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EXPLORING STUDENT EMOTIONAL EXPERIENCES IN MATHEMATICS AND STATISTICS COURSES VIA ONLINE LEARNING

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ABSTRACT

Online learning is now generally acknowledged and seen as a crucial strategy for overcoming the drawbacks of on-campus instruction, particularly in higher education. Online learning adaptability provides students with a wide range of placement options, from on-the-go placements in the midst of their daily lives to dedicated time and space for learning. Since student emotional involvement has been linked to learning and academic success, it is crucial to investigate student emotions. Therefore, this study uses a factor analysis approach to explore the emotional experiences of Universiti Poly-Tech Malaysia (UPTM) students that enrolled in Mathematics and Statistics courses for the academic semester of April 2022. The students have completed a survey-adapted version of the Achievement Emotions Questionnaire (AEQ-S) consisting of 24 items that surveyed emotional experiences before, during and after online classes. Demographic information was collected, encompassing variables like cumulative grade point average (CGPA), online learning tools, internet stability and measurement of students' enjoyment, pride, anxiety, anger, hopelessness, and boredom. A ten-point Likert scale ranging from "strongly disagree" to "strongly agree" measured the respondents' agreement with each item. The result demonstrated that emotions towards an online-based learning system are multifaceted, with three components explored,

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namely "Frustration and Disengagement", "Motivation and Achievement", and "Anxiety and Apprehension".

1.0 INTRODUCTION

Offering online learning environments is a more and more prevalent practice in higher education institutions. They are regarded as a significant teaching strategy in higher education that can get around problems with on-campus learning. Online lessons are available at any time and from any location, and this adaptability provides students with a wide range of placement options, from on-the-go placements amid their daily lives to dedicated time and space for learning (Landrum et al., 2021). It is generally recognized that learning settings affect not only the cognitive but also the emotional and motivational components of learning (AlAteeq et al., 2020; Gaballa et al., 2020). According to Sun & Zhang (2021), students revealed a dynamic shift from worry and curiosity to emotional stability during online learning. It also implies boosting students' social-emotional well-being, as well as encouraging students to self-regulate their emotions while learning online as well as at regular times.

In this study, the emotions towards online learning of 200 students in KUPTM were examined with different academic programs. Factor analysis is applied to analyze the factors influencing online learning among students. In factor analysis, the observed data values are represented as functions of many potential causes to determine which are most significant. The demographic characteristics that were considered were gender, academic program, course details, cumulative grade point average (CGPA), monthly household income, parents' occupation, online learning tools, data connectivity and internet. While the students' emotions were pride, enjoyment, hopelessness, anxiety, boredom, and anger. All data was obtained via an online survey of students within one week.

2.0 LITERATURE REVIEW

2.1 Online Learning

In recent years, online learning has changed the way education is offered and received. Rapid technological innovations have converted traditional classrooms into digital platforms, allowing students to access instructional information from any location. Online learning is generally acknowledged and regarded as a good strategy in higher education, but there is a limited study on how students emotionally experience online learning settings. Higher education institutions are increasingly offering online learning environments as a solution to address the restrictions of on-campus study. It is believed that online learning provides advantages such as reduced travel time and scheduling flexibility for students (Anshari et al., 2016).

Online education has been studied for decades, and effective online teaching is the result of careful instructional design and planning (Ilias et al., 2020; Wang et al., 2013). According to Anshari et al. (2016) and Ilias et al. (2020), learning technology innovations will continue to have a significant influence on teaching and learning methodologies in the future years and increases student accessibility though promotes greater completion rates. Technology mediates the connection between students and teachers, and the design of learning environments may significantly impact learning results (Bower, 2019; Gonzalez et al., 2020).

Although the impact of learning environments on cognitive, emotional, and motivational elements of learning is well understood, acceptance and successful use of learning technologies are critical for realizing their advantages (Stephan et al., 2019). Limited evidence suggests that emotions affect learning in online settings. Further study on students' emotional experiences in online learning settings is required, particularly in education (Riegel & Evans, 2021; Stephan et al., 2019).

2.2 Emotion

Particularly in the area of mathematics education, the adoption of online learning has become more widespread. The emotions of students are crucial in determining how well they learn as they move from conventional, physical classrooms to online settings. Math anxiety is a psychological condition that has received a lot of discussion in educational research because it has a substantial impact on students' performance, attitudes, and general well-being in mathematics education. Math anxiety can also be described as a feeling of disquiet, anxiety, or fright when faced with mathematical activities or problems. It can show itself in a variety of ways, including physiological reactions (increased heart rate, sweating), cognitive distress (fright, racing thoughts), and emotional responses (fear, frustration), which prevent effective engagement with mathematical content (Ashcraft, Mark H., 1994; Biasutti, 2017)

Students' sentiments of disquiet and discomfort when engaging with mathematical knowledge are influenced by several elements, both intrinsic and external, which are complex phenomena that can be altered. Understanding these elements is essential for addressing and reducing pupils' arithmetic fear. Negative experiences with mathematics in the past, such as failures or perceived inadequacy, can significantly impact a student's confidence and contribute to anxiety (Ashcraft & Krause, 2007). It outlines the main causes of the difficulty of abstract mathematical concepts in mathematics, including the teacher's teaching methods and attitude as well as the students' poor comprehension and ability to analyze (Estonanto & Dio, 2019).

Anxiety regarding mathematics has significant effects on math education. In order to lessen anxiety and foster a pleasant math learning experience, educators should be aware of its presence and effects. In the future, studies should examine the efficacy of therapies in various age groups and cultural situations, as well as the neurological mechanisms driving arithmetic fear (Lyons & Beilock, 2012). It discusses how interactive e-learning can be used as a solution to reduce students' math anxiety and develop their mathematical resilience for effective learning. Overall, the paper contributes to the understanding of math anxiety in business and management students and proposes e-learning as a potential strategy to overcome this issue and enhance students' mathematical skills and confidence (Jaggars & Xu, 2016).

Incorporating emotions into online education presents both opportunities and challenges. Individual subjectivity can hinder the effectiveness of emotionally resonant content, as emotions' impact varies among students. Crafting emotionally engaging materials demands significant time and resources, potentially burdening educators and course designers. Striking a balance is vital, as excessive emotional emphasis might divert focus from the core subject matter (Artino, 2012). However, potential drawbacks also arise. Emotions might be misinterpreted, leading to unintended consequences (Pekrun et al., 2017). Inequities can emerge as not all students share the same emotional reactions; overemphasizing positive emotions might alienate those struggling with math-related negative emotions (Hannula, 2019). To harness the benefits of emotional integration, educational platforms must navigate these complexities skillfully, fostering an inclusive and effective learning environment.

3.0 METHODOLOGY

3.1 Sample of Data

This study investigates the emotional experiences of UPTM students enrolled in Mathematics or Statistics courses during the brief academic semester held in April 2022. Despite the transition to online education due to the endemic phase, students' emotional responses were examined using a set of questionnaires administered through a Google Form link. A census study was conducted and a total of 200 students participated in the survey. The study utilized a modified version of the Achievement Emotions Questionnaire (AEQ-S), originally developed by (Bieleke et al., 2021), to assess emotions such as pride, enjoyment, anger, anxiety, hopelessness and boredom. The AEQ-S consisted of 24 items, which surveyed emotional experiences before, during, and after online classes. Demographic information, encompassing variables like gender, academic program, course details, cumulative grade point average (CGPA), monthly household income, parents' occupation, online learning tools, data connectivity and internet stability, was also collected. A ten-point Likert scale ranging from "strongly disagree" to "strongly agree" measured the respondents' agreement with each item. Prior to survey

administration, students received clarifications to ensure item comprehension. To enhance question clarity, comprehension, and overall reliability and validity, a pilot test involving 86 students was conducted. This preliminary phase aimed to refine question phrasing and gauge the instrument's reliability and validity. Employing the Statistical Package for the Social Sciences (SPSS), Cronbach's alpha, a measure of internal consistency, was computed to assess the reliability of the instrument. The outcomes of the internal consistency analysis for all questionnaire items are presented in Table 1, shedding light on the robustness of the scale.

Table 1: Reliability Statistics

CRONBACH'S ALPHA	N OF ITEMS
.783	24

In accordance with the data presented in Table 1, the alpha coefficient corresponding to all items is calculated at 0.783, signifying a substantial degree of internal consistency among the elements under examination. This outcome underscores a notable coherence observed within the components. Consequently, the questionnaire attains a "very good" reliability classification, aligning with the established criterion that considers a reliability coefficient equal to or exceeding 0.70 as an acceptable threshold. (Bonett & Wright, 2017).

3.2 Data Analysis

The survey encompassed twenty-four items investigating emotional responses within the online learning domain. In this study, Factor Analysis (FA) with Principal Component Analysis (PCA) was employed to establish multiple emotional categories, thereby reducing the dimensionality of the variables. Several procedural steps are implicated in conducting this analysis, encompassing the computation of a correlation matrix, the extraction of factors, the rotation of factors, and the subsequent identification of the rotated factors.

4.0 FINDINGS AND DISCUSSION

The study's findings are primarily derived using the Factor Analysis (FA) with Principal Component Analysis (PCA), in which the results were obtained from the Kaiser-Mayer-Olkin (KMO) and Bartlett's Test. The scree plot is then examined to see the eigenvalues that the curve has indicated. This process aids in locating the elements for the extraction of items. The explanation that elaborates on these findings is as follows.

4.1 Kaiser-Meyer-Olkin (KMO) and Bartlett's Test

A KMO test is used to identify whether the factor influences the number of items and measure the sampling adequacy for each item. It is found that the value of the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) equals 0.901, which is above the acceptable threshold value. It is suggested that the value of KMO should be greater than 0.7 (Rasheed & Abadi, 2014). Bartlett's test of sphericity in Table 2 illustrates the value of Chi-Square = 3201.6885, df = 276, and a p-value < 0.000, which indicates that the result shows the correlation matrix is not an identity matrix. Thus, factor analysis was suitable as the significance value of Bartlett's test was less than 0.05 (Shrestha, 2021). Subsequently, the Principal Component was used in extracting the items, and Varimax Rotation was applied to estimate the starting factor.

Table 2: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.901
Bartlett's Test of Sphericity	Approx. Chi-Square	3201.688
	df	276
	P - Value	.000

4.2 Scree Plot

Cattell (2010) has introduced that a scree plot can be used as a graphical tool to determine the number of factors to be formed. The "elbow" is where the curve's slope visibly indicates the number of factors the analysis will generate. This test determines the number of factors that can be extracted from the items used. The scree plot in Figure 1 exhibits the number of components as x–axis and eigenvalues as y–axis. It can be seen that there are three factors of which the eigenvalues are larger than one.

Figure 1: Scree Plot Diagram Showing the Eigenvalues of the Items

4.3 Factor Analysis (FA) with Principal Component Analysis (PCA)

Factor Extraction will depend on the value of factor loading. Objects with factor loadings 0 would indicate a lack of influence of the factor, whereas the value nearer to 1 or -1 will be more likely to influence the variable. In the context of this research, items exhibiting factor loadings exceeding 0.5 are considered valid contributors. Table 3 shows the value of the rotated component matrix based on factor loading value. It can be concluded that item 18, 5, 10, 16, 21, 13, 15, 7, 2, 1, 19 and 9 are classified as Component 1 named "Frustration and Disengagement". Next, items 24, 3, 6, 11, 8, 14, 22 and 23

are classified as Component 2, coded as "Motivation and Achievement". Lastly, Items 17, 4, 20 and 12 are grouped under Component 3 as "Anxiety and Apprehension".

Table 3: Categories of Factors

NO.	ITEM
EMOTION GROUP 1: FRUSTRATION AND DISENGAGEMENT	
18	Thinking about all the useless things I have to learn in mathematics/statistics, makes me irritated.
5	I'd rather not go to the mathematics/statistics class because there is no chance of understanding the material anyway.
10	I feel anger welling up in me during the mathematics/statistics class.
16	I have lost all hope of understanding the mathematics/statistics material.
21	After the mathematics/statistics class, I am angry.
13	The mathematics/statistics class bores me.
15	Because I'm angry, I get restless in the mathematics/statistics class.
7	I feel like going out during the mathematics/statistics class because it is so boring.
2	Even before entering the mathematics/statistics class, I already knew that I wouldn't understand the material.
1	It's pointless to prepare for the mathematics/statistics class because I don't understand the material anyway.
19	I find the mathematics/statistics class fairly dull.
9	I get bored during the mathematics/statistics class.
Emotion Group 2: Motivation and Achievement	
24	Because I take pride in my accomplishments in mathematics/statistics, I am motivated to continue.
3	I am motivated to go to the mathematics/statistics class because it's exciting.
6	I enjoy being in the mathematics/statistics class.
11	I feel good when I am in the mathematics/statistics class, listening to the lecturer's talk.
8	I take pride in being able to keep up with the material in the mathematics/statistics class.
14	I am proud of the contributions I have made in the mathematics/statistics class.
22	I think that I can be proud of what I know about mathematics/statistics.
23	I'm glad it paid off to go to the mathematics/statistics class.
Emotion Group 3: Anxiety and Apprehension	
17	I get scared that I might say something wrong in the mathematics/statistics class, and I'd rather not say anything.
4	I worry about the difficulty of the things I might be asked to do in the mathematics/statistics class.
20	When I don't understand something in the mathematics/statistics class, my heart races.
12	I feel nervous in the mathematics/statistics class.

5.0 CONCLUSION

In conclusion, online learning is significantly influenced by emotions. Negative emotions can undermine the learning process, while positive emotions can increase engagement and retention. This study categorises emotions among UPTM students enrolled in Mathematics and Statistics courses during online learning. Twenty-four items have been grouped under three components based on the students' emotions. In summary, the analysis outcomes show that a set of items, including 18, 5, 10, 16, 21, 13, 15, 7, 2, 1, 19, and 9, form Component 1, characterized as "Frustration and Disengagement ". The following items are included in Component 2, "Motivation and Achievement": 24, 3, 6, 11, 8, 14, and 23. Items 17, 4, 20, and 12 are included in Component 3, "Anxiety and Apprehension," as their name suggests. It is recommended that future research focus on these three components in analysing data. Various data analyses can be conducted, such as multiple linear regression, logistic regression and others. Hence, handling a lower number of variables obtained from the factor analysis method can avoid multicollinearity problems.

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