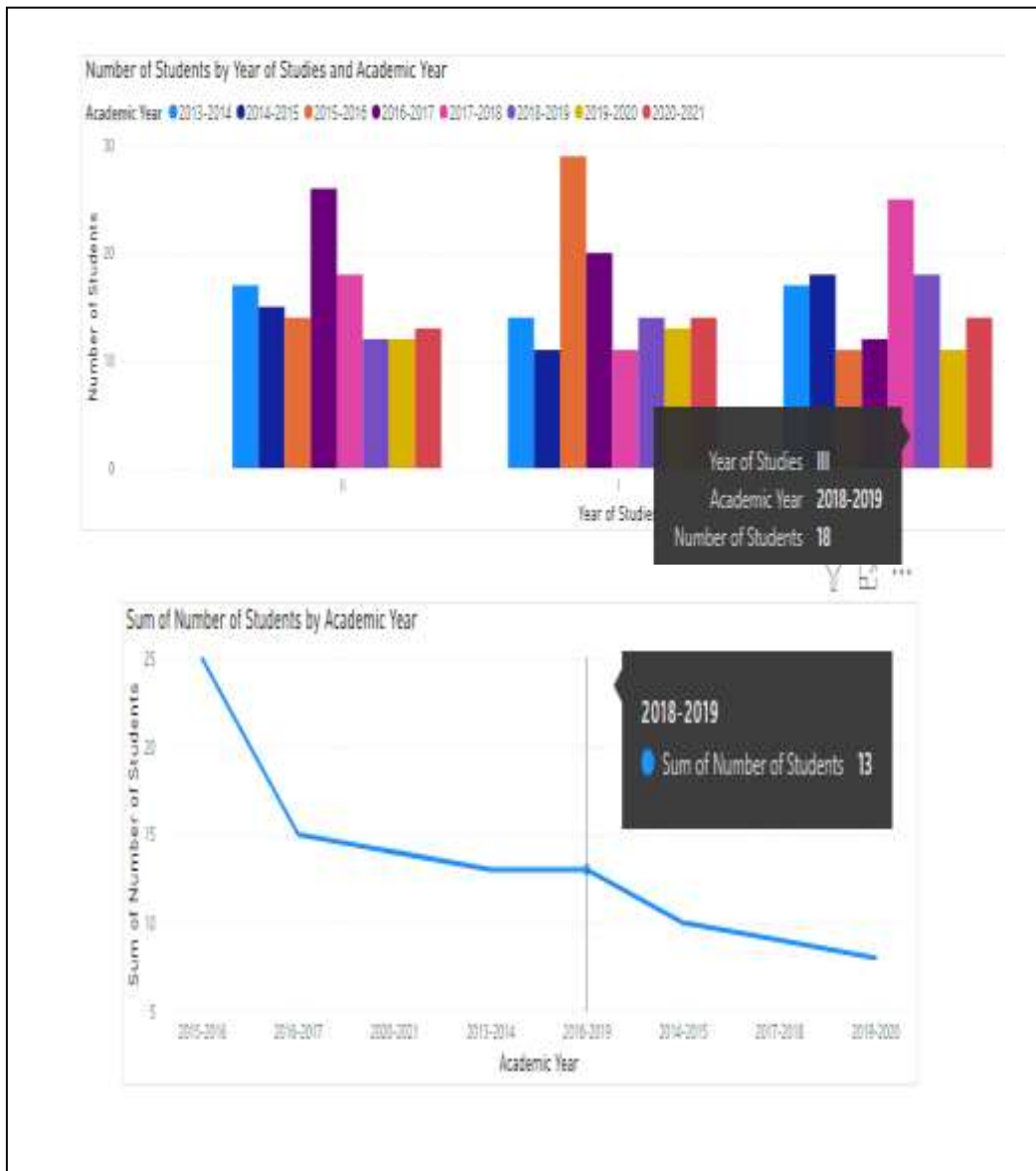


Figure 7 presents a more detailed report for graduate students versus those enrolled in that academic year. In the academic year 2018-2019 in the third year are enrolled 18 students of which only 13 of them have graduated.

Conclusion

This study presents a contribution in the field of data visualization, with a focus on higher education data. This involves designing and creating a data set,

which will be used in data visualization using various visualization techniques. This is about doing data visualization for those who want to have knowledge of the data, interpret it and make decisions from the data. Data visualization can improve the use of data in higher education. A variety of different types of stakeholders in the higher education community routinely use data to make decisions. Pedagogues look at student performance data to identify knowledge, gaps, and then adjust syllabi according to instructions. Administrators look at registrations to determine courses and create schedules.

Decision making is timely as in different academic years the pedagogue improves the syllabus of the course by influencing the performance of students. This is noticed in this study where in the years 2018-2021 the performance of students is higher compared to the years 2017-2020. On the other hand, the management through the improvement of the marketing campaigns has made the number of students in the same years as above to be constant. This is because in the academic year 17-18 in the program of implemented Informatics study in the first year are registered 10 students, in the academic year 18-19 in the first year are registered 14 students, in the academic year 19-20 are registered 15 students and in the academic year 20-21, 16 students are enrolled in the first year. As we can see, there is not much difference, but as we have pointed out in section 4, according to an instruction of the Ministry of Education, the right to higher studies have students who finish high school with an average above 6.5, added here the number of graduates who every year is declining according to the institute of statistics and a good part of them apply to study abroad, factors that have influenced the number of enrollments each academic year.

Through the visualization of data in our study we make an analysis of student results, their enrollment and graduation. The analysis performed leads us to make decisions, both by professors and university administrators. Data visualization in data analysis has a significant impact on the accuracy of the predicted results.

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