# Student Engagement And Attitude in Mathematics Achievement Using Single Valued Neutrosophic Set

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**Abstract**. Generalization of the Fuzzy set and Intuitionistic Fuzzy set concept is called as Neutrosophic set which is a powerful general formal framework. The components in Neutrosophic set has a degree of truth (T), indeterminacy (I) and falsity (F). The value of this components are between [0,1], respectively. A Neutrosphic set has a general formal framework for analysing uncertainty in data set or undetermined information. Not only uncertainty, Neutrosophic set can also analyse large information sets or big data sets as well. Single Valued Neutrosophioc sets (SVNs) was introduce to be used expediently to deal with real problems and it is appropriate in solving data mining problem and make a decision for the problem. In this paper, Single Valued Neutrosophic set (SVNs) was proposed to measuring factors impact on student engagement and attitude in mathematics achievement based on Trends in International Mathematics and Science Study TIMSS 2015 for ASEAN countries and use the data to illustrate the applicability of the proposed factors similarity measures in decision making. The result shows that the factor which is Confidence in Mathematics include in highly acceptable zone in students' engagement and attitude in Mathematics Achievement for ASEAN countries.

## 1. Introduction

Neutrosophic Set was proposed by [1] which plays a very important role in making a decision in all different fields of real world problem such as data mining, engineering, social science, e-learning, medicine and many more. Neutrosophic set is a part of neutrosophy that studies the origin, nature, and scope of neutralities, as well as their interactions with various ideational spectra. Neutrosophic concepts give most scientists concentrate on decision-making algorithms and make an applications on it. The component in Neutrosophic Set are as follows: Let W be an universe and Q is a set included in W. The component of x from W is noted with respect to the set Q as x(T,I,F). T,I,F are belongs to Q in the following way where t% is Truth (T) value in the set, i% is Indeterminacy (I) value in the set, and f% is Falsity (F) value in the set, where t varies in T, i varies in I, f varies in F. Then, set Q is called a Neutrosophic Set (NS). The value for each component are between [0,1] and each of them are independent value.

Then, [2] introduced the notion of Single Value Neutrosophic set (SVNs), which is an instance of neutrosophic set and studied various properties. SVNs provides with an additional possibility of representing the uncertainty, imprecise, incomplete, undetermined and inconsistent information that exists in the real world problem. It would be more suitable to apply indeterminate information and inconsistent information measures. [3] present the result of the audit finding by using crisp value in their proposed model, Single Value Neutrosophic Numbers (SVNN) which is an instance of neutrosophic set.

According to [4], data mining is assumed to be data "knowledge mining." The smart techniques for extracting data patterns are using data mining method [5]. Data mining is a method by which big quantities of data are analyzed to discover fresh and concealed information. The data from various angles can be evaluate and summarize into some valuable information by using data mining method. Association, classification, patterns of sequence, clustering are various method of information in data mining. Out of this, [6] was proposed fuzzy methods in data mining to solve real problems.

For real-world applications of SVNs for data mining, similarity or more usually comparative measures are used at all stages of the duties of data mining and data recovery. At the lowest level, for the extraction of relevant data, database is used to match a query to the elements which contains the data. In the process of cleaning and managing missing information, resemblance and dissimilarity measures can then be used to produce a decent collection of information. Similarities are eventually used by defining prototypes to interpret the results of the learning process into an expressive form of understanding. For an investigation, most collective data involves indeterminacy. This situation can be managed by SVNs where it plays an important role in data mining.

In this paper, a data mining process of SVNs is proposed to measure factors which will give impact on Student Engagement and Attitude in Mathematics Achievement based on ASEAN countries in Trends in International Mathematics and Science Study (TIMSS) 2015. According to [7], the TIMSS evaluation is the largest and most ambitious study undertaken by the International Association for the Evaluation of Educational Achievement and about thirty-nine countries involves in 2015. The $8^{th}$ grades Mathematics Question are based on four content areas: (1) number; (2) algebra; (3) geometry; (4) data and chance.

## 2. Neutrosophic

### *2.1. Neutrosophic sets*

A new branch of philosophy, the concept of neutrosophic set is originated from neutrosophy [7].

Definition 1:[8] Let x element in W and W be a space of objects where a neutrosophic set $\mu$ in W is characterized by a truth membership function $T_\mu$, an indeterminacy membership function $I_\mu$ and a falsity membership function $F_\mu$. The functions $T_\mu$ and $F_\mu$ are subsets in interval [0,1] that is $T_\mu$: [0,1]; $I_\mu$: [0,1]; $F_\mu$: [0,1]. It should be noted that there is no restriction on the sum of $T_\mu(x)$, $I_\mu(x)$, $F_\mu(x)$ where

$$0 \leq T_\mu(x) + I_\mu(x) + F_\mu(x) \leq 3$$

Definition 2: [8] The complement of a SVNs $\mu$ is denoted by c and is defined by

$$T_\mu c(x) = 1 - T_\mu(x),$$
$$I_\mu c(x) = 1 - I_\mu(x),$$
$$F_\mu c(x) = 1 - F_\mu(x)$$

Definition 3: (Containment) [8] A SVNs $\mu$ is contained in the other Single Valued Neutrosophic set $\Omega$, if and only if the following result holds.

$$\inf T_\mu(x) \leq \inf T_\Omega(x),\ \sup T_\mu(x) \leq \sup T_\Omega(x)$$
$$\inf I_\mu(x) \leq \inf I_\Omega(x),\ \sup I_\mu(x) \leq \sup I_\Omega(x)$$
$$\inf F_\mu(x) \leq \inf F_\Omega(x),\ \sup F_\mu(x) \leq \sup F_\Omega(x)$$

for all x in W.

Definition 4: Single-valued neutrosophic set (SVNs)[6] .

Let x element in W and W be a space of objects. A single-valued neutrosophic set B is characterized by a true membership function $T_B(x)$, an indeterminacy membership function $I_B(x)$, a falsity membership function $F_B(x)$ with $T_B(x)$, $I_B(x)$, $F_B(x) \in [0,1]$ for all x in W.

When W is continuous, a SVNs can be written as

$$B = \int x\ (T_B, I_{B,B})/x, \text{ all } \forall x \in W$$

and when W is discrete a SVNs B can be written as:

$$B = \sum (T_B, I_B, F_B)/x \text{ all } \forall x \in W$$

Definition 5: The complement of a Single Valued Neutrosophic set R is denoted by $R^c$ and is defined by

$$T_B^c(x) = F_B(x),$$
$$I_B^c(x) = 1 - I_B(x),$$
$$F_B^c(x) = T_B(x)$$

## 3. Neutrosophic Method

The notion of similarity or comparative measurements is central in the real problem where it aims to quantify the extent to which two objects are similar or dissimilar to each other. In general, the values or variable of characteristics items give the similarities and dissimilarities between objects. Therefore, the neutrosophy machine learning methods using prior similarity measures. A significant way of extracting information from case sets such as big databases is by using machine learning.

This paper considers only the machine learning methods based on neutrosophy that include indeterminacy used in applications, leaving aside other techniques such as case-based reasoning or neutrosophy association rules. Single Valued Neutrosophic set (SVNs) clustering belongs to the unsupervised learning framework. SVNs has the ability to help all the measures that have neutralized a knowledge discovery process and can be used for data modeling in the information choice and preparation phase. A lot of information involves indeterminacy for any data analysis linked to an experiment or inquiry. This scenario can be handled by a Single Valued Neutrosophic set logic and it has an important role in data mining cases.

In decision-making issues, there are generally many characteristics where some of them are essential and others may not be so essential. Selecting the right characteristics for the decision-making scenario is therefore essential [9]. Now, to prepare a panel of characteristics that are technically sound, this paper will suggest a methodical strategy for data mining with Single Valued Neutrosophic information.

### *3.1 Steps on using SVNs.*

Step 1: Selection of problem field

Consider a decision-making problem with multi-attribute options and n attributes. Let $S_1, S_2, ..., S_m$ and $E_1, E_2, ..., E_n$ denote the alternatives and attributes respectively as shown in Table 1. A finite but more significant attribute from the specified n characteristics in the decision-making process. All attributes are expressed in single valued neutrosophic number.

Table 1: Single valued neutrosophic set decision matrix

$D\langle dij \rangle_{mn}$

| | $E_1$ | $E_2$ | … | $E_n$ |
|---|---|---|---|---|
| $S_1$ | $d_{11}$ | $d_{12}$ | ... | $d_{1n}$ |
| $S_2$ | $d_{21}$ | $d_{22}$ | ... | $d_{2n}$ |
| | ... | ... | ... | ... |
| $S_m$ | $d_{m1}$ | $d_{m2}$ | ... | $d_{mn}$ |

Here, $d_{ij}$ ($i$ = 1, 2, …, $m$ and $j$ = 1, 2, …, $n$) are all single valued neutrosophic numbers.

Step 2: Single valued neutrosophic set score matrix

Definition 6: Single valued neutrosophic score function (SVNSF) corresponding to each attribute is defined as follows.

$$SVNSF(E_J) = \frac{1}{m}\sum_{r=1}^{m}\frac{2T_{rj} - I_{rj} - F_{rj}}{3}$$

where, j = 1, 2, …, n

Using this equation to calculate single valued neutrosophic score matrix as follows.

Table 2: Single valued neutrosophic score value

| | *attributes* | *Single valued neutrosophic score value* |
|---|---|---|
| *SVNSF*(*E*) | $E_1$ | *SVNSF* ($E_1$) |
| | $E_2$ | *SVNSF*($E_2$) |
| | | |
| | $E_n$ | *SVNSF* ($E_n$) |

Step 3: Selection zone
Single valued neutrosophic score values are classified into three zones.

Definition 7: SVNSF of all the attributes are classified in three categories and it is defined as follows

Highly acceptable zone: $0.50 \leq \text{SVNSF}(E_j) \leq 1$
Tolerable acceptable zone: $0.25 \leq \text{SVNSF}(E_j) \leq 0.50$
Unacceptable acceptable zone: $0.00 \leq \text{SVNSF}(E_j) \leq 0.25$

Step 4: Ranking of attributes
Based on the single valued neutrosophical score values, we can set up a panel of all characteristics in descending order and select significant characteristics from a big amount of characteristics in decision-making processes, taking into account extremely acceptable zone and acceptable zone.

Step 5: End

## 4. Measuring Factors Impact on Student Engagement And Attitude in Mathematics Achivement

The Trends in International Mathematics and Science Study (TIMSS) is the largest and most ambitious study undertaken by the International Association for the Evaluation of Educational Achievement [7]. The purpose of this article is to measure factors on student engagement and attitude in mathematics achievement for 8$^{th}$ grade students for ASEAN countries in 2015. As the outcome measure, this paper uses the set of four index values of student engagement and attitudes towards learning mathematics and average achievement in Mathematics for TIMSS 2015. The ASEAN countries that involve in TIMSS 2015 are Malaysia, Singapore and Thailand.

The ASEAN countries are presented as follows:

$W_1$:Malaysia

$W_2$: Singapore

$W_3$: Thailand

For this purpose, the following attributes about students' engagement and attitude.

1. Time Spent on Mathematics Homework ($E_1$)
2. Like Learning Mathematics ($E_2$)
3. Value Mathematics ($E_3$)
4. Confident in Mathematics ($E_4$)

Table 3: Single valued neutrosophic set decision matrix

| | $E_1$ | $E_2$ | $E_3$ | $E_4$ |
|---|---|---|---|---|
| $W_1$ | (0.17,0.51,0.31) | (0.28,0.56,0.16) | (0.04,0.42,0.54) | (0.39,0.53,0.08) |
| $W_2$ | (0.22,0.55,0.23) | (0.24,0.42,0.33) | (0.13,0.41,0.46) | (0.34,0.58,0.08) |
| $W_3$ | (0.23,0.49,0.28) | (0.20,0.58,0.23) | (0.03,0.29,0.69) | (0.50,0.45,0.05) |

Using equation SVNFS, single valued neutrosophic score matrix was calculated as follows.

Table 4: Single valued neutrosophic score value, SVNSF(Ej).

| ***attributes*** | ***Single valued neutrosophic score value*** |
|---|---|
| $E_1$ | 0.4722 |
| $E_2$ | 0.4933 |
| $E_3$ | 0.3767 |
| $E_4$ | 0.6067 |

Single valued neutrosophic score values are classified into three zones. These are described as follows.

Highly acceptable zone: $0.50 \leq SVNSF(E_j) \leq 1$

Tolerable acceptable zone: $0.25 \leq SVNSF(E_j) \leq 0.50$

Unacceptable acceptable zone: $0.00 \leq SVNSF(E_j) \leq 0.25$

From Table 4, single valued neutrosophic score values of all attributes in descending order as follows.

$$SVNSF(E_4) \geq SVNSF\ (E_2) \geq SVNSF(E_1) \geq SVNSF(E_3)$$

Then, the attributes that correlate to single values of neutrosophic score values (highly appropriate and tolerance zone) can be selected as important attributes for decision making processes. It shows that Confidence in Mathematics will give the impact on student engagement and attitude in mathematics achievement in TIMSS 2015 and then it follows with Like Learning Mathematics and Times Spent on Doing Homework.

From Table 5, the p-value index of student confidence in math indicates that it is less than 0.005 in all three countries. It is significant that student confidence in math will give impact in students' achievement in Mathematics achievement.

Table 5: p-values between overall mathematics and students' achievement and attitudes.

| **Overall Mathematics Scale: Grade 8** | p-value | | |
|---|---|---|---|
| | Malaysia | Singapore | Thailand |
| Index time spend on math homework | 0.0001 | 0.0390 | 0.1436 |
| Index of students like learning math | 0.0001 | 0.0007 | 0.2910 |
| Index of student's confidence with math | 0.0041 | 0.0150 | 0.0102 |
| Index of students value learning mathematics | 0.0001 | 0.0466 | 0.5775 |

## 5. Conclusion

Generalization concept of the classic set, fuzzy set, interval valued fuzzy set, intuitionistic fuzzy set, interval-valued intuitionistic fuzzy set, paraconsistent set, dialetheist set, paradoxist set, and tautological set is called as Neutrosophic set which is a powerful general formal framework. From the example, the proposed single valued neutrosophic multicriteria decision-making method is more suitable for real scientific and engineering applications because it can handle not only incomplete information but also the indeterminate information and inconsistent information which exist commonly in real situations.

SVNs is an example of a neutrosophic collection that gives an extra opportunity to represent real-world uncertainty, imprecise, incomplete, and inconsistent data. Applying indeterminate information and inconsistent data measures would be more appropriate. In the neutrosophic set, indeterminacy and truth-membership, indeterminacy-membership are quantified explicitly.

From this paper, attributes C4 which is Confidence in Mathematics include in highly acceptable zone. It follows with statistical p-value which also gives the same result where Confidence in Mathematics will give impact on students' mathematics achievement. But, this paper only examines the function of one trait, which is the engagement and attitude of the student, without considering the impact of other features. TIMMS results will get the government's attention and again concentrated the country on teaching and learning mathematics issues. In particular, the findings of TIMSS show a pervasive and intolerable mediocrity in teaching and studying mathematics in middle and beyond grades.

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