Ranking the Most Important Attributes of using Google Classroom in online Teaching for Albanian Universities: A Fuzzy AHP Method with Triangular Fuzzy Numbers and Trapezoidal Fuzzy Numbers

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A R T I C L E   I N F O

A B S T R A C T

This paper has conducted the study of the impact and effectiveness of Google Classroom in online teaching and learning. Based on the unified theory of acceptance and use of technology (UTAUT2), the first aim was to rank the 8 constructs namely: Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Habit, Behavioral Intention, and the last Use Behavior. Each of the constructs have their respective questions due to the questionnaire formed from the UTAUT2 theory. To evaluate the use of Google Classroom, have been analyzed the feedbacks from every participant based on a 5-likert scale output. Secondly, was completed the rank of the questions based on the most preferred 5-likert scale options. The method proposed for the purposes of this study were fuzzy AHP with triangular fuzzy numbers (TFN) and trapezoidal fuzzy numbers (TpFN). The results suggested that the most preferred construct by fuzzy with TFN numbers was the Behavioral Intention while the least preferred was the Effort Expectancy, whereas for fuzzy TpFN the most preferred construct was the Social Influence and the least preferred was the Effort Expectancy. Based on the questionnaire, the rank resulted to be the same with both methods for the most preferred question and the least important one, that were respectively from Use Behavior construct, and from Performance Expectancy construct, while the ranked questions of other constructs differed slightly with both methods. These results showed that both methods produced the same rank for the 5-likert scale options, where "Agree" option was the more important from the 5-likert scale options and "Strongly disagree" option was less important. From these findings was concluded that these changes in ranking were due to the different defuzzification methods that were used for both types of fuzzy numbers.

1. Introduction

Due to the worldwide situation of the COVID-19 pandemic, in several countries have been applied online teaching methods in schools and universities, including Albania. The most used e-learning platform was Google Classroom which is a free application, mainly used in higher education helping lecturers and students to share files between them referring to [1]. Compared with the traditional teaching style there are advantages and disadvantages in using Google Classroom [2].

In fact the students prefer the engagement in Google Classroom rather than being engaged in a class where the teachers have more active roles [3]. Google Classroom has incorporated some other applications such as Google Docs, Slides, Calendar, Sheets, where users can download them from Play Store or App store [4]. All these applications help the lecturer/tutor and students to have a better communication by attaching assignments or sharing files without the need of face to face learning. The benefit of using Google Classroom is that you can stay organized, save time and paper, interact with other users in a kind of blended learning [5],

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[6]. Classroom use of Google was expected to improve in quality and providing assistance in education [7]. Motivated by these facts the study was focused to find the most important attributes related to Google Classroom, based on the online learning theory of acceptance and use of technology 2 (UTAUT2). This theory is a technology acceptance model formulated by Venkatesh et al [8], and aimed to explain user intentions to use a new technology and subsequent usage behavior. The study questionnaire was based in the questionnaire developed by Jakkaew and Hemrungrote [9] and Jannosy [10]. The survey with 26 questions 5-likert scale have collected data from 528 students that studied mathematical courses in bachelor degree, from four different Universities in Albania. Based on the UTAUT2 theory, the questionnaire has 8 constructs: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Hedonic Motivation (HM), Habit (HT) [11], Behavioral Intention (BI) [12] and Use Behavior (UB) introduced and estimated by Jannosy [10]. For each of the questions, the answers were based on a 5-likert scale where 5 represents "strongly agree", 4 "agree", 3 "neither agree nor disagree", 2 "disagree" and 1 "strongly disagree". PE is determined by how useful Google Classroom is for students and how does it increases the learning productivity [13]. EE determines how easy it is to learn and use Google Classroom [14]. SI determines the degree that an individual will perceive the importance that the closely friends or peers, or people he or she valuate his/her opinion, believe in using Google Classroom [15]. FC describes the perception that the technology will support difficulties while using Google Classroom [8]. HM defines the fun or pleasure in using Google Classroom compared to traditional learning [16]. HT determines the degree of observed automatic behavior to an unconscious stimulus that leads to happy outcome after using Google Classroom [17], [18]. Some studies have found that the more users are in regular contact with each other, the more likely they are to develop a "habit of participation" and act cooperatively with the others [19], [20]. BI is the subjective degree that an individual will use Google Classroom frequently in the future. UB is defined from the subsequent effects of habit and others, but mostly from the effect of behavioral intention [20]. The constructs had their own set of questions, defined by Venkatesh, Jakkaew, Hemrungrote et al. The study referred to each of the construct as an attribute of its level, and each question as an attribute of the question's level, and each alternative response from 5-likert scale, as an attribute of the 5 options. Thomas Saaty [21] introduced analytic hierarchic process (AHP) as a method of measurement with ratio scales to solve real life problems in decision making, but to deal with uncertainty in complex problems and multi criteria decision making (MCDM), AHP is combined with fuzzy logic (Fuzzy AHP) [22]. The fuzzy AHP method converts the Saaty scale of AHP from 1-9, to symmetric triangular fuzzy numbers and symmetric trapezoidal fuzzy numbers. The next step calculates the defuzzification of fuzzy numbers, converting the expected results into crisp numbers and ranking the attributes according to their respective levels [23]. In order to evaluate all the attributes of Google Classroom, has been constructed a hierarchy in levels. The goal was "the best attributes for Google Classroom", level 1 were the four universities of Albania, level 2 included the eight constructs of UTAUT2, level 3 was formed by the questions for each of the constructs, and level 4 included the 5-likert point option for each of the questions. The hierarchy and its levels are as follow in figure 1 and figure 2:
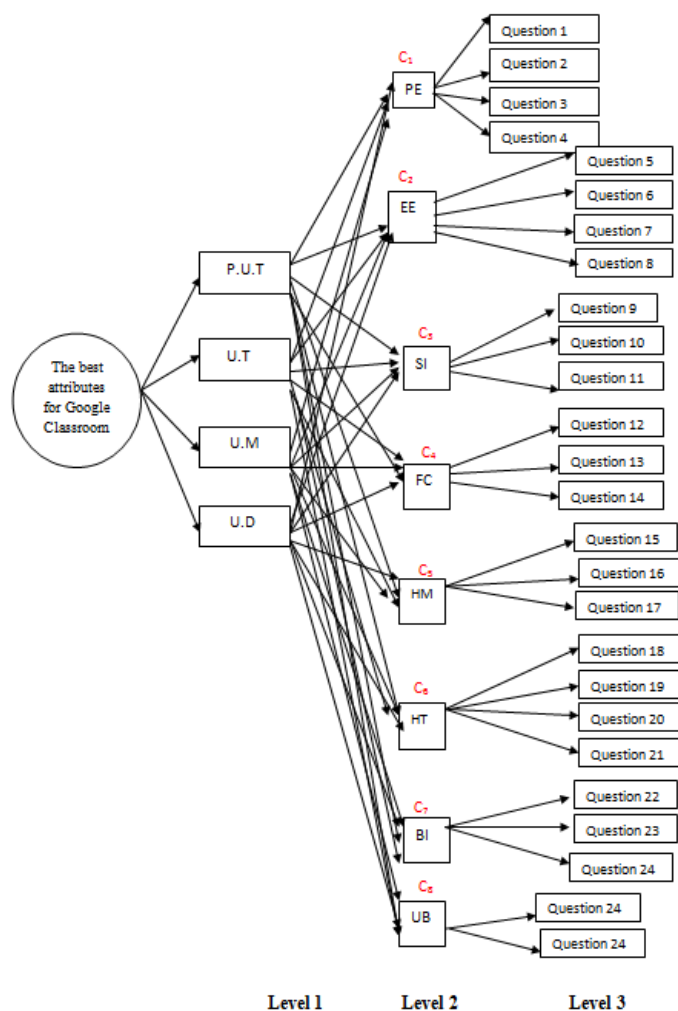
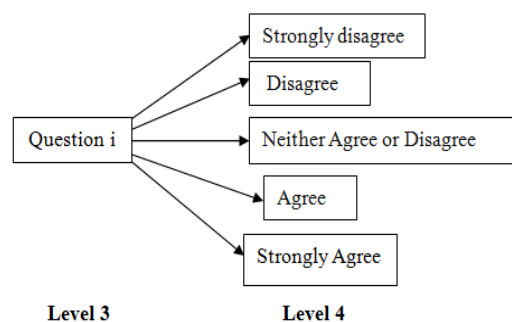

Figure 1: Hierarchy of the questionnaire

Figure 2: The 5-likert point alternative

The rankings have been evaluated by implementing the method fuzzy AHP with triangular fuzzy numbers and with trapezoidal fuzzy numbers, because it is known that trapezoidal fuzzy numbers are a generalization of triangular fuzzy numbers [24]. Thus have been compared the similar rankings and also the changes in rankings. The results obtained from this study may be very useful for lecturers and students when using Google Classroom. The findings are expected to be used by lecturers in explaining new knowledge, also in their interest to know where students are more focused during the online learning. Multi criteria decision making problems are a group of decision method,

where AHP is one of the most widely used among them. The AHP was first introduced by Saaty [25], [26] which uses the decision matrix and makes the pair-wise comparison evaluations in order to obtain the relative weights for the levels of the hierarchy (criteria and alternatives). This method has disadvantages in its inability to deal with the uncertainty decision making problems [27], [28]. To address this issue, in [29] the author introduced the fuzzy AHP, based on the fuzzy set theory by [30]. The first FAHP was applied with triangular fuzzy numbers and their relative preferences were described with the means of fuzzy numbers [31]. In [31], the author introduced the geometric mean to calculate the fuzzy weights and their combination for finding final weights, in [32], the author introduced a new approach for FAHP based on triangular fuzzy numbers and used the extent analyses to find the vector of weights for each element of the criterion. Most of previous works have used the AHP method and other MCDM methods in Learning Measurement Systems (LMS) while a little attention has been paid to the fuzzy AHP method. In [33], the author evaluated the critical success factors in implementing e-learning system using FAHP with TFN scale. They have treated the success factors from diverse points of view such as system, support from the institution, instructor, and student. In [34], the author has evaluated the LMS systems by using FAHP with TFN and two other methods, fuzzy Topsis and an Integrated Method. In the study has been showed that the content management and development is the most important criteria. In [35], the author applied FAHP in increasing the effectiveness of teaching to massive open online courses (MOOCS) and to determine the most widespread MOOCS. In [36], the author explores in detail the necessary requirements for the successful execution of distance education in industrial engineering using FAHP and SWARA. In [37], the author used the FAHP to weight the e-learning website selection index, for eight C-programming language websites, and concluded that the most important from the quality factor is "functionality", and from e-learning easily specific factors is "easy of learning community". In [38], the author used FAHP to choose the most appropriate system of LMS, and it was Joomla LMS system. In [39], the author applied fuzzy AHP to evaluate significant factors for executing a successful personalized E-Learning system. In [40], the author used FAHP with TFN numbers and other methods to achieve lean attributes for competitive advantages development. In other research papers [41], [42] the authors have evaluated the adoption of a new technology with FAHP method. In [41], the author used FAHP and Structural Equation Modeling (SEM) to predict the adoption of cloud-based technology, and found that the constructs PE, EE, SI of UTAUT2 are the most important factors predicting behavioral intention to adopt cloud-based collaborative learning technology from experts' point of view. In [42], the author applied FAHP with TFN numbers to rank the factors influencing Fin Tech adoption intention, case study China and Korea. They concluded that the price value had the most significant influence on Chinese perceptions while credibility had the most significant effect on korean perceptions. In [43], the author has evaluated the usability of website using combined weighted method: fuzzy AHP and

entropy approach. The entropy approach suggested "Response Time" (RT) as the main contributor while FAHP suggests "Ease of Navigation" (EON) as the main contributor for evaluation of usability of the academic websites. In [44], the author firstly has investigated the effective factors in electronic readiness of governmental and semi-governmental organizations of Tabriz city, and then ranked the effective factors in accepting information technologies and teleworking by fuzzy AHP technique. In general, these papers have mostly applied the FAHP method with TFN numbers. To the best of the knowledge, there is not yet an AHP study or a FAHP study on Google Classroom usage. In this paper have been studied the most important attributes of using Google Classroom for online teaching by the FAHP method with triangular fuzzy numbers and with trapezoidal fuzzy numbers. The study aimed to find the ranked sub-criteria and alternatives according to the hierarchy levels: the ranked constructs based on the students answers for each of the eight of them, the ranked questions from the most to the least important (there are 26 in total) and finally the ranked 5-likert-scale point options.

2. Ranking methods

The FAHP method has been used to find the most important attributes of Google Classroom with symmetric triangular fuzzy numbers and trapezoidal fuzzy numbers. One good reason for the selection of these methods was because the fuzzy numbers describe better the pair-wise comparisons matrices of optimality criteria than simple AHP. If the fuzzy method has been applied, the result score is always 'the-bigger-the-better' [45]. The 26 questions are organized in 8 constructs which are C1 = PE = Performance Expectancy, C2 = EE = Effort Expectancy, C3 = SI = Social Influence, C4 = FC = Facilitating Conditions, C5 = HM = Hedonic Motivation, C6 = HT = Habit, C7 = BI = Behavioral Intention and C8 = UB = Use Behavior, referred in the study as the criteria. The sub-criteria have been represented by the third level of the hierarchy, and the alternatives of the hierarchy have been represented in the fourth level showed also in figure 1.

3. The proposed framework

Both methods have been developed through 7 steps for their application. The first was to construct the hierarchy problem, then have been created the pairwise comparison matrices and checked for consistency for each of them in all levels of the hierarchy. All these steps had the decision matrices with crisp numbers. In step four were converted all crisp numbers of the decision matrices into triangular fuzzy numbers/trapezoidal fuzzy numbers according FAHP-TFN/FAHP-TPFN [46], and then were calculated the fuzzy weights for each method. The deffuzification step was not the same for both methods. This step has converted the fuzzy numbers into crisp numbers, and the greater number (weight) showed the most important attribute among them. The most interested issue was to determine exactly how have changed the ranked results regarding the most important attribute for Google Classroom. In figure 3 and figure 4 have been shown all these steps.
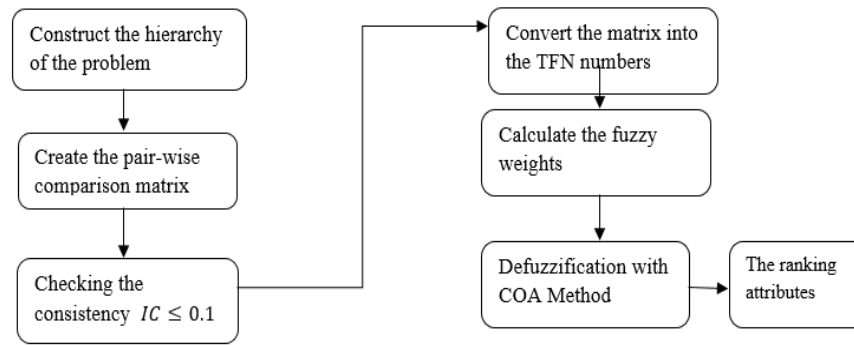
Steps for FAHP-TFN

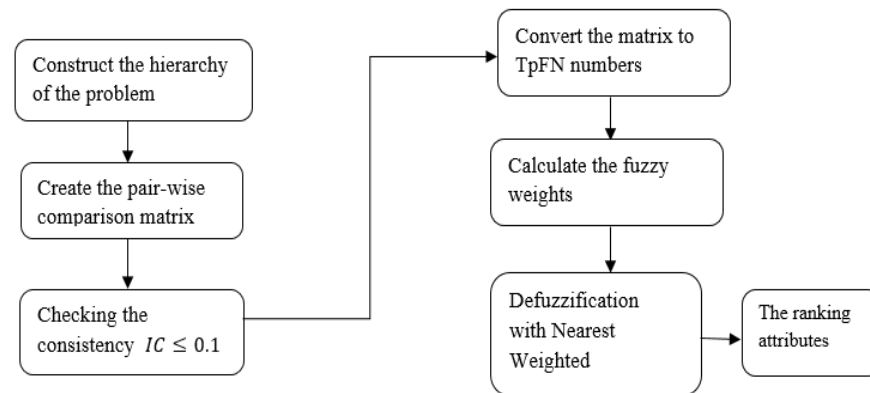
Figure 3: FAHP with TFN Numbers

Steps for FAHP-TpFN

Figure 4: FAHP with TpFN Numbers

3.1. Fuzzy AHP with TFN Numbers

Decision-makers often liked to give linguistic variables, rather than giving their judgments in numerical values [47]. A linguistic variable has linguistic terms representing approximate values of a base variable, relevant to a particular application, have been captured by approximate fuzzy numbers [48]. Each linguistic variable consists of the following elements: A name, a base variable, a set of linguistic terms and a semantic rule. To deal with data uncertainty, FAHP is a useful theory in the in the context that crisp numbers are expressed in fuzzy numbers.

Firstly a group of decision makers is formed for evaluating the criteria and attributes as linguistic variables, with the consensus of all its members [49]. The main input for AHP method is the decision matrix formed from the expert's judgment, so there will be a factor of subjectivity in their decisions [50]. The most important thing is that this matrix has to be consistent with index CI less or equal to 0.1 ($CI = \frac{\lambda_{max}-n}{n-1} \leq 0.1$) [51].

Also, it is necessary for the consistence ratio $CR = CI/RI \leq 0.1$, where RI is the random index of the n-order matrix showed in table 1.

The experts have constructed the decision matrices for all levels of the hierarchy, and then converted the numbers into fuzzy symmetric triangular numbers (TFN). The fuzzy numbers were

defined from the triangular symmetrical fuzzy membership function.

Table 1: Random Index for matrix of n-order, simple AHP (Saaty 1980)

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Table 2: Triangular fuzzy numbers and their inverse with Saaty Scale

Relative importance	Importance	TFN	Inverse of TFN
1	Equal	(1,1,1)	(1,1,1)
3	Moderate	(2,3,4)	(1/4,1/3,1/2)
5	Strong	(4,5,6)	(1/6,1/5,1/4)
7	Very strong	(6,7,8)	(1/8,1/7,1/6)
9	Extremely strong	(9,9,9)	(1/9,1/9,1/9)
2	Intermediate values	(1,2,3)	(1/3,1/2,1)
4	Intermediate values	(3,4,5)	(1/5,1/4,1/3)
6	Intermediate values	(5,6,7)	(1/7,1/6,1/5)
8	Intermediate values	(7,8,9)	(1/9,1/8,1/7)

A fuzzy number $\tilde{N}$ is called a triangular fuzzy number (TFN) if its membership function $\mu_{\tilde{N}}(x): R \rightarrow [0,1]$ is as follows:

$$\mu_{\tilde{N}}(x) = \begin{cases} \frac{x-l}{m-l} & l \leq x \leq m \\ \frac{u-x}{u-m} & m \leq x \leq u \\ 0 & x \neq [l,u] \end{cases} \quad (1)$$

In figure 5 is shown the triangular membership function.
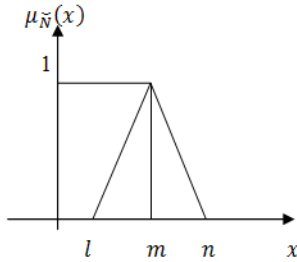
The fuzzy number $\tilde{N} = (l, m, u)$ is formed by the lower, medium and upper bounds of the crisp number. Table 2 shows the Saaty scale from 1 to 9 evaluated with symmetric triangular fuzzy numbers, also the inverse of the triangular fuzzy numbers.

In figure 6 are shown the triangular fuzzy numbers with the Saaty relative importance value.
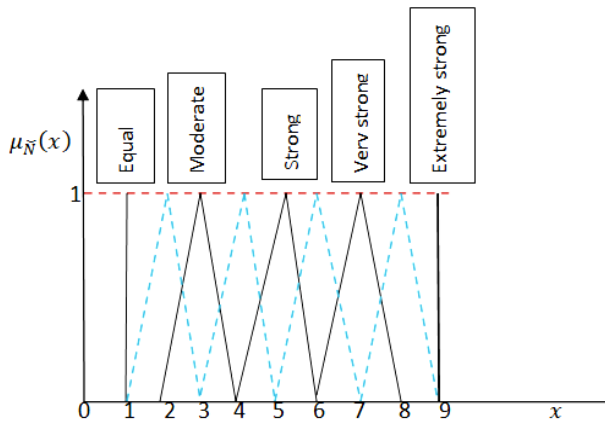
The operational laws with triangular fuzzy numbers are as follow:

a) $\tilde{N}_1 \oplus \tilde{N}_2 = (l_1, m_1, u_1) \oplus (l_2, m_2, u_2) =$
$(l_1 + l_2, m_1 + m_2, u_1 + u_2)$
b) $\tilde{N}_1 \otimes \tilde{N}_2 = (l_1, m_1, u_1) \otimes (l_2, m_2, u_2) =$
$(l_1 l_2, m_1 m_2, u_1 u_2)$ (2)
c) $\tilde{N}^{-1} = (l, m, u)^{-1} = (\frac{1}{u}, \frac{1}{m}, \frac{1}{l})$

The decision matrix A was converted into the matrix $\check{A}$ as the fuzzy TFN matrix [52]-[53]:

$$\check{A} = \begin{pmatrix} (1,1,1) & \cdots & (l_{1n}, m_{1n}, u_{1n}) \\ \vdots & \ddots & \vdots \\ (l_{n1}, m_{n1}, u_{n1}) & \cdots & (1,1,1) \end{pmatrix}$$

$$\check{a}_{ij} = (l_{ij}, m_{ij}, u_{ij}),$$

where

$$\check{a}_{ij}^{-1} = (\frac{1}{u_{ij}}, \frac{1}{m_{ij}}, \frac{1}{l_{ij}}) \quad (3)$$

For each of the criteria have been calculated the fuzzy geometric mean value:

$$\check{r}_i = \left(\prod_{i=1}^{n} \check{a}_{ij}\right)^{1/n} \quad (4)$$

Next was applied the defuzzification method named Center of Area method (COA) for the fuzzy weights:

$$\tilde{\omega}_i = \check{r}_i \otimes (\check{r}_1 \oplus \check{r}_2 \oplus \dots \oplus \check{r}_n)^{-1} \quad (5)$$

According to Voskoglou (2018) the coordinates of the Center of Area for the triangular formed with fuzzy numbers are $G\left(\frac{l+m+n}{3}, \frac{1}{3}\right)$. Point G is the intersection of the medians of the triangle formed by fuzzy numbers [54] (see figure 7).
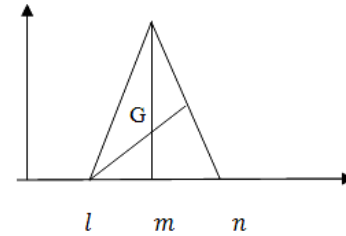

Figure 7: Center of area for TFN

The last step was to find the average M_i and the normalized weights N_i for all criteria:

$$M_i = \frac{\tilde{\omega}_1 \oplus \tilde{\omega}_2 \oplus \dots \oplus \tilde{\omega}_n}{n} \quad (6)$$

$$N_i = \frac{M_i}{M_1 \oplus M_2 \oplus \dots \oplus M_n} \quad (7)$$

These 7 steps must be performed to find the normalized weights for both criteria and their alternatives as they are represented in the hierarchy. According to these results, the alternative with the highest score is suggested to be the best alternative for the decision makers.

Triangular and trapezoidal fuzzy numbers are used very often to deal with the vagueness of the decisions related to alternative choice for each of the criteria [23]. A trapezoidal fuzzy number is denoted as $\tilde{N} = (l, m, n, u)$ where if $m = n$ it becomes a triangular fuzzy number TFN, so the TFN numbers are a special case of TpFN numbers. In this study all the linguistic variables of the pair-wise comparison matrices have been expressed in trapezoidal fuzzy number. The trapezoidal fuzzy number has the membership function as follows:

Table 3: Trapezoidal fuzzy numbers and inverse of TpFN with Saaty scale.

Relative importance value	Importance	Trapezoidal fuzzy numbers scale	Inverse of trapezoidal fuzzy numbers
1	Equal	(1,1,1,1)	(1,1,1,1)
3	Moderate	(2,5/2,7/2,4)	(0.13,0.2,0.46,0.53)
5	Strong	(4,9/2,11/2,6)	(0.05,0.15,0.25,0.35)
7	Very strong	(6,13/2,15/2,8)	(0.04,0.1,0.18,0.244)
9	Extremely strong	(8,17/2,9,9)	(0.01,0.1,0.12,0.21)
2	Intermediate values	(1,3/2,5/2,3)	(0.2,0.3,0.7,0.8)
4	Intermediate values	(3,7/2,9/2,5)	(0.1,0.15,0.35,0.4)
6	Intermediate values	(5,11/2,13/2,7)	(0.01,0.155,0.175,0.3)
8	Intermediate values	(7,15/2,17/2,9)	(0.05,0.085,0.185,0.2)

$$(x) = \begin{cases} \frac{x-l}{m-l} & l \leq x \leq m \\ 1 & m \leq x \leq n \\ \frac{u-x}{u-m} & m \leq x \leq u \\ 0 & x \neq [l,u] \end{cases} \quad (8)$$

In figure 8 is shown the triangular membership function.
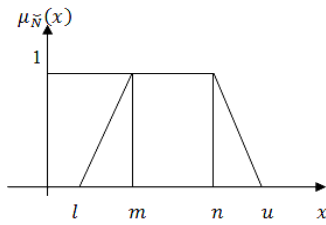

Figure. 8 TpFN membership function

Table 3 has converted the trapezoidal fuzzy numbers and the inverse of them with the Saaty scale.

In figure 9 are shown the trapezoidal fuzzy numbers with Saaty relative scale of importance.
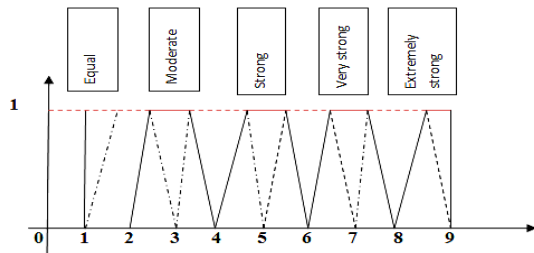

Figure 9: TpFN with relative importance of Saaty scale

The defuzzification was applied with the method of nearest weighted symmetry (NWS) for trapezoidal fuzzy numbers as described in Saneifard [56].

$$a_{ij} = \frac{l+2m+2n+u}{6} \quad (13)$$

The last step included the normalization and the ranking attributes given as:

$$N_i = \frac{a_{ij}}{\sum a_{ij}} \quad (14)$$

3.3. Data collections

In order to analyze the effectiveness and acceptance of Google Classroom, a questionnaire has been prepared based

The operational laws with trapezoidal fuzzy numbers:

a) $\tilde{N}_1 \oplus \tilde{N}_2 = (l_1, m_1, n_1, u_1) \oplus (l_2, m_2, n_2, u_2) = (l_1 + l_2, m_1 + m_2, n_1 + n_2, u_1 + u_2)$

b) $\tilde{N}_1 \otimes \tilde{N}_2 = (l_1, m_1, n_1, u_1) \otimes (l_2, m_2, n_2, u_2) = (l_1 l_2, m_1 m_2, n_1 n_2, u_1 u_2)$ (9)

c) $\tilde{N}^{-1} = (l, m, n, u)^{-1} = (\frac{1}{u}, \frac{1}{n}, \frac{1}{m}, \frac{1}{l})$

The decision matrix A was converted into the matrix $\check{A}$ as the fuzzy TpFN matrix [23]-[55]:

$$\check{A} = \begin{pmatrix} (1,1,1,1) & \cdots & (l_{1n}, m_{1n}, n_{1n}, u_{1n}) \\ \vdots & \ddots & \vdots \\ (l_{n1}, m_{n1}, n_{n1}, u_{n1}) & \cdots & (1,1,1,1) \end{pmatrix}$$

$$\check{a}_{ij} = (l_{ij}, m_{ij} n_{ij}, u_{ij}),$$

$$\check{a}_{ij}^{-1} = (\frac{1}{u_{ij}}, \frac{1}{n_{ij}}, \frac{1}{m_{ij}}, \frac{1}{l_{ij}}) \quad (10)$$

For each of the criteria were calculated the fuzzy geometric mean value:

$$\check{r}_i = \left(\prod_{i=1}^{n} \check{a}_{ij}\right)^{1/n} \quad (11)$$

The fuzzy weights were calculated as follow:

$$\tilde{\omega}_i = \check{r}_i \otimes (\check{r}_1 \oplus \check{r}_2 \oplus \dots \oplus \check{r}_n)^{-1} \quad (12)$$

firstly from Jakkaew and Hemrungrote. Details of this questionnaire have been given in the Appendix A. The questionnaire has been completed by 528 students from 4 universities in Albania, one month after they started using this platform. In table 4 are described the frequency and percentage for answers of the questionnaire.

4. Results

4.1. Results for Criteria with FAHP –TFN

The hierarchical structure has been constructed based on the questionnaire, combining all the criteria and attributes to find the goal: the most important attributes for Google Classroom. In this study the universities were in the second level, and hence haven't

taken as criteria. The constructs C_1, C_2,…,C_8 have been the criteria, and the questions Q_1, …,Q_{26} have been the sub-criteria Each question has 5 alternatives ,shown in figure 2. The eight criteria have been compared with respect to the goal "the most important attributes for Google Classroom". The decision makers were a group of mathematicians which have evaluated the answers of the questionnaire, and constructed the pair-wise comparison matrix for levels of the hierarchy [22],[57]. The first construction was the pair-wise comparison matrix with triangular fuzzy numbers as follow in table nr 5.

This matrix has the Consistency Index $0.04778 < 0.1$, and $CR = CI/RI = 0.034$, so were applied the equations (2)-(7). The results were obtained in table 6.

Based on the results for the most important construct from FAHP-TFN, it was the construct Behavioral Intention, than Social Influence, Hedonic Motivation, Use Behavior, Habit, Performance Expectancy, Facilitating Conditions and the last is Effort Expectancy. So for the students was more important to continue using Google Classroom in the future and to recommend

it for other students. Also the Social Influence have impacted their use of Google Classroom. The last preferred was Effort Expectancy, so they thought was easy to use Google Classroom, to learn to operate with it and the interaction was clear and understandable.

4.2. Results for the FAHP –TpFN Criteria.

After have been found the rank with TFN numbers for the criteria, was converted the decision matrix in table 5 into trapezoidal fuzzy numbers (see table 7).

The crisp numbers less than one were converted into trapezoidal fuzzy numbers with the use of the membership function of the generalized trapezoidal fuzzy number

$(\check{A}) = (a, b, c, d; w), (0 < w \leq 1), \mu_{(\check{A})}(x) : R \rightarrow [0, w]$, which mapped the set of all fuzzy numbers to a set of real numbers by $R(\check{A}) = \frac{w}{2}((c + d) - (a + b))$ [58], [59]. The study used the trapezoidal fuzzy numbers for $w = 1$. The results that were obtained from equations (9) to (14), are summarized in table 8.

Table 4: Students gender, university and way of access for Google Classroom.

Item	Values	Frequency	Percentage
Gender	Male	192	36.4%
	Female	336	63.6%
University	Polytechnic University of Tirana	151	28.6%
	University of Tirana	130	24.6%
	University of Medicine	53	10.0%
	University of Durres	194	36.7%
Access Google Classroom	Android	192	36.4%
	Smartphone	189	35.8%
	Personal Computer	147	27.8%

Table 5: The pair-wise comparison matrix with TFN numbers for the 8 criteria

	C_1	C_2	C_3	C_4
C_1	(1,1,1)	(1,2,3)	(0.33,0.5,1)	(1,2,3)
C_2	(0.33,0.5,1)	(1,1,1)	(0.142,0.16,0.5)	(1,1,1)
C_3	(1,2,3)	(5,6,7)	(1,1,1)	(3,4,5)
C_4	(0.33,0.5,1)	(1,1,1)	(0.2,0.25,0.33)	(1,1,1)
C_5	(1,2,3)	(1,2,3)	(1,1,1)	(1,2,3)
C_6	(2,3,4)	(6,7,8)	(0.33,0.5,1)	(3,4,5)
C_7	(3,4,5)	(4,5,6)	(1,1,1)	(1,2,3)
C_8	(3,4,5)	(4,5,6)	(1,1,1)	(1,2,3)
	C_5	C_6	C_7	C_8
C_1	(0.33,0.5,1)	(0.25,0.33,0.5)	(0.2,0.25,0.33)	(0.2,0.25,0.33)
C_2	(0.33,0.5,1)	(0.12,0.14,0.16)	(0.16,0.2,0.25)	(0.16,0.2,0.55)
C_3	(1,1,1)	(1,2,3)	(1,1,1)	(1,1,1)
C_4	(0.25,0.33,0.5)	(0.2,0.25,0.33)	(0.33,0.5,1)	(0.33,0.5,1)
C_5	(1,1,1)	(1,2,3)	(1,2,3)	(1,1,1)
C_6	(0.33,0.5,1)	(1,1,1)	(1,1,1)	(1,1,1)
C_7	(0.33,0.5,1)	(1,1,1)	(1,1,1)	(1,1,1)
C_8	(1,1,1)	(1,1,1)	(1,1,1)	(1,1,1)

Table 6: FAHP with TFN numbers for the criteria

	$\check{r}_i$	$\widetilde{\omega}_i$	COA	N_i	Rank
C_1	(0.426, 0.613, 0.914)	(0.036, 0.065, 0.125)	0.075	0.0538	6
C_2	(0.292, 0.35, 0.51)	(0.025, 0.037, 0.069)	0.043	0.03	8
C_3	(1.4, 1.76, 2.05)	(0.12, 0.188, 0.28)	0.196	0.14	2
C_4	(0.37, 0.47, 0.69)	(0.031, 0.05, 0.094)	0.058	0.0416	7
C_5	(1.09, 1.62, 2.05)	(0.093, 0.173, 0.28)	0.182	0.13	3
C_6	(1.18, 1.46,1.88)	(0.1, 0.156, 0.257)	0.171	0.122	5
C_7	(1.18, 1.45, 1.75)	(0.1, 0.155, 0.239)	0.494	0.354	1
C_8	(1.36, 1.58, 1.75)	(0.117, 0.169, 0.239)	0.175	0.125	4

Table 7: The pair-wise comparison matrix with TpFN numbers for the 8 criteria

	C_1	C_2	C_3	C_4
C_1	(1,1,1,1)	(1,1.5,2.5,3)	(0.2,0.3,0.7,0.8)	(1,1.5,2.5,3)
C_2	(0.2,0.3,0.7,0.8)	(1,1,1,1)	(0.01,0.155, 0.175,0.32)	(1,1,1,1)
C_3	(1,1.5,2.5,3)	(5,5.5,6.5,7)	(1,1,1,1)	(3,3.5,4.5,5)
C_4	(0.2,0.3,0.7,0.8)	(1,1,1,1)	(0.1,0.15,0.35,0.4)	(1,1,1,1)
C_5	(1,1.5,2.5,3)	(1,1.5,2.5,3)	(1,1,1,1)	(2,2.5,3.5,4)
C_6	(2,2.5,3.5,4)	(6,6.5,7.5,8)	(0.2,0.3,0.7, 0.8)	(3,3.5,4.5,5)
C_7	(3,3.5,4.5,5)	(4,4.5,5.5,6)	(1,1,1,1)	(1,1.5,2.5,3)
C_8	(3,3.5,4.5,5)	(4,4.5,5.5,6)	(1,1,1,1)	(1,1.5,2.5,3)

	C_5	C_6	C_7	C_8
C_1	(0.2,0.3,0.7,0.8)	(0.13,0.2,0.46,0.53)	(0.1,0.15,0.35,0.4)	(0.1,0.15,0.35,0.4)
C_2	(0.2,0.3,0.7,0.8)	(0.04,0.1,0.18,0.244)	(0.05,0.15,0.25,0.35)	(0.05,0.15,0.25,0.35)
C_3	(1,1,1,1)	(1,1.5,2.5,3)	(1,1,1,1)	(1,1,1,1)
C_4	(0.13,0.2,0.46,0.53)	(0.1,0.15,0.35,0.4)	(0.2,0.3,0.7,0.8)	(0.2,0.3,0.7,0.8)
C_5	(1,1,1,1)	(1,1.5,2.5,3)	(1,1.5,2.5,3)	(1,1,1,1)
C_6	(0.2,0.3,0.7,0.8)	(1,1,1,1)	(1,1,1,1)	(1,1,1,1)
C_7	(0.2,0.3,0.7,0.8)	(1,1,1,1)	(1,1,1,1)	(1,1,1,1)
C_8	(1,1,1,1)	(1,1,1,1)	(1,1,1,1)	(1,1,1,1)

Table 8: TpFN results for the criteria level.

	$\check{r}_i$	$\widetilde{\omega}_i$	NWS	N_i	Rank
C_1	(0.29,0.41,0.8,0.91)	(0.025,0.039,0.096,0.13)	0.07	0.067	6
C_2	(0.12,0.27,0.42,0.53)	(0.01,0.025,0.05,0.08)	0.04	0.038	8
C_3	(1.4,1.6,1.92,2.05)	(0.12,0.152,0.23,0.3)	0.2	0.19	1
C_4	(0.24,0.32,0.61,0.67)	(0.02,0.03,0.07,0.1)	0.053	0.05	7
C_5	(1.09,1.37,1.85,2.06)	(0.094,0.13,0.22,0.3)	0.18	0.17	2
C_6	(1.04,1.23,1.66,1.78)	(0.09,0.11,0.19,0.26)	0.158	0.152	5
C_7	(1.11,1.27,1.6,1.7)	(0.09,0.12,0.19,0.25)	0.16	0.154	4
C_8	(1.36,1.49,1.67,1.755)	(0.12,0.14,0.2,0.26)	0.17	0.16	3

Table 9: The ranked criteria with two types of fuzzy numbers.

Method	Rank of the criteria							
FAHP -TFN	C_7	C_3	C_5	C_8	C_6	C_1	C_4	C_2
FAHP-TpFN	C_3	C_5	C_8	C_7	C_6	C_1	C_4	C_2

Table 10: The IC, CR indexes for the matrixes of questions, third level:

	CI	CR
$C_1=(Q_1, Q_2, Q_3, Q_4)$	0.099	0.1
$C_2=(Q_5, Q_6, Q_7, Q_8)$	0.03	0.033
$C_3=(Q_9, Q_{10}, Q_{11})$	0.033	0.056
$C_4=(Q_{12}, Q_{13}, Q_{14})$	0.0035	0.006

$C_5=(Q_{15}, Q_{16}, Q_{17})$	0.051	0.088
$C_6=(Q_{18}, Q_{19}, Q_{20}, Q_{21})$	0.068	0.075
$C_7=(Q_{22}, Q_{23}, Q_{24})$	0.017	0.03
$C_8=(Q_{25}, Q_{26})$	0	0

Table 11: The ranked results for questions level

TFN	Q_{25}	Q_{12}	Q_9	Q_{15}	Q_5	Q_1	Q_{22}	Q_{18}	Q_{16}	Q_{10}	Q_2	Q_{26}	Q_7
	1	2	3	4	5	6	7	8	9	10	11	12	13
TpFN	Q_{25}	Q_{12}	Q_9	Q_{15}	Q_{22}	Q_1	Q_5	Q_{18}	Q_{16}	Q_{10}	Q_2	Q_{26}	Q_{23}
	1	2	3	4	5	6	7	8	9	10	11	12	13

Q_{14}	Q_{19}	Q_{23}	Q_{24}	Q_{21}	Q_6	Q_3	Q_{13}	Q_{20}	Q_8	Q_{11}	Q_{17}	Q_4
14	15	16	17	18	19	20	21	22	23	24	25	26
Q_{14}	Q_7	Q_{19}	Q_{21}	Q_6	Q_3	Q_{24}	Q_{13}	Q_{20}	Q_{11}	Q_{17}	Q_8	Q_4
14	15	16	17	18	19	20	21	22	23	24	25	26

The FAHP-TpFN method has shown that the most important criteria were C_3 and the last important was C_2. So Social Influence was the most preferred criteria, then Hedonic Motivation, use behavior, Behavioral Intention, Habit, Performance Expectancy, Facilitating Conditions, and the last Effort Expectancy. Social Influence construct has been evaluated as the most preferred criteria that included friends, peers or other people. They had a direct impact for the students in using Google Classroom. The second evaluated was Hedonic Motivation criteria concerning an enjoyable use for Google Classroom. The last was Effort Expectancy criteria, as an easy use of Google Classroom.

4.3. Comparison results for the criteria level

Referred to the results in table 6 and table 8, were summarized the ranking criteria with the triangular and trapezoidal fuzzy numbers in table 9. These results have shown that only criteria C_7 differs in rank between the two methods, all the others have the same rank. This was obtained due to the fact that the method of defuzzification in the two types of fuzzy numbers were not the same according their formulas. The results obtained from them give an important rank for the decision makers to judge the preferences of the Google

Classroom constructs in more detail. In general, the ranked criteria of the most important and the last important one was the same, only the rankings between them differed less.

4.4. Comparison results for questions level

Here have been applied FAHP TFN and FAHP TpFN for the third level of the hierarchy, formed with the 26 questions as alternatives for each of the criteria of the second level. For all of them have been constructed the pair-wise comparisons matrices. The consistency has been less than 0.1, otherwise the decision makers had to reevaluate the comparisons matrix. For the third level, named as the sub-criteria has been constructed the decision matrices. Every matrix of the criteria, has been evaluated for its consistency IC and the consistent ratio CR. If they were consistent

then becomes the application of FAHP. In Table 10 are shown the eight criteria with the sub-criteria, and their consistency value. For all the matrices the coefficients were less or equal to 0.1. So were applied the FAHP-TFN and FAHP-TpFN method. In table 11 are shown only the ranked results. The results after have been applied FAHP – TFN have shown that based on their importance with each other every Q_i had the following rank: Q_{25}, Q_{12}, Q_9, Q_{15}, Q_5, Q_1, Q_{22}, Q_{18} ,Q_{16}, Q_{10}, Q_2, Q_{26} ,Q_7 ,Q_{14} ,Q_{19}, Q_{23} ,Q_{24} ,Q_{21} ,Q_6 ,Q_3 ,Q_{13} ,Q_{20} ,Q_8 ,Q_{11} ,Q_{17} ,Q_4 . So the most important question between them was Q_{25} "I use Google Classroom for writing quizzes and submitting assignments behavior", and the last important was Q_4 "If I use Google Classroom, I will increase my chances of passing the course".

The results that have been applied FAHP – TpFN have shown that every Q_i had the following rank: Q_{25}, Q_{12}, Q_9, Q_{15}, Q_{22} ,Q_1, Q_5, Q_{18}, Q_{16}, Q_{10}, Q_2, Q_{26}, Q_{23}, Q_{14}, Q_7, Q_{19}, Q_{21}, Q_6, Q_3, Q_{24}, Q_{13}, Q_{20}, Q_{11}, Q_{17}, Q_8, Q_4. So the most important question between them was Q_{25} and the last important was Q_4. Both methods have ranked the questions and was found that the most important and the last important from them are the same for the decision maker, but the ranking between them differs slightly.

The most important question was Q_{25} in the Use Behavior: "I use Google Classroom for writing quizzes and submitting assignments behavior", and the last important one was Q_4: "If I use Google Classroom, I will increase my chances of passing the course" part of the Performance Expectancy construct. It was known that FAHP with TpFN numbers was the generalization of FAHP with TFN numbers [60], also had a better rank according to the expert opinions. Also, based to the unified index for comparing fuzzy numbers TFN and TpFN [61], [60] was shown that the trapezoidal FAHP method is the most suitable one, as it provides the most accurate results when compared to other methods.

4.5. Comparison results for 5-likert scale level

For the 5-likert scale have been denoted the five points with A_1=Strongly disagree, A_2=Disagree, A_3=Neither agree nor disagree, A_4=Agree, A_5=Strongly agree. Also have been evaluated the fuzzy pair-wise comparison matrices of alternatives according to each of the sub-criteria, and then have been applied FAHP method with both types of fuzzy numbers. Tables 12 and 13 have shown the results of the FAHP method for both cases. According to the theory [23], [31] the total of results preferences was compared for each of them as shown in tables below, and the one that has the highest total was the most important.

Table 12: Results for alternative level with FAHP-TFN

	A_1	A_2	A_3	A_4	A_5
Total	1.0188	1.378	1.867	2.651	1.1027
Rank	5	3	2	1	4

Table 13: Results for alternative level with FAHP-TpFN

	A_1	A_2	A_3	A_4	A_5
Total	0.93937	1.3338	1.875	2.685	1.10274
Rank	5	3	2	1	4

The findings resulted that both methods gave the same ranking (see table 12, 13). It is obvious that the total for each A_i differed slightly with both types of fuzzy numbers. So the alternative that has been the most important and the most selected in the answers was A_4 "Agree", then A_3 "Neither agree nor disagree", then A_2 "Disagree", A_5 "Strongly agree", and lastly A_1 "Strongly disagree".

5. Conclusions

Nowadays due to the situation of COVID-19 pandemic the application of Google Classroom in online teaching played an important role in high education. The evaluations for the usage of Google Classroom have been done by using the questionnaire according to the UTAUT2 model. This study found out the ranked attributes for Google Classroom, from the most to the least preferred. Attributes were three types: criteria, sub-criteria and alternative, based on the hierarchy structure proposed by this paper. In order to make better decisions, have been applied the FAHP method with two types of fuzzy numbers: triangular fuzzy numbers and trapezoidal fuzzy numbers. FAHP could capture the vagueness of the judgments, by making the fuzzy weights more objective to the goal. Based on the results of FAHP-TFN the most preferred criteria or construct was BI (Behavioral Intention), the most preferred question was "I use Google Classroom for writing quizzes and submitting assignments behavior", and the most selected alternative was A_4 "Agree". For the results of FAHP-TpFN the most preferred criteria or construct was SI (Social Influence), the most preferred question was "I use Google Classroom for writing quizzes and submitting assignments behavior", and the most selected alternative was A_4 "Agree". There was a slight difference in the criteria level for the two methods. Trapezoidal fuzzy numbers were the generalization of the triangular fuzzy numbers and have often being used by decision makers for a better selection of the attributes. This study is expected to help the user to evaluate the use of Google Classroom, and also to help policy-makers when deciding to implement e-learning. Especially these study results orient better the direction of institutions of higher learning. For the future

research recommendation, this study will be more complete to consider even the private universities and some other public universities. Maybe this will make differences in the study results. It is thought to include the master degree students, age > 22, and lecturers/tutors to show other results. An important point will be the evaluation of the hierarchy structure of the problem with gaussian fuzzy numbers, in order to eliminate the case of zero weights in order to make an optimal decision.

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Appendix

   A. Here we present the full questionnaire developed by the authors Venkatesh V. et al (2003), Jakkaew P., Hemrungrote S. (2017) completed by 528 students from 4 universities of Albania.

Questionnaire/Items	Source
Performance Expectancy (PE)	
1. I find Google Classroom useful in this course of math (PE1)	(Jakkaew P, Hemrungrote S)
2. Using Google Classroom enables me to achieve course related tasks more quickly (downloading notes, assignment submission,etc.) (PE2)	(Jakkaew P, Hemrungrote S)
3. Using Google Classroom increases my learning productivity (PE3)	(Jakkaew P, Hemrungrote S)
4. If I use Google Classroom, I will increase my chances of passing the course (PE4)	(Jakkaew P, Hemrungrote S)
Effort Expectancy (EE)	
1. It is easy for me to become skilful at using Google Classroom (EE1)	(Venkatesh et al 2003)
2. I find Google Classroom easy to use (EE2)	(Al-Maroof RAS, Al-Emran M)
3. Learning to operate Google Classroom is easy for me (EE3)	(Venkatesh et al 2003)
4. My interaction with Google Classroom is clear and understandable. (EE4)	(Venkatesh et al 2003)
Social Influence (SI)	
1. My friends who are important to me think that I should participate in Google Classroom (SI1)	(Jakkaew P, Hemrungrote S)
2. My peers who influence my behavior think that I should use Google Classroom(SI2)	(Jakkaew P, Hemrungrote S)
3.Other people whose opinions I value prefer that I use Google Classroom (SI3)	(Jakkaew P, Hemrungrote S)
Facilitating Conditions (FC)	
1.I have the resources necessary to participate in Google Classroom (internet smartphone etc) (FC1)	(Jakkaew P, Hemrungrote S)
2. I have the knowledge necessary to participate in Google Classroom (FC2)	(Jakkaew P, Hemrungrote S)
3. I can get help from others when I have difficulties while using Google Classroom (FC3)	(Jakkaew P, Hemrungrote S)
Hedonic Motivation (HM)	
1.Using Google Classroom is fun, compared to traditional classroom. (HM1)	(Jakkaew P, Hemrungrote S)
2. Using Google Classroom is enjoyable, compared to traditional classroom (HM2)	(Jakkaew P, Hemrungrote S)
3. Using Google Classroom is entertaining, compared to traditional classroom (HM3)	(Jakkaew P, Hemrungrote S)
Habit (HT)	
1. Using Google Classroom has become a habit for me (HT1)	(Jakkaew P, Hemrungrote S)
2. Using Google Classroom has become natural to me (HT2)	(Jakkaew P, Hemrungrote S)
3. Using Google Classroom is addictive (HT3)	(Jakkaew P, Hemrungrote S)
4. I feel that I must use Google Classroom (HT4)	(Jakkaew P, Hemrungrote S)
Behavioral Intention (BI)	
1. I intend to continue using Google Classroom in the future (BI1)	(Jakkaew P, Hemrungrote S)
2. It is worth to recommend the Google Classroom for other students (BI2)	(Al-Maroof RAS, Al-Emran M)
3. I plan to continue to use Google Classroom frequently (BI3)	(Jakkaew P, Hemrungrote S)
Use Behaviour (UB)	
1. I use Google Classroom for writing quizzes and submitting assignments behaviour (UB1)	(Kumar JA, Bervell B)
2. I use Google Classroom to interact with online materials, peers and instructor (UB2)	(Kumar JA,Bervell B)