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SELECTION OF VIDEO CONFERENCE APPLICATION FOR MATHEMATICS LEARNING USING INTUITIONISTIC FUZZY MAX-MIN AVERAGE COMPOSITION METHOD

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ABSTRACT

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In this article, the Intuitionistic Fuzzy Max-Min Average Composition method is used, which aims to choose the right video conferencing application for learning mathematics. The results show that the learning process in Mathematical economics, Calculus, Statistics, and Geometry courses are more appropriate using the Microsoft Teams video conferencing application than Zoom and Google Meet.

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1. INTRODUCTION

Mathematics is one of the basic fields of science that has an important role in developing science and technology. Mathematics is also a tool to develop the way of thinking of every human being. Therefore, learning mathematics is very necessary both for everyday life and in dealing with advances in science and technology (Science and Technology), so mathematics needs to be provided to every student since elementary school, even since kindergarten (kindergarten). The need for mathematics subjects to be given to all students starting from kindergarten schools whose purpose is to equip students with the ability to think logically, analytically, systematically, critically, and creatively, and work together. In learning mathematics, various learning models and learning strategies are very well applied in the teaching and learning process in the classroom. Associated with the learning model and learning strategies used, educators tend to choose and use appropriate learning models and learning strategies in accordance with the subject matter to be delivered [1]. According to Kamaruddin et al. [2] mastery of mathematics from an early age is very important. This is necessary so that students can have the ability to obtain, manage and utilize information to survive in an ever-changing and competitive situation.

The current outbreak of the Covid-19 virus has hampered all human activities in various fields, especially in the education, which involves students and education staff. Teaching and learning activities in schools indeed run differently than before. Different policies issued by the Indonesian government to limit the spread of the Covid-19 virus are by imposing physical and social distancing to the implement Large-Scale Social Restrictions [3]. So in a situation like this, the distance learning system currently being carried out is an online-based. Thus, learning activities carried out by students and educators are assisted by several media applications, such as Zoom application, Google Meet, and Microsoft Teams, which can support the synchronous process of teaching and learning mathematics [4].

This poses a challenge for all levels of education to keep face-to-face classes active. One of them is at the Higher Education level, where several courses must be taught face-to-face directly to support the process of knowledge transfer and student cognitive development. The obstacles generally found in online mathematics learning are related to quotas or network conditions and mathematical material that is difficult to understand due to the limitations of the teacher's explanation, and this cannot be separated from the use of learning applications correctly and adequately [5]–[7]. In addition, there are also advantages of online learning in mathematics material, namely the recorded explanation can be repeated, there is an increase in good learning outcomes, and graduate learning outcomes can be adequately completed [8]–[10].

That way, online learning during this pandemic period certainly provides a new experience for educators and students, where there are advantages and disadvantages. The advantages of online learning are that it is not limited by time, has a lot of free time, is independent, provide and s learning experiences through video, audio, and text in conveying information. However, the disadvantage is that the delivery of material could be more precise because the internet network can be slow at any time. There is a lack of interaction between students and teachers, so there is boredom and a monotonous atmosphere in learning [11].

The online learning experience that has been carried out during the Covid-19 pandemic, so that it can be taken into consideration in choosing the right learning application for mathematics material according to the needs of the material from the various types of applications available for use in teaching mathematics. According to Ekawardhana, [12] students are more interested in learning to use video conferencing because it is influenced by the learning style of most students, namely audio-visual. So that the determination of the selection of applications in learning will affect students' mathematics learning outcomes. It is proven in research [13]–[16] which revealed that students' mathematics learning outcomes increased after using video conferencing in learning. This emphasizes that using video conferencing applications in learning mathematics is very important.

Choose the right application in learning mathematics, of course, the right method is needed as well, in the development of probability science, the fuzzy method has been widely used in research, especially in decision-making. Fuzzy set theory was first introduced by Zadeh [17]. Before the theory of fuzzy sets emerged, it was known that a classical set was often called a crisp set whose membership had a value of either true or false. Many researchers have continued to improve and apply this theory in real life, for example, Anatassov [18] introduced the intuitionistic fuzzy set which is a generalization of the fuzzy set concept. In 2014, Ejegwa [19] reviewed the intuitionistic fuzzy set. Because the intuitionistic fuzzy set theory, in reality, is not always true if the degree of non-membership of each element of the fuzzy set is equal to one minus the degree of membership, because there is an indeterminate degree. The intuitionistic fuzzy set is a generalization of the fuzzy set. In intuitionistic fuzzy sets, several operations can be defined, such as complement, intersection, union, addition, and multiplication. In addition, it can also be defined as a relation on intuitionistic fuzzy sets, such as the Cartesian product [20].

Ejegwa proposed the application of intuitive fuzzy sets in career determination using normalized hamming distance. Thiruveni et al. introduce medical diagnostic reasoning using extended Hausdorff distances for intuitive fuzzy sets. Sundari, et al [21], introduced a revision of the concept of Intuitionistic Fuzzy Max-Min Average Composition resulting from an intuitive fuzzy modification developed by Samuel et al. [22]. Intuitive fuzzy sets can be more relevant for application solutions to decision-making problems, so in this article, we use Intuitionistic Fuzzy Max-Min Average Composition because the purpose of this study is to choose the right video conferencing application for learning mathematics.

2. RESEARCH METHODS

The data obtained from this study are primary data collected through filling out online questionnaires in the form of a Zoho form by students of mathematics education study programs starting at the undergraduate, postgraduate, and doctoral levels as respondents. The questionnaire contains questions about experiences using video conferencing applications while studying mathematics courses. The type of application selected based on three applications often used in mathematics learning by the conference will then be processed and considered with application criteria and types of courses presented in the following **Table 1**.

Table 1. Subject Table

Variable	Subject
A1	Mathematical Economics
A2	Calculus
A3	Statistics
A4	Geometry

The subjects taken are taught online synchronously by special lecturers in mathematics education study programs, including the subjects in Mathematical Economics, Calculus, Statistics, and Geometry, as shown in **Table 1**.

Table 2. Video Conference Application Criteria for Learning Mathematics

Variable	Criteria
K1	Completeness of Features and Services
K2	Ease of Use
K3	App Availability on All Devicest
K4	Internet Quota Consumption
K5	Access Speed

The application criteria used in **Table 2** are criteria that support the online learning process for mathematics material which is carried out synchronously. The complete features and services in the application support the ease of use and availability of the application on all devices. Application internet quota consumption also affects learning performance, and access speed is the most common criterion affecting the learning process.

Table 3. Video Conferencing App

Variable	Subject
B1	Zoom
B2	Google Meet
B3	Microsoft Teams

The applications in **Table 3** which are the focus of research are three applications, namely Zoom, Google Meet, and Microsoft Teams, these applications are generally used in synchronous online learning. [23], [24]. Then the data will be processed using the Intuitionistic Fuzzy Max-Min Average Composition method.

2.1 Determination of Respondents

Respondents in this study were undergraduate students who were actively studying in the mathematics education study program at universities. Then fill out the Zoho Form online questionnaire that has been distributed. The respondent criteria needed to fill out the questionnaire are respondents who have used one or all of the video conferencing applications and have studied the courses selected in this study.

2.2 Questionnaire Filling

Respondents filled in several questions such as name, level of education, and video conferencing applications that had been used. Next, respondents fill in several options starting from numbers 1- 4 to assess the criteria that have been determined based on the respondent's experience in using video conferencing applications in mathematics education courses.

2.3 IFS Basic Definition

The following are some of the basic definitions used;

Definition 2.1. *Let X be a non-empty set. A fuzzy set A in X is given by* $A = \{< x, \mu A\,(x) >/x \in X\}$ where $\mu A : X \to [0,1]$ is a membership function in the fuzzy set A. $\mu A(x) \in [0,1]$ is the degree of membership $x \in X$ in A. The generalization of the fuzzy set is the intuitionistic fuzzy set (IFS) proposed by Atanassov [18].

Definition 2.2. *If A and B are two IFS of the set* X, A⊆B if and only if $\forall x \in X, \mu_A(x) \le \mu_B(x)$ and $v_A(x) \ge v_B(x)$.

$$A = \{< x, v_A(x), \mu_A(x) >/x \in X\}$$

$$A \cap B = \left\{< x, min\big(\mu_A(x), \mu_B(x)\big), max(v_A(x), v_B(x)) >/x \in X\right\}$$

$$A \cup B = \left\{< x, max\big(\mu_A(x), \mu_B(x)\big), min(v_A(x), v_B(x)) >/x \in X\right\}$$

2.4 Intuitionistic Fuzzy Max-Min Average Composition

Definition 3.1. *Suppose* $P(X \to Y)$ and $Q(Y \to Z)$ are two IFRs. Composition Max-min $P \circ Q$ is the intuitionistic fuzzy relation of $P \circ Q(X \to Z)$ calculated using the membership function

$$\mu_{P\circ Q}(x,z) = Sup\left(\min\left(\mu_R(x,y), \mu_Q(y,z)\right)\right)$$

$$\gamma_{R\circ Q}(x,z) = Inf\left(\max\left(\gamma_R(x,y), \gamma_Q(y,z)\right)\right) \text{ for all } (x,y) \text{ di } XxZ \text{ and for all } y \text{ in } Y$$

Definition 3.2. *Suppose* $P(X \to Y)$ dan $Q(Y \to Z)$ are two IFRs. The composition of Max-min Average P∘ Q is an intuitionistic fuzzy relation of $P \circ Q(X \to Z)$ calculated using the membership function

$$\mu_{P\circ Q}(x,z) = Sup\left(\min\left(\mu_R(x,y), + \mu_Q(y,z)\right)\right)$$

$$\gamma_{R\circ Q}(x,z) = Inf\left(\max\left(\gamma_R(x,y), + \gamma_Q(y,z)\right)\right) \text{ for all } (x,y) \text{ di } XxZ \text{ and for all } y \text{ in } Y$$

2.5 Algorithm

Count $\boldsymbol{R} = \boldsymbol{P} \circ \boldsymbol{Q}$

Count $\boldsymbol{R}'$, where $\boldsymbol{is}$ equal to $\boldsymbol{R}$, but included in the margin of hesitation $\boldsymbol{\pi_R}$

Count $\boldsymbol{T}$, where $\boldsymbol{T} = \{\boldsymbol{\mu_T} = \boldsymbol{\mu_R} + \boldsymbol{\mu_R} \times \boldsymbol{\pi_R}, \boldsymbol{v_T} = \boldsymbol{v_R} + \boldsymbol{v_R} \times \boldsymbol{\pi_R}\}$

Count $\boldsymbol{U}$, where $\boldsymbol{U} = \{\boldsymbol{\mu_T}, \boldsymbol{1} - \boldsymbol{v_T}\}$

Count $\boldsymbol{V}$, where $\boldsymbol{V} = \frac{\boldsymbol{U}}{\boldsymbol{2}}$

Choose a minimum value of V in each line, so it can be concluded that the course is better to use one of the video conferencing applications.

3. RESULTS AND DISCUSSION

Let X be four mathematics courses, namely, $X = \{A1, A2, A3, A4\}$ and Y is a set of criteria for a good zoom application to support the online math learning process, namely $Y = \{K1, K2, K3, K4, K5\}$. For the set of video conferencing applications is Z= $\{B1, B2, B3\}$.

Table 4. Subject vs Criteria for a Good Video Conference $P(X \to Y)$

P	K1	K2	K3	K4	K5
A1	(0.77, 0.20)	(0.81, 0.19)	(0.85, 0.13)	(0.74, 0.22)	(0.87, 0.13)
A2	(0.79, 0.17)	(0.80, 0.16)	(0.79, 0.20)	(0.83, 0.17)	(0.85, 0.14)
A3	(0.77, 0.22)	(0.81, 0.14)	(0.83, 0.12)	(0.82, 0.10)	(0.82, 0.10)
A4	(0.80, 0.18)	(0.84, 0.10)	(0.85, 0.11)	(0.83, 0.14)	(0.81, 0.18)

For Table 4 explains the correlation results $X \to Y = (D_K, D_T)$ which contains the degree of membership (D_K) and non-membership (D_T) where is the degree of membership (D_K) obtained from the results of respondents' answers which are averaged using the formula $D_K = \frac{\sum_{i=1}^{n} S_i}{\theta}$ where S_i is the total score obtained by each respondent in each category, and $\theta = N \times K \times B \times i_{max}$ where N is the number of respondents, K is the number of subcategories, B is the number of applications used, and i_{max} is the maximum score for each item. For (D_T) determined based on the researcher's subjective assessment of the value of $D_K + D_T \leq 1$.

Table 5. Criteria for a Good Video Conference vs Video Conference Applications $Q(Y \to Z)$

Q	B1	B2	B3
K1	(0.84, 0.11)	(0.76, 0.23)	(0.74, 0,25)
K2	(0.89, 0.08)	(0.85, 0.14)	(0.72, 0,27)
K3	(0.90, 0.08)	(0.86, 0.13)	(0.74, 0.22)
K4	(0.84, 0.10)	(0.79, 0.19)	(0.78, 0,18)
K5	(0.84, 0.13)	(0.85, 0,12)	(0.82, 0.16)

For Table 5 explains the correlation results $Y \to Z = (D_K, D_T)$ which contains the degree of membership (DK) and non-membership (D_K) where is the degree of membership (D_T) obtained from the results of respondents' answers which are averaged using the formula $D_K = \frac{\sum_{i=1}^{n} S_i}{\theta}$ where S_i is the total score obtained by each respondent in each category, and $\theta = N \times A \times K \times i_{max}$ where N is the number of respondents, A is the number of courses, K is the number of subcategories, and i_{max} is the maximum score for each item. For (D_T) determined based on the researcher's subjective assessment of the value of $D_K + D_T \leq 1$.

Table 6. Max-Min Average Composition IFS R= $P \circ Q$

R	B1	B2	B3
A1	(0.88, 0.11)	(0.86, 0.13)	(0.85, 0.15)
A2	(0.85, 0.12)	(0.85, 0.13)	(0.84, 0.15)
A3	(0.87, 0.10)	(0.85, 0.11)	(0.82, 0.11)
A4	(0.88, 0.09)	(0.86, 0.12)	(0.84, 0.16)

The data in Table 6 is obtained from the results of operations using Definition 3.2 where the Composition is the Max-min Average $P \circ Q$ is an intuitionistic fuzzy relation of $P \circ Q(X \to Z)$ calculated using the membership function

$$\mu_{P \circ Q}(x, z) = Sup\left(\min\left(\mu_R(x, y), + \mu_Q(y, z)\right)\right)$$

$$\gamma_{R \circ Q}(x, z) = Inf\left(\max\left(\gamma_R(x, y), + \gamma_Q(y, z)\right)\right)$$ for all (x, y) di XxZ and for all y in Y

Table 7. $\boldsymbol{R'} = [(\boldsymbol{P} \circ \boldsymbol{Q}) - \mathbf{1}]$

R'	B1	B2	B3
A1	(0.88, 0.11, 0.01)	(0.86, 0.13, 0.01)	(0.85, 0.15)
A2	(0.85, 0.12, 0.03)	(0.85, 0.13, 0.02)	(0.84, 0.15, 0.01)
A3	(0.87, 0.10, 0.03)	(0.85, 0.11, 0.04)	(0.82, 0.11, 0.07)
A4	(0.88, 0.09, 0.03)	(0.86, 0.12, 0.02)	(0.84, 0.16)

The data in Table 7 is obtained from the results of the difference in membership accumulation by adding up the maximum and minimum values for each membership and then deducting one with the x $[(P \circ Q) - 1]$ algorithm.

Table 8. $\boldsymbol{T} = \{\boldsymbol{\mu_T} = \boldsymbol{\mu_R} + \boldsymbol{\mu_R} \times \boldsymbol{\pi_R}, \boldsymbol{v_T} = \boldsymbol{v_R} + \boldsymbol{v_R} \times \boldsymbol{\pi_R}\}$

T	B1	B2	B3
A1	(0.888, 0.111)	(0.8686, 0.1313)	(0.85, 0.15)
A2	(0.875, 0.123)	(0.867, 0.1326)	(0.8484, 0.1515)
A3	(0.8961, 0.103)	(0.884, 0.1144)	(0.8774, 0.1177)
A4	(0.9064, 0.0927)	(0.8772, 0.1224)	(0.84, 0.16)

The data in Table 8 is obtained from the results of the $\{\mu_T = \mu_R + \mu_R \times \pi_R, v_T = v_R + v_R \times \pi_R\}$ algorithm, the algorithm sums up the maximum value in membership R and then multiplies it again with the difference from the results of Table 7.

Table 9. $\boldsymbol{U} = \{\boldsymbol{\mu_T}, \mathbf{1} - \boldsymbol{v_T}\}$

U	B1	B2	B3
A1	(0.888, 0.889)	(0.8686, 0.8687)	(0.85, 0.85)
A2	(0.875, 0.877)	(0.867, 0.8674)	(0.8484, 0.8485)
A3	(0.8961, 0.897)	(0.884, 0.8856)	(0.8774, 0.8823)
A4	(0.9064, 0.9073)	(0.8772, 0.8776)	(0.84, 0.84)

The data in Table 9 is obtained from the results of the $\{\mu_T, 1 - v_T\}$ algorithm, the algorithm produces the difference of v_T in Table 8 which is reduced by 1 to produce a value U.

Table 10. $\boldsymbol{V} = \frac{\boldsymbol{U}}{\mathbf{2}}$

U	B1	B2	B3
A1	(0.8885)	(0.86865)	(0.85)
A2	(0.876)	(0.8672)	(0.84845)
A3	(0.89655)	(0.942)	(0.87985)
A4	(0.90685)	(0.8774)	(0.84)

The data in Table 10 is obtained from the results of the $\frac{U}{2}$, algorithm, where membership U adds up $\mu_T + (1 - v_T)$ and then divided by 2, resulting in a single value of V.

4. CONCLUSIONS

Based on Table 10, it can be concluded that the Mathematics Economics, Calculus, Statistics, and Geometry courses are better at using the Microsoft Teams video conferencing application in online learning.

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