FACTORS INFLUENCING STUDENTS' PERFORMANCE IN COMPUTER PROGRAMMING: A FUZZY SET OPERATIONS APPROACH

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ABSTRACT
We are still far from a full understanding of why some students learn to program easily and quickly while others do not. Some factors influencing performance of students in learning computer programming was investigated in this study; with a view to provide a basis for informed discussions on how to improve curricula and enhance the interest of Computer Science students in programming. A structured questionnaire was administered on 168 students of Computer Science at the University of Ibadan, Nigeria on factors they considered affecting their performance in computer programming. A fuzzy set operations approach to solving group decision making problems was then adopted on their responses. This method considers two kinds of sets. The first set is a collection of factors, while the second set is a collection of decision-makers. Respondents gave their opinions according to their own criteria for each factor on a five-point scale (Strongly Agreed, Agreed, Undecided, Disagreed and Strongly Disagreed). The union of their evaluations to all the currently available alternatives was represented in the form of a fuzzy set. The result showed that the punctuality and regularity of the lecturers were the most important factors, followed by the students' personal interest in programming students' regular attendance at classes, students' positive perception about programming and the lecturers' attitudes in class in that order.

KEYWORDS: *Fuzzy set operations, Outliers, Decision maker, Computer Programming.*

I. INTRODUCTION

The number of Computer Science students who could not write error-free computer programs and the failure rates in programming courses at the university level are indicators that learning to program is a difficult task. One source suggests that the failure rate is as high as 30 percent (Guzdial and Soloway, 2002). Student's success or failure in programming courses usually affects the decision whether to continue in the field of Computer Science or not. In some cases students were asked to change their courses to a less tasking one as a result of too much failure in a particular field of study. If a student fails, or passes with a struggle, that student is not likely to register for a follow-on course in that field and they try harder in other courses to get a good cumulative gross product average which tends to affect their capability in the field of concern. In spite of researches on factors that influence the enrolment and success of students in programming, it is still not fully understood what makes computer programming easy for some, but difficult and frustrating for others.

One can argue that the same set of students who failed or passed with a struggle in programming courses do well in other courses which they took alongside the programming courses, which suggests that something is wrong somewhere. Various factors identified by various researchers on this issue so far are not limited to learning computer programming alone, they are applicable in all spheres of learning, this makes further studies in this area very important as the global demand for software powered technologies is on the increase. It might be very difficult to meet this demand if students of Computer Science do not know how to program.

The key idea behind the use of fuzzy set operations approach is the nature of the problem at hand; the problem involves the need to seek consensus among many decision makers (students) who are directly affected by the factors been considered. Selecting the factors that influence students' performance in computer programming is not an easy task as it involves human decision making process where basically

there exist elements of vague, imprecise or subjective judgment which cannot be handled effectively by probability theories. Due to these constraints, a method that can be suitably applied is the fuzzy set theory where students gave their opinions according to their own criteria for each factor by selecting a value from [0, 1], the union of their evaluations to all the currently available alternatives can then be represented in the form of a fuzzy set.

In this paper, we identify the crucial factors that influence the performance of students in computer programming by giving questionnaire to a group of students who were already in the second, third and fourth year in the University of Ibadan, Nigeria. The factors were ranked according to how much influence they have on the students' performance. In determining the best criteria, we implemented a decision making method using Fuzzy set operation approach introduced by Çagman and Wang (2011) since it is simple and effective to use.

The rest of the paper is organized as follows. Works related to this study are presented in Section 2. The basic concepts underlying the Fuzzy set operation is presented in Section 3, while the methodology adopted for the study is presented in Section 4. Section 5 presents the implementation details while the results and discussion are presented in Section 6. In Section 7, we present the conclusion for the study and in Section 8, the future direction of this study is presented.

II. RELATED WORKS

The failure rates in programming courses at the university level are evidence to the fact that learning to program is a difficult task. In spite of research on factors that influence the enrolment and success of students in programming, it is still not fully understood what makes computer programming easy for a very little number of students, but difficult and frustrating for others.

Attitude, they say, is the key to success. According to Erin (2008), attitude is equally as important as ability. (Erin N. Goodykoontz, 2008). Popham, (2005) suggest that student attitudes toward a subject lead to academic success in that subject. Researchers have also found that self efficacy is one of the factors that influence students in acquiring programming skills. For instance Askar and Davenport (2009) work on investigation of factors related to self efficacy for Java programming showed that self efficacy among males were stronger than that of females. This may account for why males dominate the programming world. Miliszewska and Tan (2007) concluded in their work on challenges of imparting programming skills on students that good laboratory facilities, collaboration and on-line submission systems were among the factors that play important roles. The curriculum organization and the teaching methods were also found to be factors that affect students' performance in programming, according to Tavares et al (2001).

The fuzzy set theory introduced by Zadeh (1965) has been extensively used not just in solving engineering and industrial problems but also in management and social sciences, in particular in decision making problems involving human perception. The application of fuzzy set theory in decision making was first discussed in (Bellman and Zadeh, 1970) and later it was applied in many research areas. In particular, fuzzy AHP (Boran *et al.*, 2009), fuzzy TOPSIS (Carlsson and Fuller, 1996), fuzzy outranking method (Ribeiro, 1996) are some of well known methods that have been introduced and can effectively deal with subjective variables in any problem.

Furthermore, due to its theoretic nature, one can also solve decision making problems by merely using the properties of fuzzy set (Abdel-Kader and Dugdale, 2001; Çagman and Wang, 2011; and (Lee, 1996). For instance, Çagman and Wang (2011) applied simple fuzzy set operations in their methods to solve group decision making problems. The new method introduced by Çagman and Wang (2011) was used by Daud *et al*., (2012) to determine the factors influencing students' choice in pursuing to higher institutions in Malaysia. Yusof & Jemain (2004) also used fuzzy set operations approach to determine which factor influenced the students' choice of higher institutions most. They concluded that fees had the largest membership value and was therefore selected as the most important factor when considering the University of Choice, followed by size of university, programs offered, intake regulation, reputation, scholarship and loans offered, location, campus facilities and campus environment. They concluded that fuzzy set operations approach gave reasonable result as it catered subjectivity of the data. Besides, the approach also helped to eliminate in the evaluation the so called outlier decision makers. This elimination serves the purpose of having a more accurate and reliable result.

Selecting the factors influencing Computer Science students in studying computer programming is not an easy task as it involves human decision making process where basically there exist elements of vague, imprecise or subjective judgment. Due to these constraints, a method that can be suitably applied is the fuzzy set theory. Therefore in this study, we employed fuzzy set operations approach to examine the factors that may affect students while learning computer programming.

III. BASIC CONCEPTS

Below, we describe some preliminary definitions of fuzzy set operations as given by Zadeh (1965)
In a universe U, a fuzzy set $\tilde{A}$ is defined by as

$$\tilde{\mathbf{A}} = \{(x, \mu_{\tilde{A}}(x)) : x \in U, \mu_{\tilde{A}}(x) \in [0, 1]\} \quad (1)$$

Where the function, $\mu_{\tilde{A}}(x)$ is called a *membership function*. The value of the membership function, $\mu_{\tilde{A}}(x)$ specifies the grade or degree to any element x in U. Larger values of, $\mu_{\tilde{A}}(x)$ indicate higher degrees of membership. Any fuzzy set is identified by its membership function.
Let $\tilde{A}$ be a fuzzy set in the universe U as in (1). Then the support of $\tilde{A}$ is defined as

$$supp\tilde{\mathbf{A}} = \{x : x \in U, \mu_{\tilde{A}}(x) > 0\} \quad (2)$$

The cardinality of a crisp set A, denoted as $|A|$, is the number of elements of the set A, and the cardinality of a fuzzy set $\tilde{A}$ is defined as:

$$card\tilde{\mathbf{A}} = \sum_{x \in U} \mu_{\tilde{A}}(x) \quad (3)$$

The mean relative cardinality of $\tilde{A}$ is defined as

$$mrc\tilde{\mathbf{A}} = \frac{card\tilde{A}}{|supp\tilde{A}|} \quad (4)$$

and the *α-level set (α-cut)* of $\tilde{A}$ is defined as

$$\tilde{\mathbf{A}}_{\alpha} = \{x : x \in U, \mu_{\tilde{A}}(x) \geq \alpha\} \quad (5)$$

where $\alpha \in [0,1]$. The concept of α-cut is very important in the relationship between fuzzy sets and crisp sets.

IV. METHODOLOGY

A structured questionnaire was administered on 168 students of Computer Science at the University of Ibadan, Nigeria on factors they considered affecting their performance in computer programming. Ninety of them were in their second year while forty and thirty-eight were in their third and final year respectively. The structured questionnaire containing the factors evaluated by the respondents is presented in Appendix A. Students gave their evaluations for all the considered factors according to their opinion in the form of membership grade of fuzzy set. Each of the criteria was evaluated with a value in the interval [1, 5] from the point of view of each student; 1 for Strongly Disagree and 5 for Strongly Agree. Their evaluation were thereafter normalized to [0, 1] as recognized by the fuzzy set operations. For the sake of clarity, the procedure given by by Çagman and Wang, (2011) is explained thus:
Let $A = \{a_1, a_2, \ldots, a_n\}$ be an alternative set and let $B = \{b_1, b_2, \ldots, b_m\}$ be a decision-maker set in a finite universe U_a and U_b, respectively. Then, this method can be described by the following steps in k-cycles.
Step k.1: Let an evaluation of decision-maker $b_i \in B_k$ for an alternative $a \in A$ be a value $b_i(a) \in [0,1]$. Where B_k is a set in k-cycle and $B_1 = B$. Then, for all elements of A, each decision-maker b_i gives his/her evaluations separately and independently according to his/her own preference by a fuzzy set as

$$\tilde{\mathbf{A}}_{bi} = \{(a, \mu_{\tilde{A}bi}(a)) : a \in A, \mu_{\tilde{A}bi}(a) = b_i(a)\} \quad (6)$$

The set labeled (6) is called the *b_i-fuzzy set* for $b_i \in B_k$.
In order to apply the fuzzy set formula in set (1), we have to deal with the universal set, that is, the alternative set A, ($U_a = A$). In this way, each decision-maker bi presents a fuzzy set $\tilde{A}_{bi}$ where the elements are the considered alternatives. Here we assume that the majority of the experts can offer fair and proper evaluations for the alternatives.
Step k.2: In the fuzzy sets $\tilde{A}_{bi}$, an alternative a is given evaluations $b_i(a)$ by the decision-makers $b_i \in B_k$. By using the arithmetic mean concept we can obtain a fuzzy set as follows:

$$\tilde{A}_{Bk} = \{(a, \mu\tilde{A}_{Bk}(a)) : a \in A, \mu\tilde{A}_{Bk}(a) = \frac{1}{|Bk|} \sum_{b_i \in B_k} \mu\tilde{A}_{bi}(a)\} \quad (7)$$

Set labeled (7) is called the *fuzzy mean set* of the sets $\tilde{A}_{bi}$ in the *k*-cycle.

Step k.3: The distances between the sets $\tilde{A}_{bi}$ and the set $\tilde{A}_{Bk}$ for all $b_i \in B_k$ can be characterized by fuzzy sets as

$$\tilde{A}_k(b_i) = \{(a, \mu\tilde{A}_{k(bi)}(a)) : a \in A, \mu\tilde{A}_{k(bi)}(a) = |\mu\tilde{A}_{bi}(a) - \mu\tilde{A}_{Bk}(a)|\} \quad (8)$$

Set (8) is called the *fuzzy distance sets* in *k*-cycle. In this step, we investigate how close each b_i-fuzzy decision set $\tilde{A}_{bi}$, $b_i \in B_k$, to the fuzzy mean set $\tilde{A}_{Bk}$ can be.

Step k.4: By using the mean relative cardinality (4) of each b_i-fuzzy distance sets $\tilde{A}_{k(bi)}$, $b_i \in B_k$, we can evaluate the decision-makers' performance by the following fuzzy set as

$$\tilde{B}_k = \{(b, \mu\tilde{B}_k(b)) : b \in B_k, \mu\tilde{B}_k(b) = 1 - mrc\tilde{A}_k(b)\} \quad (9)$$

This is called the *decision-makers performance fuzzy set* in the *k*-cycle. In order to apply the fuzzy set formula (1), we have to deal with the universal set, that is the decision-maker set *B*, ($U_b = B_k$). In this step, we shall investigate the performance of the decision-makers. The $\mu\tilde{B}_k(b)$ is an evaluation of the performance of decision-maker *b* in *k*-cycle; the higher the better.

Step k.5: Let $s_k^2 = \frac{1}{n}\sum_{bi \in Bk}(\mu\tilde{B}k(bi) - mrc\,\tilde{B}_k)^2$ be sample variance where s_k is the sample standard deviation and *n* is the cardinality of $supp\tilde{B}_k$. Then we can get statistically, an αk as

$$\alpha k = mrc\tilde{B}_k - s_k \quad (10)$$

By using αk we find a subset of the set B_k as

$$\tilde{B}_{\alpha k} = \{b : b \in B_k, \mu\tilde{B}_k(b) \geq \alpha_k\} \quad (11)$$

which is called α_k - *level set*. Where if $\tilde{B}_{\alpha k} \in B_k$, then the procedure has to start (k+1) - cycle with $B_{k+1} = \tilde{B}_{\alpha k}$ If $\tilde{B}_{\alpha k} = B_k$, then the procedure is finished. That is;

$$k\text{-cycle} \begin{cases} \text{goes to } (k+1) - \text{cycle}, & \text{if } \tilde{B}\alpha k \subset Bk \\ stops, & \text{if } \tilde{B}\alpha k = Bk \end{cases}$$

V. IMPLEMENTATION

The considered factors as arrived at after a comprehensive interview was conducted considering all necessary stakeholders in the area of study are as presented in Appendix A.

Data was obtained from 168 students of the University of Ibadan in order to implement the procedure that was described in section 3. By implementing (6) and (7) of the method, we obtained the average membership set from the evaluations of the respondents; the fuzzy distance sets in the cycles were obtained by using (8) and (9). The alpha level set was obtained by using (10) and by using (11), another set was obtained which was used to repeat the procedure for the next cycle after some of the respondents have been eliminated until all the outlier decision makers were eliminated.

VI. RESULTS AND DISCUSSION

The summary presented in Table 1 was obtained from the first cycle with all the 168 decision makers to the last cycle (the sixteenth) when the procedure stopped because there were no outliers left among the decision makers.

Table 1: Summary of the results obtained in the different cycles of the process

Cycle No	No of Decision Makers Evaluated	Value of α_k -level set	No of Outlier Decision Makers	No of Decision makers evaluated in the next cycle
1.	168	0.685283	23	145
2.	145	0.725617	24	121
3.	121	0.748649	20	101
4.	101	0.764725	18	83
5.	83	0.779031	15	68
6.	68	0.794791	16	52
7.	52	0.811823	10	42
8.	42	0.825264	10	32
9.	32	0.841794	5	27

10.	27	0.853463	6	21
11.	21	0.864371	5	16
12.	16	0.877352	3	13
13.	13	0.880794	2	11
14.	11	0.888801	2	9
15.	9	0.892403	1	8
16.	8	0.892634	0	8

Table 1 showed the summary of the result obtained for each cycle; the Cycle number, Number of decision makers evaluated, Value of α_k - level set, Number of outlier decision makers and the Number of decision makers evaluated in the next cycle.

From Table 1, the number of decision makers decreases with the number of cycles. That is, as the number of cycle increases, the number of decision makers decreases until all the outlier decision makers were eliminated.

Also, the α_k - level set which was used to determine the number of decision makers whose decisions were not consistent with that of other decision makers increases as the number of cycle increases, thereby increasing the reliability of the result.

Furthermore, the number of decision makers considered as outliers and therefore eliminated from the process does not have any uniform pattern. It is a function of decision makers whose evaluations fall within a range of values considered to have deviated too much from the evaluations of other decision makers.

Lastly, the number of decision makers who continued with the process keeps decreasing as some of them were eliminated in each cycle until cycle eighteen which is the last cycle when none of them was eliminated as all the remaining decision makers gave consistent values to each of the factors considered. The procedure stopped at the 16^{th} cycle when all the outliers have been eliminated as there was no membership value that was less than the alpha level set in this cycle. We obtained a set of membership value for each of the factors considered.

Table 2: Rating for each member using Fuzzy set operation approach

Rank	Factor	Membership Value
1.	Programming languages lecturers come to class punctually	0.875
2.	Programming languages lecturers come to class regularly	0.875
3.	I have interest in programming beyond the class	0.84375
4.	I attend programming classes regularly	0.8125
5.	Knowing programming will make me somebody in life	0.78125
6.	Programming languages lecturers allow students to ask questions and take time to explain	0.78125
7.	Programming languages lecturers use various teaching methods and techniques	0.75
8.	Programming languages lecturers interact appropriately with students in class	0.75
9.	Programming languages lecturers are friendly in class	0.75
10.	Programming languages lecturers are adequately prepared before coming to class	0.71875
11.	My background in Mathematics and Physics is very strong	0.71875
12.	Programming languages lecturers spend extra time to explain things in class	0.71875
13.	Programming languages lecturers enforce discipline in their class	0.6875
14.	Programming languages lecturers use enough relevant instructional materials	0.65625
15.	Programming courses should be taught in the morning	0.65625
16.	Programming languages lecturers teach well to my understanding	0.625
17.	Programming languages lecturers make me develop interest in their course	0.625
18.	Programming languages lecturers attend to me whenever I have difficulty with their course	0.625
19.	I do not have enough time to study programming	0.46875
20.	Programming languages lecturers are too serious in class	0.4375
21.	We have programming classes at unfavourable times	0.34375
22.	Programming languages lecturers do not deliver course content well	0.34375
23.	The environment where we have programming lectures is not conducive	0.28125
24.	Programming languages lecturers show partiality in their dealing with students	0.25
25.	Programming languages lecturers waste time on irrelevant matters in class	0.25

26.	I do not have interest in programming from onset	0.25
27.	Our society does not place values on programmers	0.21875
28.	Programming languages lecturers handle their class with levity	0.21875
29.	Studying programming is a wasteful effort	0.1875
30.	Programming languages lecturers usually come late to class	0.1875

From Table 2, rating for each factor at the termination of the procedure showed the Rank, Factor and the Membership value associated with each of the factors when the procedure terminated in the sixteenth cycle. As presented in the table, the result shows that the punctuality and regularity of lecturers have the highest membership value of 0.875. Thus, they are the most important factors that influence the performance of students in programming according to this study, followed by the students' interest in programming, their regularity in class, their perception about programming, lecturers reaction to questions in class, lecturers teaching methods and techniques, lecturers interaction with students in class, their preparation before coming to class, students background in Mathematics and Physics, different lecturers attitudes, time to study programming, timing of programming classes, lectures environment and other factors as presented in the table till the last factor with membership value 0.1875. A total of thirty factors were considered, out of which only the first eighteen factors are important because other factors have membership values that are considered so low that their effect on the issue being investigated might not be much.

It is worthy to note here that out of the first eighteen factors in Table 2 that have high membership values, majority has to do with the lecturers, little has to do with the students while none has to do with the environment. We can therefore infer that majority of the factors being investigated has to do with the lecturers. This could be as a result of the fact that studies in this area have centered on the students (both internal and external) and possibly there has been improvement on the part of the students after the implementation of recommendations given by the different researchers in this area.

As reflected in Table 2, it is clear that among the factors that have to do with the lecturers, attitudes have very high membership values especially lecturers' regularity, punctuality, teaching methodology and teacher friendliness in class. The result suggested that if lecturers come to class with better teaching approach, punctually and regularly, students might have more interest in computer programming and therefore come to class regularly which may change their perception about programming to a positive one and therefore better performance in computer programming. Some of these results are in agreement with what other researchers have found in this area. For example, James (1991) found that teaching methods and techniques have effect on students' performance. The quality of study which is a direct result of some of the factors mentioned above was also found to have effect on students' performance (John, 1996). Akinola *et al.* (2012) also opined that a priori knowledge of Physics and Mathematics are essential in order for a student to excel in Computer Programming. This happens to surface as 11th rank in this study.

The most important factor according to this study in relation to students is their personal interest in programming; next to it is their attendance at classes and then their perception about programming. These results are in conformity with what other researchers have done in this area. For instance, Schauman, *et al.*, (1985) found that class attendance has effect on students' performance.

VII. CONCLUSION

As studies reveal that the dropout and failure rates in computer programming courses at the university level is alarming, it is imperative to know what factors affect the interest of students in computer programming. Fuzzy sets operation approach was used as a decision making method in this study and gave a reasonable result as it offers subjectivity of the data. Besides, this approach also helps to eliminate in the evaluation of the so-called outlier decision-makers. This elimination serves the purpose of having a more accurate and reliable result.

This study reveals that lecturers punctuality and regularity; their teaching methodology, attitudes and friendliness, students' personal interest in programming, students' regular attendance of classes and perception about programming, all contribute most to the performance of students in learning computer programming..

As a recommendation, teachers of computer programming need to be enjoined to improve on their attendance and attitude at programming classes. Relevant instructional materials should be provided to

aid the teaching and learning and the lecture time table should be designed in favour of having programming lectures in conducive atmospheres and periods.

VIII. FUTURE WORK

It was observed from this study that the outliers were not evenly spread among the different respondents based on their level of study; this suggests that the factors considered herein did not affect the students of the different levels of study equally, therefore further studies in this area should be restricted to respondents who were reasonably affected almost equally by the factors being considered.

REFERENCES

[1]. Abdel-Kader, M. and Dugdale, D. (2001). Evaluating Investments in Advanced Manufacturing Technology: A Fuzzy Set Theory Approach. *British Accounting Review*, 33 (4), 455-489.
[2]. Akinola, O. S., Akinkunm, B. O., and Alo, T. S. (2012): A Data Mining Model for Predicting Computer Programming Proficiency of Computer Science Undergraduate Students, Africa *Journal of Computing & ICTs*. Vol 5, No.1 pp 43– 52
[3]. Askar Petek and David Davenport (2009). An Investigation of Factors Related to Self Efficacy for Java Programming among Engineering Students. *The Turkish Online Journal of Educational Technology*, Vol. 8, Issue 1, No. 3, pp. 26-32.
[4]. Bellman, R. E. and Zadeh, L. A. (1970). Decision-Making in a Fuzzy Environment. *Management Sciences*, 17 (4), 41-164.
[5]. Boran, F. E., Genç, S., Kurt, M. and Akay, D. (2009). A Multi-Criteria Institutionistic Fuzzy Group Decision Making for Supplier Selection with TOPSIS Method. *Expert Systems with Applications*, 36, 11363-11368.
[6]. Çagman, N., and Wang, X. (2011). A New Group Decision-Making Method Based on Fuzzy Set Operations. *European Journal of Pure and Applied Mathematics*, 4 (1), 42-49.
[7]. Carlsson, C., and Fuller, R. (1996). Fuzzy Multiple Criteria Decision Making: Recent Developments. *Fuzzy Sets and Systems*, 78, 139-153.
[8]. Daud Mohamad, Aidatulsima Abdullah, Siti Shafiqah Razali and Suhaila Zulkifli (2012). Factors Influencing Students' Choice in Pursuing to Higher Institutions: A Fuzzy Set Operation Approach, *IJRRAS*, Vol. 12, No. 3, pp. 463-467.
[9]. Erin N. Goodykoontz (2008). Factors that Affect College Students' Attitude Toward Mathematics.
[10]. Guzdial, M. and Soloway, E. (2002). Log on education: teaching the Nintendo generation to program. *Communications of the ACM*, 45(4), 17-21.
[11]. James R. Leonard (1991). Using a Software Engineering Approach to CS1: A Comparative Study of Student Performance. *SIGCSE Bulletin*, Vol. 23, No. 4.
[12]. John B. Raley (1996). Factors Affecting the Programming Performance of Computer Science Students.
[13]. Lee, H. M. (1996). Group Decision Making Using Fuzzy Sets Theory for Evaluating the Rate of Aggregative Risk in Software Development. *Fuzzy Sets and System*, 80, 261-271.
[14]. Millszewska Iwona and Grace Tan (2007). Befriending computer programming: A proposed approach to teaching introductory programming. *Issues in informing science and information technology.* Volume 4.
[15]. Popham, W. (2005). Students' Attitudes Count. *Educational Leadership*, pp. 84-85.
[16]. Ribeiro, R. A. (1996). Fuzzy Multiple Attribute Decision Making: A Review and New Preference Elicitation Techniques. *Fuzzy Sets and Systems*, 78, 155-181.
[17]. Schauman Howard, Edward Walsh, Camille Olson, and Barbara Etheridge (1985). Effort and Reward: The Assumption that College Grades are Affected by Quantity of Study, *Social Forces*, Vol. 63, No. 4.
[18]. Tavares J., Brzezinski I., Huet I., Cabral A. & Neri D. (2001). "Having Coffee" With Professors and Students Talk About Higher Education Pedagogy and Academic Success. *24th International HERDSA Conference.*
[19]. Yusof M., & Jemain A. (2004). A Fuzzy Approach to Criteria Identification Influencing Students' Choice in Selecting Public Universities (*in malay*). *Jurnal Teknologi*,Vol. 40, pp. 59-71.
[20]. Zadeh, L. A. (1965). Fuzzy Sets. *Information and Control*, 8, 338-353.

APPENDIX A

A FUZZY SET OPERATIONS APPROACH TO DETERMINE THE FACTORS INFLUENCING STUDENT'S PERFORMANCE IN COMPUTER PROGRAMMING

Questionnaire

Level of study: …….Programming languages taken so far: ……

Please tick the option that best describe your opinion about these factors.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
5	4	3	2	1

S/N	Expression	5	4	3	2	1
1.	Programming languages lecturers are adequately prepared before coming to class					
2.	Programming languages lecturers teach well to my understanding					
3.	My background in Mathematics and Physics is very strong					
4.	Programming languages lecturers use various teaching methods and techniques					
5.	I have interest in programming beyond the class					
6.	Programming languages lecturers make me develop interest in their course					
7.	Programming languages lecturers use enough relevant instructional materials					
8.	Programming languages lecturers attend to me whenever I have difficulty with their course					
9.	Programming languages lecturers come to class punctually					
10.	We have programming classes at unfavourable times					
11.	Programming languages lecturers interact appropriately with students in class					
12.	Programming languages lecturers spend extra time to explain things in class					
13.	Knowing programming will make me somebody in life					
14.	Programming languages lecturers come to class regularly					
15.	The environment where we have programming lectures is not conducive					
16.	Programming languages lecturers enforce discipline in their class					
17.	Programming languages lecturers are friendly in class					
18.	I do not have enough time to study programming					
19.	Programming languages lecturers allow students to ask questions and take time to explain					
20.	Programming languages lecturers show partiality in their dealing with students					
21.	I attend programming classes regularly					
22.	Programming languages lecturers do not deliver course content well					
23.	Programming languages lecturers waste time on irrelevant matters in class					
24.	Studying programming is a wasteful effort					
25.	Programming languages lecturers usually come late to class					
26.	Our society does not place values on programmers					
27.	Programming languages lecturers handle their class with levity					
28.	Programming languages lecturers are too serious in class					
29.	Programming courses should be taught in the morning					
30.	I do not have interest in programming from onset					

Thank you.

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