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# MODEL OF DETERMINATION OF COOPERATIVE LEARNING TYPE TECHNIQUES USING AHP METHOD

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**ABSTRACT–**Cooperative learning can accelerate knowledge transfer and social interaction between students. There are various cooperative learning techniques that can be used in the learning process. The determination of cooperative learning techniques needs to pay attention to the objectives to be achieved from the application of cooperative learning. In general, there are 5 goals to be achieved in cooperative learning, namely: Reward Interdependence, Task Interdependence, Individual Accountability, Teacher Imposed Structure, and Group Competition. Each cooperative learning technique will provide different results for each objective. Therefore, it is necessary to determine the weight of each goal properly so that later it can be considered which cooperative learning techniques can be used. One method that is very good in the process of determining the weight using a pairwise comparison matrix is the Analytical Hierarchy Process (AHP). The reason for using the AHP method is that the expert sometimes finds it difficult to directly assess which goals of cooperative learning should be prioritized and it will be more comfortable to provide an assessment in the form of comparisons between existing goals. The purpose of this study is to propose a model for determining cooperative learning techniques using the AHP method. The novelty of this research is to produce a model that can assist universities in determining the cooperative learning model that best suits their conditions. The results showed that the existence of this model can help the process of determining the type of cooperative learning based on priority cooperative learning goals. The results showed that the Jigsaw II method is the best cooperative learning technique.

**KEY WORDS** : Cooperative Learning, Pairwise Comparison Matrix, Analytical Hierarchy Process, Cooperative Learning Goals

## 1. INTRODUCTION

The community at this time has faced the need to collaborate and work together, including in the world of education to develop collaborative skills[1]. Collaborative ability in problem solving is one of the skills that since 2015 has been assessed in The Program for International Student Assessment (PISA)[2]. Learning that is oriented towards skills and prioritizes motivation will not succeed if it ignores the involvement of students and involves them actively in learning because it will end up in students feeling bored and monotonous[3].

Cooperative learning emphasizes the formation of small groups of students with different abilities and backgrounds[4], which emphasizes efforts to pursue the highest achievement for each individual and group involved in learning through communication, team work, and mutual trust[5]. Slavin[6] argues that the cooperative learning model is structured and can be used at any level and in most subjects in schools. This model involves the teacher as a facilitator who divides students into a study group and directs the discussion to be carried out. Members of this study group are heterogeneous which means they consist of students with different backgrounds (race, gender, character, ability, etc.)[7]. Heterogeneity in groups will train students to be able to

interact with each other and confidently share thoughts in order to solve existing problems[8].

There are 7 (seven) cooperative learning that can be used, namely: Teams Game Tournament (TGT), Student Team Achivement Division (STAD), Jigsaw, Jigsaw II, Small-Group Teaching, Johnson Techniques, and Wheeler Techniques. Each technique has different outcomes related to goals in cooperative learning. In general, there are 5 (five) goals in cooperative learning, namely: Reward Interdependence, Task Interdependence, Individual Accountability, Teacher Imposed Structure, and Group Competition[9].

Each educational institution has a different emphasis on cooperative learning goals[10], so it is necessary to determine the priority weight of each goal in cooperative learning so that cooperative learning techniques can be selected which are appropriate[10]. Basically, when the expert is needed to determine the priority weight of each existing criterion[11, p. 20], they will experience difficulties and will be more comfortable to provide an assessment in the form of a comparison[12]. Analytical Hierarchy Process (AHP) is a decision making method based on a pairwise comparison matrix given by the expert[13]. This method is very suitable if the determination of priority weights is based on comparisons between existing goals[14].

Based on the results of research conducted by a number of researchers, there is no suitable model for determining the cooperative learning model based on the 5 (five) goals proposed by[9]. The purpose of this study is to propose a model for determining cooperative learning techniques using the AHP method. The novelty of this research is to produce a model that can assist universities in determining the cooperative learning model that best suits their conditions.

## 2. RESEARCH METHOD

Model of Determination of Cooperative Learning Techniques using AHP Method will be proposed in this study.

### 2.1. Method

This research was conducted at STMIK TIME based on learning that has been running in the 2019-2020 period by involving assessments from lecturers.

Figure 1 illustrates the phases of the study process.

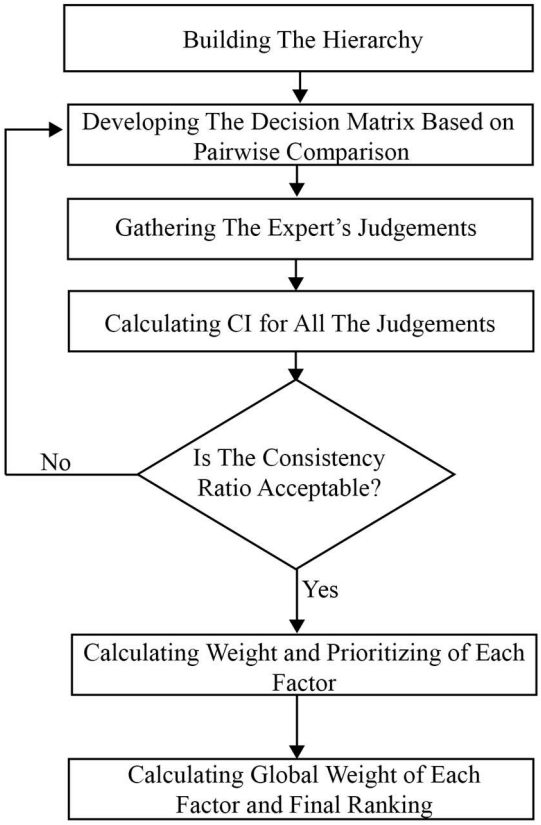


Fig. 1. Research Method

Based on Figure 1, it can be seen that the research begins with determining the techniques and goals of cooperative learning. The goal of cooperative learning will be the basis for determining the appropriate cooperative learning model. The next step is to determine the weight of each goal. Then measure the consistency based on the weight obtained. Then based on the weight of each existing goal, the most suitable cooperative learning technique can be obtained.

### 2.2 Cooperative learning

Lee[15]believe that the success of TGT depends on collaboration with different team members in each group, because in addition to improving learning outcomes, this will develop a number of important competencies needed in community life. Students with high academic achievement tend to be self-directed and find it difficult to work together in groups, especially when working with group members with lower levels of academic achievement and will find it easier to work with group members with uniform academic achievement[16].

The principle of rotation in cooperative learning offers many advantages because it allows each student with the dynamics in social life that tends to be diverse and can develop creative and critical thinking skills, interpersonal skills, leadership, communication skills, and collaborative skills, as well as expertise in certain fields[17].

The characteristics of the various types of cooperative learning can be seen in Table I[6].

Table 1. Characteristics of the type of cooperative learning (RI : Reward Interdependence, TI: Task Interdependence, IA : Individual Accountability, TIS : Teacher Imposed Structure, GCS : Group Competition Used, H : High, L : Low)

| Techniques | Goal | | | | |
|---|---|---|---|---|---|
| | RI | TI | IA | TIS | GCS |
| TGT | H | L | H | H | Yes |
| STAD | H | L | H | H | Yes |
| Jigsaw | L | H | H | H | No |
| Jigsaw II | H | H | H | H | Yes |
| Small-Group Teaching | L | H | L | L | No |
| Johnson Techniques | L | L | L | L | No |
| Wheeler Techniques | H | H | L | H | Yes |

Based on Table I, it can be seen that there are 5 (five) goals that are considered in the selection of cooperative learning, namely: Reward Interdependence, Task Interdependence, Individual Accountability, Teacher Imposed Structure, and Group Competition Used. Each technique will then be measured according to the 5 (five) existing goals. There are 7 (seven) techniques measured, namely: TGT, STAD, Jigsaw, Jigsaw II, Small-Group Teaching, Johnson Techniques, and Wheeler Techniques.

2.3 Analytical Hierarchy process

The stages of AHP are as follows[18].

1. Create a comparison matrix for each goal.
2. Find relative weight for each goal.
3. Calculating the consistency ratio.

## 3. RESULT AND DISCUSSION

This research will propose The Model of Determination of Cooperative Learning Techniques using AHP Method.

### 3.1. Create a Comparison Matrix For Each Criteria Using Hesitant Fuzzy Geometric Mean

A pairwise comparison matrix is a matrix that includes expert comparisons of the value of different parameters in order to evaluate the weight of each criterion. Equation 1 shows the pairwise comparison matrix.

$$D = \begin{bmatrix} d_{11} & d_{12} & \dots & d_{1n} \\ d_{21} & d_{22} & \dots & d_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ d_{n1} & d_{n2} & \dots & d_{mn} \end{bmatrix} \quad (1)$$

where $d_{ij} = 1$ when i = j

### 3.2. Find Relative Weight of Each Criteria

For calculating relative weight of each criteria, Matrix N is determined as can be seen in Equation 2[19].

$$N = \begin{bmatrix} w_{11} & w_{12} & \dots & w_{1n} \\ w_{21} & w_{22} & \dots & w_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ w_{n1} & w_{n2} & \dots & w_{mn} \end{bmatrix} \quad (2)$$

Where $w_{ij}$ can be determined using Equation 3.

$$w_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad (3)$$

Then the weight of alternative i can be calculated using Equation 4.

$$Weight\ of\ Alternative\ i = \frac{\sum_{j=1}^{n} w_{ij}}{n} \quad (4)$$

### 3.3 Calculating The Consistency Ratio

Consistency ratio can be calculating using Equation 5[20].

$$CR = \frac{CI}{RI} = \frac{Consistency\ Index}{Random\ Consistency\ of\ A} \quad (5)$$

Where $CI$ can be calculating using Equation 6.

$$CI = \frac{\lambda max - n}{n - 1} \quad (6)$$

Random Index (RI) Value can be seen in Table 2.

Table 2.Random Index

| n | RI |
|---|---|
| 1 | 0.00 |
| 2 | 0.00 |
| 3 | 0.58 |
| 4 | 0.90 |
| 5 | 1.12 |
| 6 | 1.24 |
| 7 | 1.32 |
| 8 | 1.41 |
| 9 | 1.45 |
| 10 | 1.49 |

CR is acceptable if $CR \leq 0.1$

In Table II, it can be seen the value of the Random Index (RI) for each number of categories being measured.

### 3.4 An Illustrative Examples

The Model of Determination of Cooperative Learning Techniques using AHP Method was used to illustrate the process of determining the cooperative learning techniques with the 5 (five) goals.

1. The assessment of each goal for calculating the weight of each goal that given by the expert can be seen in Table 2

Table 3. Expert Opinion

| | Goal 1 | Goal 2 | Goal 3 | Goal 4 | Goal 5 |
|---|---|---|---|---|---|
| Goal 1 | 1 | 1/3 | 1/2 | 2 | 1/2 |
| Goal 2 | 3 | 1 | 2 | 4 | 1 |
| Goal 3 | 2 | 1/2 | 1 | 3 | 3 |
| Goal 4 | ½ | ¼ | 1/3 | 1 | 1 |
| Goal 5 | 2 | 1 | 1/3 | 1 | 1 |

In Table 3 it can be seen that the experts provide an assessment for each goal in the form of a pairwise comparison matrix. Based on this pairwise comparison matrix, the weight of each goal can be measured.

2. Find Relative Weight of Each Criteria.
The matrix N that obtained from calculation using Equation 2 can be seen as follows.

$$N = \begin{pmatrix} 0.12 & 0.11 & 0.12 & 0.18 & 0.08 \\ 0.35 & 0.32 & 0.48 & 0.36 & 0.15 \\ 0.24 & 0.16 & 0.24 & 0.27 & 0.46 \\ 0.06 & 0.08 & 0.08 & 0.09 & 0.15 \\ 0.24 & 0.32 & 0.08 & 0.09 & 0.15 \end{pmatrix}$$

To find the weight of each criteria a matrix W is found by calculating the average for each row of the matrix "N".

$$W = \begin{pmatrix} w_1 = \dfrac{0.12 + 0.11 + 0.12 + 0.18 + 0.08}{5} = 0.13 \\ w_2 = \dfrac{0.35 + 0.32 + 0.48 + 0.36 + 0.15}{5} = 0.33 \\ w_3 = \dfrac{0.24 + 0.16 + 0.24 + 0.27 + 0.46}{5} = 0.27 \\ w_4 = \dfrac{0.06 + 0.08 + 0.08 + 0.09 + 0.15}{5} = 0.09 \\ w_5 = \dfrac{0.24 + 0.32 + 0.08 + 0.09 + 0.15}{5} = 0.18 \end{pmatrix}$$

Notice that $\sum w_i = 1$

3. Calculating The Consistency Ratio
\lambda_{max} can be calculated as follows.

$$\lambda_{max} = \sum AW$$

Where AW calculated as follows.

$$AW = \begin{pmatrix} 1 & \frac{1}{3} & \frac{1}{2} & 2 & \frac{1}{2} \\ 3 & 1 & 2 & 4 & 1 \\ 2 & \frac{1}{2} & 1 & 3 & 3 \\ \frac{1}{2} & \frac{1}{4} & \frac{1}{3} & 1 & 1 \\ 2 & 2 & \frac{1}{3} & 1 & 1 \end{pmatrix} x \begin{pmatrix} 0.13 \\ 0.33 \\ 0.27 \\ 0.09 \\ 0.18 \end{pmatrix} = \begin{pmatrix} 0.65 \\ 1.8 \\ 1.51 \\ 0.51 \\ 1.28 \end{pmatrix}$$

$$\lambda_{max} = 0.65 + 1.8 + 1.51 + 0.51 + 1.28 = 5.25$$

Consistency Index (CI) can be calculated as follows.

$$CI = \frac{\lambda_{max} - n}{n - 1} = \frac{5.25 - 5}{5 - 1} = 0.0625$$

The Random Index (RI) from Table 1 is 0.9. Consistency Ratio (CR) can be calculated as follows.

$$CR = \frac{CI}{RI} = \frac{0.0.625}{1.12} = 0.056$$

Since CR $\leq$ 0.1, the CR is acceptable.

The priority of each goal is as follows.
Goal 2 > Goal 3 > Goal 5 > Goal 1 > Goal 4

Based on the research results with illustrative examples, it can be seen that the Jigsaw II method is the best cooperative learning technique.

## 4. CONCLUSION

Based on the research results, it can be seen that the AHP method can determine the priority level of each goal well. Based on the results of the AHP method, it can be seen that cooperative learning techniques can be determined properly based on the priority of existing goals. The results showed that the Jigsaw II method is the best cooperative learning technique. Further Research, this research can be developed by receiving input in the form of linguistic variables.

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