

Analysis of "Mathematics Proficiency" Online Course Data Through Process Mining

Sagit Kedem-Yemini
Logistics Department
Sapir Academic College
Sderot, Israel
sagity@mail.sapir.ac.il

Dor Tiram, Shir Berenson, Ifat Menashe and Gadi Rabinowitz
Industrial Engineering and Management Department
Ben-Gurion University
Beer Sheva, Israel

dorti@post.bgu.ac.il, shirbere@post.bgu.ac.il, ifatmen@bgu.ac.il, rgadi@bgu.ac.il

Abstract

A pre-requisite for exact sciences students is to master basic mathematical skills. Since 2016, to reduce the drop-out level of such students, Ben-Gurion University of the Negev offers a "Mathematics Proficiency" online – self-evaluation and training course. The course was developed by the Mathematics department in collaboration with the University's Academic Development and Teaching Improvement Unit. The goal of this study was to classify key learning patterns and characteristics and relate those to student's achievements at the end of the first semester of studies in the faculties of engineering and natural sciences (STEM in general), mainly via process mining and statistical analysis.

Process mining combines data mining with process modeling and analysis to discover, monitor and improve organizational processes by extracting knowledge from event logs available in the databases of organization's information systems. In this research we utilized three leading process mining tools: Disco, ProM and Celonis, combined with R for statistical analyzes. Our analysis relied on the event and self-evaluation logs of the students' online course, without disclosing their personal identity.

After defining the examined population and the research method, an extensive data cleaning was carried out. We had over 25.5 thousand records reflecting 6265 students participating during 3 academic years of activities. Then, process mining tools were applied for modeling as well as identifying behavior patterns, those displayed over 1,100 variants, reflecting student behavior and diversity, Learning those patterns with process mining tools led to definition of 5 main learning patterns. Finally, the effect of the behavioral patterns during the course was examined through students' success, particularly on the average grade in the first semester of studies.

The results show that 72% of the students did not use the on-line course despite recommendation, but from those who did use it, approximately half have performed most of the recommended tests (as per personal recommendation). Statistical analysis indicated that there was no distinct difference between students that studied up to 2 self-evaluation tests before abandoned and students that did not use the on-line course at all. However, significant correlation was found between persistence learning pattern and students' average. Students who have conducted most of the recommended tests (over 75%), achieved on the average, final score higher by 5.4 points (in 0-100 scale) than students who did not perform any tests at all.

Farther statistical analysis showed that the student's behavioral pattern in the Math Proficiency online course was related to the different student characteristics. It was checked by chi-square test for independence in every learning pattern, and gender, faculty, academic year, department and student type – all found with distinct dependence to student behavior.

This study found significant relation between students' behavior on the Math Proficiency online course and their success (reflected by semester's average score) and students' characteristics. While this may help in recommending behavior to students and assessing their success prior to academic studies, it is important to note that there are many variables that influence the student's learning process during the semester. Others can be explored in further follow-up works

Keywords

Process Mining, Mathematics Proficiency, Behavior Pattern, Academic Studies, STEM Education

Biography / Biographies

Sagit Kedem-Yemini is an Industrial Engineer, proficient in information systems and currently holding two lecturing positions: a tenured lecturer position at Sapir Academic College (Logistics Department) and an adjunct lecturer at Ben Gurion University (both in IE&M and Faculty of Business and Management). Her teaching portfolio is broad, focusing on Enterprise Systems implementation (SAP and Oracle Applications) and derivatives of ERP data collection – from Business Analytics to Process Mining. Additionally, she has extensive experience in academic curriculum development, is head of her department's teaching committee and serves as liaison officer to the graduation projects unit. Her research interests include Process Mining and its practical applications, ERP relates issues and DSS development. Since 2015 serves as member of JITCAR Editorial Review Board and since 2019 serves as GJCIE International Scientific Committee Member.

Prior her to academic career, Dr. Kedem-Yemini worked at a global Clean-Room Fab Build-Up Construction Management Company with major clients (such as Intel, Tower Semiconductors, and Teva Pharmaceuticals), where she held various positions, including Logistics Manager, Scheduling Manager and CIO (Chief Information Officer).

Dor Tiram is currently an undergraduate student in the Industrial and Engineering Department at Ben Gurion University. This study was part of his final project for Bachelor of Science degree, and this is his first academic paper. Dor works at an e-commerce start-up company. His professional experience is in the area of fraud prevention and payments.

Shir Berenson is currently a senior in the Industrial and Engineering Department at Ben Gurion University. This study was part of her final project for Bachelor of Science degree, and this is her first academic paper.

Ifat Menashe is currently working at Ben Gurion University's Office of the Rector as an academic performance analyst. Her First degree was in Economics and Statistics, while her Masters was at Industrial and Engineering. Her research interests include implementation of advanced statistics models in information systems. Since 2015, she is Lecturer at Ben Gurion University.

Prior her current position, Mrs. Menashe worked at Adalya Consulting and Management as an economics and statistics consultant, and in the Ministry of Treasury of Israel as a state guarantee referent in the Accountant General Division.

Gadi Rabinowitz's research efforts are devoted towards identifying practical Industrial Engineering problems and developing new interdisciplinary approaches for solving them. These efforts have been focused mainly on: quality engineering and management, production and logistics operations scheduling, optimal inspection and maintenance policies, risk management in product development projects, production queuing networks, and decision support systems for green technology development. His main produce appears in 54 refereed articles, 73 proceeding articles, 43 conference presentations, and 5 national reports of primary health care quality measurement. His research efforts include 25 funded research grants, and advising 15 PhD, 34 MSc graduate students. His current main positions are BGU's Presidential Directorate for Strategic Data (since 2019), an acting member of the CHE steering committee for developing national CRIS network in Israel (since 2016), and incumbent of the Solomon and Abraham Krok Chair in Entrepreneurial Management (since 2017).