

## **SIMILARITIES AND DIFFERENCES OF LEARNING APPROACHES OF STUDENT IN STATISTICS AND MATHEMATICS: A CASE STUDY FROM TURKEY**

Eti Mizrahi<sup>1</sup>, Ayse Aysin Bilgin<sup>2</sup>, Irma Hacinliyan<sup>1</sup>, Gizem Intepe<sup>3</sup>, Sitki Gozlu<sup>4</sup>

<sup>1</sup>Department of Mathematics, Istanbul Technical University, Turkey

<sup>2</sup>Department of Statistics, Macquarie University, Australia

<sup>3</sup>Mathematics Education Support Hub, Western Sydney University, Australia

<sup>4</sup>Department of Management Engineering, Istanbul Technical University, Turkey  
mizrahi1@itu.edu.tr

*Mathematics has been the language of science. In many degree programs such as business and engineering, there is at least one or more Mathematics unit(s). Similarly, with the increased emphasis on data analysis, statistics finds its place in many degree programs too. Mathematics and statistics departments around the world are offering, usually, first year mathematics and/or statistics units to their students. It is common to hear from academics that students are not engaged in such service units. In this study, we investigated students' learning approaches in statistics and mathematics units and identified the similarities and differences between two groups. The results of this study might shed light into curriculum development for such statistics and mathematics units and enable students to choose deeper learning approaches.*

### INTRODUCTION

In recent years, learning approaches of students have been studied in higher education in various disciplines (Biggs, 1987; Entwistle, 1981; Ramsden, 2004). Research showed that the learning approaches adopted by students are related to their conceptions of learning and the unit they are studying (Marton & Säljö 1976). Studies usually focus on two fundamental learning approaches called deep and surface approaches, which are related to students' way of interpreting the instructions and the learning tasks (Marton & Säljö 1976; Cano & Berben, 2009). Surface approaches emerge from an expectation to get the task out of the way with least inconvenience, while deep approaches emerge from a felt need to engage the task properly and meaningfully (Biggs & Tang, 2011). Ramsden (1981) defined a third approach, which is called "strategic approach" that identifies students who seek to maximize their academic performance by effective study. The literature shows that learning approaches are not student specific, but they are subject/course specific. One student can have surface approach to learning in one unit and deep approach to learning in another unit in the same semester (Ramsden 2004).

The learning approaches are also associated with students' conceptions and attitudes toward the unit they are studying, such as mathematics (Crawford et. al., 1998; Mji, 2003, Alkhateeb & Hammoud 2006). Research showed that the perceptions of clear objectives and good teaching are related to deep approach to learning while fragmented conceptions of mathematics were related to surface approach to learning (Cano & Berben 2009). Alkhateeb and Hammoud's (2006) study revealed that students with more positive attitudes toward mathematics engage in more deep approach activities. It is imperative that we understand students' learning approaches in mathematics so that we can influence them to utilize deep approach to their learning if they are not already doing so. Researchers documented that deep approaches to learning enhance students' engagement with their learning and help them to achieve better learning outcomes.

The studies of learning approaches in statistics courses are rare (Bilgin et. al., 2014, Chiesi et. al., 2015) and there are many gaps in the literature about learning approaches of students in statistics courses. Given that in many countries, students' interest in mathematics is declining (OECD, 2017, p.64 & p.66) and statistics, arguably, is thought to be a sub-discipline of mathematics, it is important to understand the similarities and differences of students' learning approaches, if any, in service mathematics and statistics units. This paper will present a comparison of learning approaches of students in mathematics and statistics service courses from a Turkish University based on a larger multinational study on learning approaches in statistics, which also includes students from Australia, Italy, Argentina, Vietnam and Finland.

## DATA COLLECTION

Istanbul Technical University (ITU), which mainly offers engineering degrees, was the data collection site. This university requires students to get good marks from their high school Mathematics and Science units to be able to get a place to study. It is considered to be one of the oldest and best universities in Turkey for engineering degrees.

The participants of the first-year mathematics unit, Calculus I, were surveyed at the beginning of the following semester during their second year mathematics unit in September 2017 while statistics unit students were surveyed at the end of the semester they studied statistics in 2012. Both statistics and mathematics units are compulsory service units that are taught to students from different engineering faculties (such as management, mines and ocean engineering).

Demographic (Bilgin et. al., 2014) and the Approaches and Study Skills Inventory for Students (ASSIST) (Entwistle, 1997) surveys were used for data collection after translating them into Turkish (Bilgin & Gozlu, 2014). The ASSIST (Tait, et. al., 1998) helped us to identify students' learning approaches, by using a five-point Likert scale for 52 statements relevant to learning. These 52 statements form the middle part of the ASSIST. The first part is useful for describing "what is learning?" from students' perspectives based on six statements. The third part uses eight statements to identify student preferences for different types of courses and teaching, that support understanding (related to deep approach) or transmit information (related to a surface approach). The learning approaches scores calculated by using subscales for each approach are, as follows: deep approach (seeking meaning, relating ideas, use of evidence, interest in ideas), surface approach (lack of purpose, unrelated memorizing, syllabus-boundness, fear of failure), and strategic approach (organized studying, time management, alertness to assessment demands, achieving, monitoring effectiveness).

## RESULTS

There were 103 (55% female and 45% males) and 84 (37% female and 63% male) students in mathematics and statistics units, respectively. Pearson's Chi-squared test showed that the gender distribution between the two disciplines was not statistically significantly different from each other ( $\chi^2=2.8$ ,  $df=2$ ,  $p=0.25$ ). Mathematics students were slightly younger (mean age=20.7 years,  $std=1.5$ ) than statistics students (mean age=22.6 years,  $std=1.1$ ). Based on Welch two sample t-test, we found that the difference of the average ages was statistically significant ( $t = -9.8$ ,  $df=174.6$ ,  $p < 0.001$ ). The age differences between the two groups can be explained by the fact that students enroll into statistics unit after completing their first year mathematics unit. Following from that only 6 of the 103 mathematics students had a job during the semester, while more than one third of the statistics students had a job (31 out of 84). Given that ITU draws students from many cities, it is not surprising that the first-year students are in the settling mode and did not have a job, compared to more mature statistics students who might be in their second or third year at the university. Interestingly, more than half of the mathematics students stated that *they liked studying* (58%), while just over one third of the statistics students *liked studying* (37%). A majority of the mathematics (88 out of 103) and statistics (72 out of 84) students stated that they *liked studying mathematics at high school*. While 4 out of 5 mathematics students (82%) stated that they would like to study towards a higher degree after completing their bachelor's degree, only 2 out of 3 statistics students had the same plan (66%).

There were no statistically significant differences between the two cohorts' learning approaches (Table 1). The distribution of learning approaches scores for two cohorts were very similar (Figure 1), although the variability of the scores were wider for mathematics students. The graduates of ITU are highly valued in industry therefore its students are highly motivated and engaged with their learning. That might be why their deep and strategic approaches scores are higher than their surface approach scores.

The results showed that there were no statistically significant differences between girls' and boys' learning approaches in this study ( $p>0.05$  for each approach). However, we found that when students stated that they liked studying, their deep ( $p<0.001$ ) and strategic approach ( $p<0.001$ ) scores were statistically significantly higher and surface approach scores ( $p<0.001$ ) were statistically significantly lower than who did not like studying. This finding was similar to the larger study, which included four other Turkish universities (Gozlu et. al., 2013). Interestingly, if

students stated that they liked studying mathematics in high school, their three learning approaches scores, were not statistically significantly different from scores of students who stated that they did not like studying mathematics in high school (each p value is greater than 0.05). Similarly, when they considered enrolling into a higher degree in the future, they had significantly higher deep ( $p=0.008$ ) and strategic ( $p=0.02$ , not significant after multiple comparisons adjustment) approaches scores compared to students who did not consider the same option, but their surface approaches scores were not statistically significantly different. We also found statistically significant positive association between students' perceptions of how well they are doing in their assessed work (which ranged between 1 and 9) and their strategic learning approach ( $r_s=0.42$ ,  $p<0.0001$ ).

Table 1: The comparisons of the learning approaches between mathematics and statistics

Disciplines	Learning Approaches <sup>^</sup>		
	Deep	Strategic	Surface
Mathematics	57.8 (9.0)	68.3 (11.8)	49.5 (9.0)
Statistics	57.6 (8.8)	66.0 (9.8)	48.1 (8.6)
	$p=0.85^*$	$p=0.17^*$	$p=0.31^*$

<sup>^</sup> The highest possible scores for deep and surface approaches are 80 while it is 100 for strategic approach. \* Welch two sample t-tests.

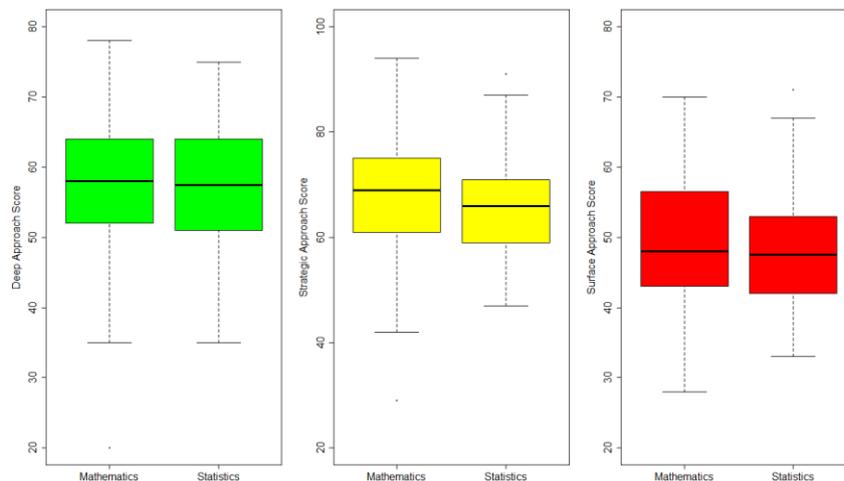


Figure 1: The distribution of learning approaches scores for mathematics and statistics students

Student preferences for different types of teaching and their learning approaches scores were significantly related to each other. We found that the deep and strategic approaches scores were positively associated with a teaching style that *supports understanding* ( $r_s=0.49$ ,  $p<0.0001$  and  $r_s=0.21$ ,  $p=0.007$ , respectively) and that surface approach scores were positively associated with a teaching style *transmits information* ( $r_s=0.21$ ,  $p=0.006$ ).

### DISCUSSION AND CONCLUSION

The aim of this study was to understand students' learning approaches along with the factors that may be related to these approaches in mathematics and statistics and whether they were similar or different. The results of this study showed that students' learning approaches towards mathematics and statistics units were very similar to each other. This similarity can be explained by the fact that students usually considered statistics as a mathematics unit. This may have prevented the students from differentiating between learning approaches in two units. We suspect that this students (mis)conception is due to their high school education where statistics is embedded in mathematics curriculum (the case of Turkey).

Results also showed that students who stated that they liked studying had higher deep and strategic approach scores than who did not like studying. This outcome supports the idea that students who were using deep approach were likely to have positive emotions about learning

(Biggs & Tang, 2011) and also is consistent with the study results of Alkhateeb & Hammoud (2006) who claimed that students who are more positive towards mathematics have engaged in deeper approach activities. Not surprisingly, students who wanted to enroll into a higher degree (82% mathematics, 66% statistics), also had higher deep and strategic approaches scores.

It is important to point out that the participants only came from ITU in Turkey. Since ITU is a prestigious school with country's best students, other universities could be included into future research in order to generalize our findings to the nation.

Given that we found significant associations between different learning approaches and different types of teaching, we plan to investigate the impact of teaching style(s) on learning approaches of students in mathematics/statistics in a future study.

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