Selecting multiple intelligences on children with weighted product, analytical hierarchy process, simple additive weighting and TOPSIS

M Ahsan\textsuperscript{1}\textsuperscript{*}, W Setiyaningi\textsuperscript{1}, M Susilowati\textsuperscript{2}, R Dijaya\textsuperscript{3} and P H Tjahjanti\textsuperscript{3}

\textsuperscript{1} Informatics Study Program, Faculty of Science and Technology, Universitas Kanjuruhan Malang, Jl. S. Supriadi, No. 48 Malang Jawa Timur, Indonesia
\textsuperscript{2} Program Studi Sistem Informasi, Fakultas Sain dan Teknologi, Universitas Mahamayani Yogyakarta Bantul, Jl. Villa Puncak Tidar Blok N No. 1, Dau, Malang, Jawa Timur, Indonesia
\textsuperscript{3} Universitas Muhammadiyah Sidoarjo, Jl. Mojopahit No 666 B Sidoarjo, Jawa Timur-Indonesia

\*ahsan@unikama.ac.id

Abstract. Multiple intelligence is intelligence possessed by every human being, among these intelligences are linguistic intelligence, musical intelligence, naturalist intelligence, visual-spatial intelligence, logic-mathematical intelligence, interpersonal intelligence, intrapersonal intelligence, and kinesthetic intelligence. Various methods are carried out by researchers to find out intelligence such as through numbers, images, music, words, physical and social-emotional activities. The purpose of this study is to decide and classify student intelligence based on multiple intelligence. The method used is Weighted Product (WP), Analytic Hierarchy Process (AHP) Simple Additive Weighting Method (SAW), ELimination Et Choix TRADITIONAL REAL (ELECTRE), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The four methods are a method that is in MADM and there have been many studies related to that method but no one has examined the determination of multiple intelligence related to these four methods. The results of the Weighted Product method calculation have the highest preference value 0.189261912 namely Verbal-Linguistic Intelligence, Analytic Hierarchy Process Method has the highest preference value 0.294117647 Verbal-Linguistic Intelligence, Simple Additive Weighting method has the highest preference value 0.677316667 verbal-Linguistic Intelligence and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) has the highest value 0.679314281 Verbal-Linguistic Intelligence.

1. Introduction
Multiple Intelligence is one of intelligence possessed by humans [1,2]. The eight types of intelligences consists of 1. Musical (rhythmic intelligence) 2. Bodily (kinaesthetic intelligence), 3. Logical (mathematical intelligence), 4. Visual (spatial intelligence), 5. The Verbal (linguistic intelligence), 6. Interpersonal intelligence, 7. Sometimes intrapersonal intelligence and 8. Naturalistic intelligence [3,4].

Multiple Intelligence is development of brain intelligence (IQ), emotional intelligence (EQ) and spiritual intelligence (SQ) [5]. Intelligence is an ability that haven by someone to see a problem, then solve the problem or create something that can useful for others [6]. While Howard Gardner defines
intelligence as follows: the ability to solve a problem, the ability to create new problems to solved and the ability to create something or offers a valuable service in a cultural community [7]. The purpose of this study is to decide intelligence of students based on multiple intelligence to classify intelligence and know how to learn based on eight intelligences. In addition, it can also make it easier for children to know their intelligence, especially for students.

2. Object of research
This research was conducted to determine intelligence of children in junior high school using the method Weighted Product (WP), Analytic Hierarchy Process (AHP) Simple Additive Weighting Method (SAW), ELimination Et Choix TRaduisant la realitE (ELECTRE), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [8].

The method used in selecting multiple intelligence is as shown in Figure 1 Weighted Product (WP), Analytic Hierarchy Process (AHP) [9], Simple Additive Weighting Method (SAW), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [10].

![Diagram of research concepts and flow of methods](image)

**Figure 1.** Figure step of selecting Multiple intelligence on children. There are stages or processes of the four methods used in determining children's intelligence based on multiple intelligence.

Figure 1 is a map of research concepts and flow of methods Weighted Product (WP), Analytic Hierarchy Process (AHP), Simple Additive Weighting Method (SAW), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The first phase of the WP method normalizes, the preference for alternative $Ai$ is given, Where $\sum W_i = 1$. $W_j$ is the rank positive for the profit attribute, and negative for the cost attribute, and the relation preference of each alternative. The first step of the SAW method determines the suitability rating of each alternative on each criterion, makes a decision matrix based on criteria (Ci), then normalizes the matrix based on the equation adjusted for the attribute type (attribute
gain or cost attribute) so that the normalized R matrix is obtained. From the ranking process, namely the sum of the multiplications of normalized matrices R with the weight vector so that the largest value is chosen as the best alternative (Ai) as a solution. AHP first step makes a hierarchical structure that starts with the main goal. The second step evaluates each criterion and makes a paired comparison matrix and the next evaluation calculates the eigenvectors from each matrix, and gives hierarchical consistency. The TOPSIS procedure is: making a normalized decision matrix; Make a weighted normalized decision matrix; determine the matrix of positive ideal solutions and matrix ideal negative solutions; determine the distance between the values of each alternative with a matrix of positive ideal solutions and a matrix of ideal negative solutions; and Determine preference values for each alternative.

3. Method
The method used in this study is direct observation to the place by interviewing students after the permission date to the relevant parties. Then spread the questionnaire to students to fill in five times to analysed and adjusted to an expert, namely a psychologist. The results of the interview, the analysis of the questionnaire has calculated using the Method Weighted Product (WP), Analytic Hierarchy Process (AHP), Simple Additive Weighting Method (SAW), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [11].

Figure 2. Figure Method with Selecting Multiple intelligence on children. Instrument test multiple intelligence is C₁, C₂, C₃, C₄, and instrument interview is C₁, C₂, C₃, C₄

Figure 2 is the research concept used the Multi-Attribute Decision Making (MADM) technique with multiple intelligence test instruments and direct interviews, this study used a method Weighted Product (WP), Analytic Hierarchy Process (AHP), Simple Additive Weighting Method (SAW), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [12].

Multiple-Attribute Decision Making can process through three stages, namely arrangement of the components of the situation, analysis, and synthesis of information. At this stage preparation of the constituent, constituent will be design, the situation table estimates that alternative identification and specification goals, criteria and attribute.[11] One way of specifying the purpose of the situation [Oi, i=1,…,t] is by way of registering the possible consequences of the alternatives which have identified [Ai, i=1,…,n]. Besides that, the attributes that will be use are also compiled [ak, k=1,…,m] [13]. The model of Multi-Attribute Decision Making (MADM) is evaluating N alternative Aᵢ (i = 1,2,...,N) to M attributes or criteria Cⱼ (j = 1,2,...,M), where each attribute does not depend on each other. Each alternative decision matrix for each attribute, X has given [2].
\[ X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \]  

Where \( x_{ij} \) is an alternative performance rating to \(-i\) to attribute to \(-j\). Weight values that indicate the relative importance of each attribute are given as, \( W \):  

\[ W = \{w_1, w_2, w_3, \ldots, w_n\} \]

Performance rating \( X \), and weight values \( W \) is the main value that represents the absolute preference of the decision maker [14].

There are several methods that can be used to solve problems Multi-Attribute Decision Making (MADM) among others [15].

4. Results and discussion

Determination of intelligence based on the methods that has implemented in Upper Senior High School (SMA) runs smoothly and has the support of the counselling section teacher. The results of the questionnaire trials has carried out for 6 months and the questionnaire validity has processed. Validity and reliability tests of intelligence questions was out in the upper Senior High School Gondanglegi Malang. The validity test technique carried out was through item analysis with the help of the SPSS 22.00 computer program for Windows. The following is a table of results of the trial validity of the intelligence problem.

4.1. Case analysis

In the analysis of this case, it will be discussed on how the calculation of Weighted Product (WP), Analytic Hierarchy Process (AHP), Simple Additive Weighting Method (SAW), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). For example, one student named Arif Budiawan has tested multiple intelligence. Here is an alternative that is initialized in the analysis: \( A_1 = \) Alternative 1 (Rhythmic Intelligence), \( A_2 = \) Alternative 2 (Kinaesthetic Intelligence), \( A_3 = \) Alternative 3 (Mathematical Intelligence), \( A_4 = \) Alternative 4 (Spatial Intelligence), \( A_5 = \) Alternative 5 (Linguistic Intelligence), \( A_6 = \) Alternative 6 (Interpersonal Intelligence), \( A_7 = \) Alternative 7 (Intrapersonal Intelligence) and \( A_8 = \) Alternative 8 (Naturalistic Intelligence) [16,17].

The Questionnaires was test for validity are immediately distributed back to students by applying the Method Weighted Product (WP), Analytic Hierarchy Process (AHP), Simple Additive Weighting Method (SAW), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [10,18].

| Criteria          | Variable | Value        |
|-------------------|----------|--------------|
| Interview 1       | 6.164414003 |
| Interview 2       | 5.385164807 |
| Interview 3       | 7.071067812 |
| Interview 4       | 5.477225575 |
| Test results 1    | 4.123105626 |
| Test results 2    | 3         |
| Test results 3    | 4.358898944 |
| Test results 4    | 6.164414003 |
The weight value used Weighted Product (WP), Analytic Hierarchy Process (AHP), Simple Additive Weighting Method (SAW), and Technique for Order Preference by Similarity to Ideal Solution method on Table 1 in selecting a student's intelligence.

| Method  | Multiple Intelligence                  |
|---------|---------------------------------------|
| AHP     | Verbal-Linguistic Intelligence        |
| SAW     | Mathematical Intelligence             |
| WP      | Intrapersonal Intelligence             |
| TOPSIS  | Interpersonal Intelligence             |
| WP      | Rhythmic Intelligence                 |
| TOPSIS  | Visual-Spatial Intelligence           |
| WP      | Kinaesthetic Intelligence              |
| TOPSIS  | Naturalistic Intelligence              |

The highest analysis and results of alternative values are the recommended results based on the method used. Table 2 is the results of decisions from a student's intelligence. The following are the results of intelligence from students in Senior High School.

![Figure 3](image-url)

**Figure 3.** Results of intelligence from students in Senior High School. The results of filling out the respondents' questionnaire in determining intelligence based on multiple intelligence.

The graph of the results of Figure 3 above is the result of a multiple intelligence test that filled out by respondents in junior high school.

5. **Conclusion**

The results of the decision method can represent the decisions of an expert in determining children's intelligence based on Multiple Intelligence and can help a counselling teacher to see how students learn
The instruments used in the study need to be reviewed to obtain the results that match the reality. The method used in the research can help the psychology teacher (BK) to give recommendations for students in choosing majors and as material to decide the way or style of learning from a student.

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