Exploring the Stress among Students During Online Distance Learning: An Integration of Statistical Approach and Fuzzy Analysis

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Article Info	ABSTRACT
	Education is one of the most affected sectors due to COVID-19 that forced online distance learning to be implemented during the pandemic. However, most students are still coping and struggling with this new method of learning. Hence, the stress and depression arise, consequently affect the student's performances. This is a quantitative research study that was carried out using a structured online survey and a random sample approach. 100 students from UiTM Terengganu, Malaysia are selected for the research sample. A 21-item online survey was used in the quantitative technique to incorporate student stress in online distance learning (ODL). Descriptive analysis is carried out to gauge the student's perception of the challenges that they faced in this type of learning. In this research, the Fuzzy Analytic Network Process (FANP) was used to identify the most influential factors that may cause stress among students during online distance learning. Five factors and twenty-one sub-factors were chosen and studied. The factors were time management, environment of study, resources, and family's as well as lecturer's concerns. The percentage value, which denoted the rank of each factor, was calculated using the FANP. Results show the environment of study was the most dominating factor, which contributed to student's stress during ODL. The findings of this research are useful for different groups of decision makers in education to plan effective strategies for the implementation of ODL.

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1. Introduction

The life and environments of people all over the world have been dramatically changed since the outbreak of the Covid-19 pandemic. The virus was first discovered in Wuhan, China, in December 2019 and eventually has spread worldwide. Due to this, many sectors, including education have received a big impact. Almost two years into the pandemic, educational institutions are still suffering an on/off opening and closure, inhibiting the learning of more than 1.7 billion of students, from primary to tertiary levels[1]. To ensure the continuity of learning, Malaysia's government has implemented an online distance learning (ODL) approach as a new platform of learning to the students. In ODL, educators/students need to interact virtually using any online meeting tools such as Zoom, Google Classroom, Telegram or Microsoft Teams. The advantage is it allows quicker access to knowledge and is available at any time and from any place [2] . However, this new method requires both educators and students to learn and be familiar with the technology, in order to survive the learning process. Students and instructors are required to learn new skills in order to survive online learning. Many students are still coping and adapting to this abrupt transition. The shift to virtual communication reduces much-needed personal contact, which may lead to anxiety and depression among the students. These will later affect the level of student's performances and productivity[3].

It is well known that students, especially college or university students, have many existing problems to be handled including life shifts, personal matters, assessments/assignments, and career exploration [3]. Student's performances are strongly influenced by their ability to manage these matters. Since learning through ODL requires the students to be independent, it is indeed adding up their pressure[4]. There are many factors which may trigger the stress during ODL. The most significant issues are lack of accessibility to internet and digital devices, which prohibits the students from joining the live classes, hindering the proper learning process, and enabling them from completing their assessments, which may later affect their final semester grade. According to [1], the final semester results are the major concern of most students. Hence the frustration, which may lead to stress arises. Apart from internet connectivity and availability of digital devices, other factors which may distract and inhibit online classes are time management, environment of studies, resources, family and lecturer's concerns.

This study, therefore, focuses on the stress caused by the pandemic among learners as they continue to carry out their academic obligations utilising online learning as a tool in furthering their academic efforts in the face of the new normal's societal constraints. The exploratory study seeks to investigate the problems faced by the students during online learning, and determine the most influential causes of stress, and finally figure out the solutions. The research questions are:

  i. What are the problems faced by students in online learning?
 ii. Do students feel stress during online learning?
iii. Which factor contributes most to students' stress?

The main contribution of this paper is a fuzzy based evaluation technique, which used in this research to rank the influential factor contributing to stress among students ODL. Fuzzy based evaluation has been used in many problem domains[5], [6] but limited reports are presented for measuring students' stress in online learning.

2. Literature Review

The transition from traditional teaching to online learning is required in order to enable the learning process to continue. Online distance learning is educating the student remotely while the learner is not physically present in the classroom. While learning is taking place, the learner might attend the class anywhere through their internet such as their houses or hostel. There are e-Learning resources that can be accessed whenever they are needed, so the student does not have to worry about falling behind or being ahead of the rest of the class because there is no class to keep them back. Online learning is a modern sort of distant learning that provides unconventional and underprivileged learners with more access to educational material.

Online learning has positive and negative impacts on education. Distractions are unavoidable since pupils are not in the classroom but rather at home. They may be conflicted between attending lessons and wanting to listen to music, sleep, social media, house chores or do something else. This can lead to poor student achievement. This requires teachers to make their classes more entertaining in order to persuade their pupils to pay attention. He also alluded to hidden expenses and complex technologies. Online classes may save money due to lower transportation and material costs, but there may be hidden costs, such as purchasing software, internet bills and

other computer programmes to support the online sessions. The technology employed may also be complex. Online learning has been linked to stress owing to academic, economical, and social issues[7]. Navigating through the programmes used in online classrooms may be difficult and time-consuming, particularly for younger students and their learning coaches. Both teachers and students are affected by unpredictable or restricted internet access, which directly interferes with students' rights in the huge online education system. Teachers are confronted with the necessity for immediate pedagogical reform, while parents bear the burden of providing various types of assistance for their children's online learning at home. Some students are suffering video conferencing fatigue and are dealing with an abundance of materials and technological time[8].

Stress is an emotional imbalance exacerbated by a variety of factors such sociodemographic characteristics, health status characteristics, and living and learning conditions [9]. Students who did not have access to an outdoor space disclosed high level of stress. Conflicts at home, difficulties isolating, and noisy environments all contributed to the students' stress, regardless of where they lived. Some students claim that learning online is more stressful than learning in a traditional classroom. Professors often compensate for the reduced amount of physical contact by requiring more articles to read or videos to be viewed when their content is moved from the classroom to the hybrid format to the pure online classroom. Attempting to digest abundant information leaves students feeling overwhelmed, frustrated, and discouraged. It can then lead to students losing engagement and connection with the content, making them less likely to engage in hybrid or online courses. Students continue to prefer classroom classes over online classes due to the numerous issues they encounter when taking online classes, such as a lack of motivation, a lack of understanding of the material, a decrease in communication levels between students and instructors, and a sense of seclusion caused by online classes[10].

There is a substantial association between gender stress and characteristics connected to future schooling. Female students were more likely than boys to experience severe despair, stress, and exam anxiety[11]. Studies determined that the quick speed of online courses, the absence of having to physically attend a class, and the difficulties building relationships with other students frequently increased their stress. Students often need one-on-one help and extra support from teachers after class. They don't typically get enrichment like this in person in ODL. Due to this, many students may not be able to grasp the concepts as fluently as they would in a school or university setting. Conversely, the ability to do course work when and where students wished, create a relationship with the instructor, and have questions answered online all had a beneficial impact on students' stress[12].

Lack of confidence and dissatisfaction with grades scores obtained in online learning has a positive relationship with stress level. Highest percentage of stress among students is their uncertainty over the end of semester exams and assessments [1]. They are afraid that they might not do well in their examination since they have a lack of social interaction and less discussion with their friends and need to study alone for their assessment. They don't have their customary circles to depend on face to face. They're passed on to adapt in their home alone.

3. Methodology

A cross-sectional survey was digitally conducted using the students of UiTM (Kuala Terengganu campus) as the respondents. The sampling method applied in this study was convenience sampling, which is practical since the collection of responses can be immediately done[13]. Convenience sampling is the non-probabilistic technique since the sampling frame is impossible to obtain. The link of an online self-administered questionnaire (in the form of Google Form) was distributed through social networking sites such as WhatsApp and Telegram to the students of UiTM Kuala Terengganu. The respondents were encouraged to share the survey links to others. One hundred students from various backgrounds took part in the survey.

The questionnaire consisted of 21 items (sub factor) covering five factors: (1) time management, (2) environment of the studies, (3) resources, (4) family's concerns and (5) lecturer's concern. A 5-likert scale was used where 1 was designated as 'strongly disagree' and 5 was 'strongly agree'. Cronbach's Alpha was calculated to determine the validity of the questionnaire and descriptive statistics was used to characterize the fundamental characteristics of this study.

The fuzzy mathematics was applied in the development of methods of decision making. There are few types of multi-criteria that can be used in the decision-making process, such VIKOR, Analytic Hierarchy Process (AHP) and Fuzzy Technique for Order Preference by Similarities to Ideal Solution (TOPSIS). Specifically, Analytical Network Process (ANP) was used for this research.

Analytical Network Process is a multi-criteria decision making that can solve complex problems. Analytical Hierarchical Process (AHP) was developed by [14] to solve the multi criteria decision making[15]. However, their feedback in AHP was not considered for the criteria. Later in 1996, researchers in [16] developed an Analytical Network Process (ANP) to get a better decision maker. Many decision problems cannot be structured hierarchically because they involve the interaction and dependence of higher-level elements in a hierarchy on lower-level elements. The importance of the criteria not only dictates the importance of the alternatives in a hierarchy, but the importance of the alternatives also determines the value of the criteria. Feedback allows us to factor the future into the present in order to identify what we need to do in order to achieve our goals. Instead of being represented in a hierarchy, ANP then is represented by using a network [17], [18]. ANP has been approved to make a decision model more flexible and easier.

Researchers in [15] have developed two standard Multi Criteria Decision Making (MCDM) approaches: the Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP). AHP structures a decision dilemma as a hierarchy with an objective, decision criteria, and alternatives in multi-criteria decision analysis, while ANP structures it as a network[15]. If interdependent relationships contribute to significant effects on the decision model, ANP is considered as the more reliable method to solve the problems.

3.1 Basic Concept of Fuzzy Set Theory

A fuzzy set A in the universe of discourse $X \{ , x, \ldots . xn\}$ is defined in Equation (1) as:

$$\underline{A} = \{< x, \mu_A(X) > |x \epsilon X\} \tag{1}$$

which is characterized by a membership function in the interval of [0,1]. Therefore, the function $\mu (x)$ is termed as the grade of membership of x in a.

3.2 Triangular Fuzzy Number

A triangular fuzzy number is among the popular shapes of fuzzy number, which can be denoted as A = (a,b,c) and the membership function is given by Equation (2):

$$\mu \bar{A} = (x) \begin{cases} x - a/b - a \, , & a \leq x \leq b \\ c - x/c - b, & b \leq c \leq c \\ 0, & otherwise \end{cases} \tag{2}$$

The significance of factors and sub-factors were assessed using linguistic variables. Language variables at five different levels were used, denoted as "equally important," "weakly important," "strongly important," "very important" and "absolutely important" at five fuzzy scales. Each linguistic variable was given a value. Normally, the scales used to measure the importance of factors and subfactors range from 0 to 1. The conversion of linguistic variables into numbers is shown in Table 1 followed by Chang's extent analysis[18].

Table 1. Linguistic variables and triangular fuzzy

Linguistic scale of importance	Triangular Fuzzy Scale	Triangular Fuzzy Reciprocal Scale	Scale in survey
Equally important	(1,1,1)	(1,1,1)	1
Weakly important	(2/3,1,3/2)	(2/3,1,3/2)	2
Strongly important	(3/2,2,5/2)	(2/5,1/2,2/3)	3
Very strongly important	(5/2,3,7/2)	(2/7,1/3,2/5)	4
Absolutely important	(7/2,4,9/2)	(2/9,1/4,2/7)	5

3.3 Local Weight of Factors

Local weights of factors and sub-factors were calculated using a pairwise comparison matrix based on linguistic scale evaluation. The linguistic scale evaluation was formerly counted by applying pairwise comparison techniques. All linguistic scales were represented by triangular fuzzy numbers

(Table 1). To fulfill the pre-conditions of Fuzzy ANP, no dependencies among the factors were assumed. Chang's extended analysis [18] was applied to compute the local weight for both factors and subfactors as in the following:

Step 1: The value of fuzzy synthetic extent with respect to the ith object is defined as Equation (3):

$$S_i = \sum_{j=1}^{m} M_{g_i}^j \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^j\right]^{-1} \tag{3}$$

Step 2: The degree of possibility of $M_2 = (a_2, b_2, c_2) \geq M_1 = (a_1, b_1, c_1)$ is defined as Equation (4):

$$V(M_2 \geq M_1) = \sup_{y \geq x}[\min(\mu_{M1}(x), \mu_{M2}(y))] \tag{4}$$

Step 3: Compute Local Weight vectors as formulated in Equation (5):

$$W = (d(A_1), d(A_2), .., d(A_{n)})^T \tag{5}$$

and through normalization, weighting vector normalization can be calculated as Equation (6):

$$d(A_i) = \frac{d\prime(A_i)}{\sum_{i=`1}^{n} d\prime(A_i)} \tag{6}$$

Furthermore, the Interdependent Weights of the Factors (IWF) can be calculated based on the degree of relative impact of factors (DRIF) and the normalized local weights factors (NWF) from Equation (6). Thus, the IWF can be calculated as the following Equation (7).

$$IWF = DRIF \times NWF \tag{7}$$

Calculating the Global Weights for sub-Factors (GWF) is formulated as in Equation (8) followed with calculating the percentage of factor (PF) as in Equation (9):

$$GWF = Local\ Weight \times IWF \tag{8}$$

$$PF = GWF \times scale\ value\ for\ each\ factor \tag{9}$$

The last important step is to rank the preference order in such that the highest value of percentage is the most influential factor affected students' stress during ODL.

4. Results and Discussion

This research was conducted to propose a suitable method to evaluate the factors which may contribute to stress among students during ODL. The weights were generated by using data from one hundred students from UiTM Terengganu (Kuala Terengganu campus) who are currently undergoing ODL. The evaluation was measured based on five levels, denoted as 'lowest' to 'highest' according to one's preference. The respondents were required to complete the survey and ranked each criterion. The calculation using the Fuzzy ANP methods reveals the following results for each respondent. The ranking was based on the value of the percentage of factors with the greatest value placed at the top.

4.1 Cronbach Alpha

Cronbach's Alpha was used to determine the reliability of the items used to represent each variable. As can be observed in Table 2, the Cronbach's Alpha values for all factors are greater than or equal to 0.7, demonstrating that there is a good consistency of measured items for all variables [16].

Table 2. Summary of Cronbach Alpha [2]

Factor	Item	Cronbach's Alpha	Reliability
Time Management (C1)	3	0.83	Very Good
Environment of study (C2)	4	0.70	Good
Resources (C3)	6	0.87	Very Good
Family concern (C4)	3	0.83	Very Good
Lecturer concern (C5)	5	0.87	Very Good

4.2 Descriptive Statistics

Based on Table 3, the highest mean was obtained for the sub-factor of 'Different teaching methods by different lectures' with mean value of 3.71. This is followed by 'Distraction' (3.65), 'Lack of focus' (3.55), 'Tight schedule '(3.42) and 'Long time spent on assignment' (3.40).

Table 3. Descriptive Statistics for Sub Factor

Factor	Sub-factor	N	Minimum	Maximum	Mean	Std. Dev
Time Management	Tight Schedule	100	1.00	5.00	3.4200	1.19916
	Long time spent on assignments	100	1.00	5.00	3.4000	1.07309
	Unable to meet the dateline	100	1.00	5.00	3.0500	1.28216
Environment of study	Study Space	100	1.00	5.00	3.2200	1.12439
	Distractions	100	1.00	5.00	3.6500	1.11351
	Lack of focus	100	1.00	5.00	3.5500	1.04809
	Peer supports	100	1.00	5.00	3.2700	1.20483
Resources	Limited learning materials	100	1.00	5.00	3.3000	1.12367
	Corruption of online learning materials	100	1.00	5.00	3.1700	1.29533
	Lack of facilities	100	1.00	5.00	2.0100	1.02981
	Limited software accessibility	100	1.00	5.00	2.7700	1.25412
	Limited data/internet accessibility	100	1.00	5.00	2.7000	1.38170
	Poor internet connectivity	100	1.00	5.00	2.7300	1.27013
Family's concerns	Lack of understandings of family members	100	1.00	5.00	2.6400	1.28330
	No cooperation from parents (students were asked to do house chores)	100	1.00	5.00	2.7200	1.31103
	Sibling's distractions	100	1.00	5.00	2.6300	1.44708
Lecturer concern	Heavy workloads (too much tasks/assessments assigned)	100	1.00	5.00	3.2800	1.06439
	Syllabus cannot be completely covered	100	1.00	5.00	3.1400	1.11028
	Different teaching methods used by different lectures	100	1.00	5.00	3.7100	1.07586
	No proper guidance from lectures	100	1.00	5.00	3.1500	1.14922
	Lack of communications between lecturers and students	100	1.00	5.00	3.1100	1.15378

Majority of respondents agreed that the choice of medium for teaching was not consistent, where lecturers were using different types of online meeting apps such as Google Classroom, Microsoft Teams, Telegram and others to conduct the classes. This has instigated many problems such as confusions as the platform of teaching is not fixed, device problems (as the students have

to install many apps to their devices, which later resulted in slow performances) and also device incompatibilities as not all the students are using a high-performance device.

The students also agreed that ODL, especially at home, may inhibit their learning process, since they have to face many distractions that may divert their focus in class. Some of the students were having difficulties in balancing their responsibilities as a student, while at the same time they had to fulfill other tasks as a child or older sibling. Even if students are engaged in online learning, they are most likely monitoring their social media status, email, text messages, and so on. Several of them also need to run errands for their family. This might make some of the students just ignore the online class. Most of the students also think that their schedule is packed with too many subjects per day, thus they need to spend more time digesting all the information they learned and completing their homework and assignments. Lowest mean was obtained by the sub-factors 'Lack of facilities' (2.01), 'Sibling's distractions' (2.63) and 'Lack of understanding from family members' (2.64). This indirectly suggests that most of the students do have proper facilities for online learning at home and the family members are supportive, in giving the best for their children's education (although some may not, but the percentage is low).

The average means for all factors studied were between 2.78 to 3.49 (Refer Table 4). The highest mean score was obtained for Study Environment factor with the value of 3.49. 70% of the students agreed that 'Environment of study' plays a significant role towards the success of ODL, followed by 'Time management' and 'Lecturer's concerns, with both of these factors contribute to 66% of agreement. Most students disagreed that the 'Resources' and 'Family's concerns' can interrupt their ODL.

Table 4. Descriptive Statistics Factor

Factor	N	Minimum	Maximum	Mean	Std. Dev
Time Management	100	1.00	5.00	3.2900	1.02894
Environment of study	100	1.33	5.00	3.4900	.91435
Resources	100	1.00	5.00	2.7800	.96367
Family concern	100	1.00	5.00	2.6633	1.16582
Lecturer concern	100	1.20	5.00	3.2780	.90023

4.3 Numerical Application

The pairwise comparison matrices of factors were constructed based on a survey involving students of UiTM (Kuala Terengganu campus) as the respondents. The results were calculated by taking the geometric mean of individual evaluations (Refer Table 5).

Table 5. Pairwise comparison matrices of factors

	C1	C2	C3	C4	C5
C1	(1.0000,1.0000, 1.0000)	(0.9524,0.9519, 0.9723)	(1.1079,1.0647, 1.0600)	(1.1423,1.0885, 1.0902)	(1.0335,1.0118, 1.0104)
C2	(1.0285,1.0505, 1.0500)	(1.0000,1.0000, 1.0000)	(1.1633,1.1185, 1.0902)	(1.1994,1.1435, 1.1116)	(1.0851,1.0629. 1.0494)
C3	(0.9434,0.9392, 0.9026)	(0.9173,0.8941, 0.8596)	(1.0000,1.0000, 1.0000)	(1.0310,1.0224, 1.0197)	(0.9328,0.9503, 0.9626)
C4	(0.9252,0.9187, 0.8754)	(0.8996,0.8745, 0.8337)	(0.9807,0.9781, 0.9699)	(1.0000,1.0000, 1.0000)	(0.9047,0.9295, 0.9440)
C5	(0.9801,0.9884, 0.9676)	(0.9529,0.9408, 0.9215)	(1.0389,1.0523, 1.0720)	(1.0593,1.0759, 1.1053)	(1.0000,1.0000, 1.0000)

After that, the values of synthetic extent of factors were calculated (refer Table 6). The fuzzy synthetic values were compared with other factors to obtain the probability level of each factor. Percentages of factors were being determined by multiplying the global weight of factors with the scale value (Refer Table 7). The scale value was determined according to the level of preference.

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Table 6. Synthetic of factors

Factor	Value of Fuzzy Synthetic Extend of Factors
C1	(0.2071, 0.2042, 0.2064)
C2	(0.2166, 0.2145, 0.2132)
C3	(0.1909, 0.1918, 0.1908)
C4	(0.1863, 0.1876, 0.1859)
C5	(0.1990, 0.2018, 0.2037)

Table 7. Percentage of factors

Factor	Global weights	Linguistic evaluation	Scale value	Percentage
Time Management	0.0880	Medium	0.5	0.0440
Environment of study	0.1420	High	0.75	0.1065
Resources	0.0125	Medium	0.5	0.0063
Family concern	0.0000	Medium	0.5	0.0000
Lecturer concern	0.0453	Medium	0.5	0.0227

Table 8 tabulates the preference orders of ranking of factors that affect students' performances during ODL. The highest percentage value was obtained for factor C2 ('environment of study', with four integrated sub-factors which are 'study space' (S21), 'distraction' (S22), 'losing focus' (S23) and 'peer support; (S24)) with percentage of 0.1065. Most students were having difficulties in handling their environment of study during ODL because most of them were joining the classes from home, so the surroundings are not very suitable for study. They might face interruptions from siblings, parents, or any unpleasant background sounds. One of the ways to solve this is, parents may create a comfortable space or area for their kids, as based on current situations of Covid 19 in our country, this ODL may last at least for 1-2 years more. Hence, this investment is not going to be a waste. Second highest factor was C1 ('time management', with three integrated sub-factors which are 'tight schedule', 'long time spent on assignments' and 'unable to meet the dateline') with a percentage of 0.0440. Regardless of any methods of learning, poor time management will result in delayed/pending tasks and will definitely lead to stress. It becomes more tedious for online classes, since students have to be independent, with limited monitoring from their teachers/lecturers. Therefore, students should be self-disciplined and properly manage their timetables, so that they will be able to complete any given tasks, within the given period. Students should practice self-responsibility for not doing any unnecessary activities, such as browsing through social media, reading/replying emails, or online shopping, especially when they are attending classes. The third highest was factor C5 ('lecturer's concerns') with a percentage of 0.0227 followed by C3 ('Resources') and the lowest was C4 ('family concerns') that means parents give full support during ODL. Students are more likely to engage in the ODL if the lecturers communicated effectively, exhibited interest in students' learning and advancement, showed respect for students, and properly assessed students' work[19] [17]. Greater support from family and friends social support was linked to less depression symptoms [11]. Similar to the descriptive statistics calculated earlier, these results suggest that most of the students still can afford proper online learning facilities (i.e., devices for online) and the family members are still supportive in providing the best for their kids. Although some may suffer these problems, this is at least a good indication which signifies that the awareness towards the importance of learning and education is still high in our community.

Table 8. Ranking the most stressful factors during ODL

Factor	Percentage	Ranking order
Time Management	0.0440	2
Environment of study	0.1065	1
Resources	0.0063	4
Family concern	0.0000	5
Lecturer concern	0.0227	3

5. Conclusion

This research shows the 'environment of study' is the most influential factor contributing to stress among students ODL. Therefore, a good working environment in terms of the facilities (study space, with proper amenities: chair, table, stationeries, etc) and surrounding (situation of the study place/area) are very necessary in ensuring the survival of students during ODL. These results showed the superiority of Fuzzy ANP in interpreting the percentage which reflects the impact of the factors that contribute to the stress during ODL. On the other hand, the findings from this study is a wake-up call for parents, teachers, and counselors to educate pupils on stress coping techniques in order for them to have a better future and a healthier well-being. Government agencies and representatives must make strategic decisions quickly and efficiently to relieve student stress. It is critical to provide students with training in order to enhance their educational experience, which may aid in the reduction of stress in online learning. There is also a need to hunt for a better virtual teaching delivery technique in order to lessen student stress and protect university students' mental health. However, one of the limitations of this analysis was the use of a non-probabilistic sampling technique, which made inferential statistics impossible. Nevertheless, the presented results are not applicable to all UiTM Terengganu students due to the use of convenience sampling procedure. Thus, in the near future, this research may be improved by applying a more proper sampling technique.

Conflict of Interest
The authors declare no conflict of interest in the subject matter or materials discussed in this manuscript.

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