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ANALYZING STUDENTS' PERFORMANCE IN CALCULUS USING FUZZY ANP: AN INNOVATIVE APPROACH

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ABSTRACT

Universiti Teknologi MARA offers many diploma programs with different study plans for students to enroll. One of the diploma programs offered is Diploma in Computer Science (CS110) which requires students to take Calculus in their study plan. However, previous students' achievements have shown that many Computer Science students performed badly in this subject. There must be underlying reasons or factors that lead to this low achievement. The identification of the factors involved is crucial in measuring and analyzing the students' performance. For that reason, Fuzzy Analytic Network Process (FANP), a decision-making instrument was constructed in this project, focusing on the selection process to calculate, rank and identify the most influential factor that contributes to the students' performance in Calculus. Three factors and eleven sub-factors were analysed. Then, the percentage value of each sub-factor was calculated using FANP, which has subsequently produced the ranking for each sub-factor. By identifying the factor, both students and lecturers can work together to find ways to overcome the problem. The findings show that sub-factor of relationship between students and lecturer (S23) hits the first place in the ranking order followed by parenting style (S13) and instructional strategies and methods (S22).

Keywords: calculus, fuzzy ANP, factors

1. INTRODUCTION

At the university level, Mathematics has become one of the crucial indicators to measure students' academic achievement. Most of the programs in the field of science and technology have included Mathematics as one of their subjects in the study plan [1]. This requires students to have a strong foundation in Mathematics to help them survive in their study. However, students' performance in Calculus, one of the subjects offered in Mathematics field, is quite worrying. Students learn Calculus only to pass the examination; as a result, the tasks or problems discussed and learnt during lessons seem meaningless to them [2]. As for educators, the quality of teaching has been a major challenge to improve the students' performance. Accordingly, identifying the factors that influence students' achievement in Calculus is very important and has been the focus of researchers in order to suggest related aspects that need extra attention and further improvement [3].

The uncertainty of factors has become the main issue in tackling this problem. If this issue is not addressed, it will lead to poor academic performance and quality of life. In this project, Fuzzy Analytic Network Process (ANP) method was applied to investigate the factors and sub-factors that contributed to

the students' performance. As the most contributing sub-factor can be obtained using the method, it has been widely used to solve the problems related to decision-making process. The method also provides a ranking order based on the percentage of each sub-factor that benefits the students and lecturers to improve the achievement of this subject.

2. METHODOLOGY

This project used Fuzzy Analytical Network Process (ANP), a Multi-Criteria Decision Method (MCDM) to rank the sub-factors that affect students' performance in Calculus.

2.1. Development of the Hierarchical Structure

This project comprises three levels of hierarchy; objective, factors and sub-factors (Figure 1). The chosen factors (demographic, instructional and individual) were adapted from [3], together with eleven sub-factors (Table 1).
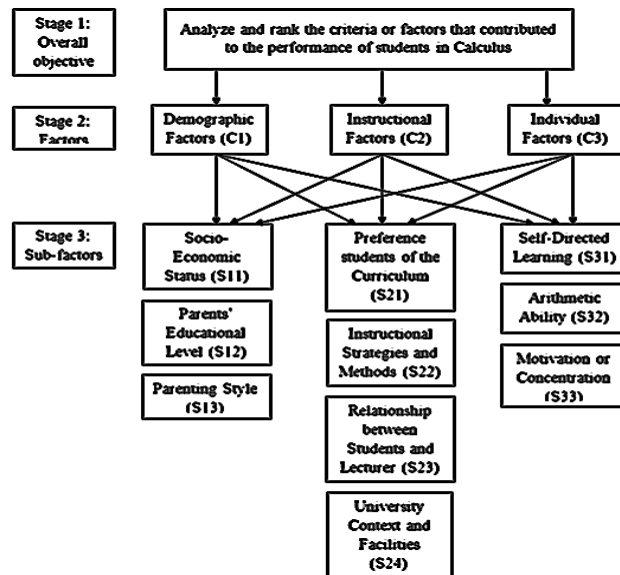

Figure 1. Hierarchical Structure of the Student's Performance

2.2. Execution of steps in obtaining the ranking of sub-factors [4]:

Step 1: Compute Local Weights of Factor and Sub-Factors

Local weights of factors and sub-factors were computed using pairwise comparison technique. All linguistic scales were represented by triangular fuzzy number [4]. Chang's extended analysis [5] was applied to compute the local weights for factors and sub-factors that comprises three steps; finding the value of fuzzy synthetic extent, computing the degree of possibility and producing the local weights.

Step 2: Compute Interdependent Weights of the Factors/Sub-Factors

The interdependent weights were computed by multiplying the degree of relative impact of factors/sub-factor with the normalized local weights of factors.

Step 3: Calculate Global Weight for the Sub-Factors

The global weights for sub-factors were calculated by multiplying the weight of the factor to which it belongs to with the local weight of sub-factors.

Step 4: Calculate the Percentage of Sub-Factors

The percentage of each sub-factor was determined by multiplying the global weight of sub-factor and scale value.

Step 5: Establish the Ranking Order

The highest value of percentage of sub-factors was identified by establishing the ranking order of all values. This last step indicates the factor which brings the largest impact to students' performance in Calculus.

3. RESULT AND DISCUSSION

The outcomes of the project were generated by analyzing the data from 32 respondents that had responded regarding factors and sub-factors of their performance. Table 1 shows the percentage value of each sub-factor and the preference ranking order of sub-factors.

Table 1. Ranking of Sub-Factors by Percentage Value

Sub-Factors	Percentage	Ranking
S11 - Socio-Economic Status	0.0833	4
S12 - Parents' Educational Level	0.0000	6
S13 - Parenting Style	0.1667	2
S21 - Preference Students of the Curriculum	0.0000	6
S22 - Instructional Strategies and Methods	0.0872	3
S23 - Relationship between Students and Lecturer	0.1727	1
S24 - University Context and Facilities	0.0768	5
S31 - Self-Directed Learning	0.0000	6
S32 - Arithmetic Ability	0.0000	6
S33 - Motivation or Concentration	0.0000	6

The result shows that sub-factor of relationship between students and lecturer (S23) is at the first place in the ranking order, followed by sub-factor of parenting style (S13). The finding which reveals the most contributing sub-factors of students' performance in Calculus meets the purpose of the project. It is hoped that the finding will benefit students and lecturers in improving the academic performance in Calculus. Future studies might consider other factors and different approaches that may offer more comprehensive, yet more accurate and thorough results.

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