An Enhanced Systematic Student Performance Evaluation Based on Fuzzy Logic Approach for Selection of Best Student Award

Presented by: TRACY ADELINE AJOL
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Success in life not defined by exam results

AFTER every major public school examination, we see a media frenzy and much talk about the high achievers.

Pictures of the “superstars’ and their impressive results in exams such as Ujian Pencapaian Sekolah Rendah (UPSR), PT3 (Pentaksiran Tingkatan Tiga), Sijil Pelajaran Malaysia (SPM) and Sijil Tinggi Persekolahan Malaysia (STPM) are always splashed across our dailies.

The SPM is a major examination for secondary school students and seen as a the first big hurdle. Students are under pressure to do well in the examination.

The outcome of SPM paves the way for college and tertiary admissions.

Students who excel are offered scholarships and grants to pursue degree programmes in prestigious foreign institutions.
Not just academic: PT3 results slip to place equal importance on psychometric, co-curricular and sports assessment

By FAIRUZ MOHD SHAHAR - December 20, 2016 @ 5:41pm

PUTRAJAYA: The Education Ministry is mooting to change the format of the Form Three Assessment (PT3) examination results slip by displaying all four assessment components -- academic, psychometric, co-curricular and sports -- on its front page.

Education Minister Datuk Seri Mahdzir Khalid said the proposal's goal is to underscore the fact that PT3 is not only about academic achievements but also about other skills.

"Many parents still look at how many A's their children score in the exam as a criteria. "The front page of PT3 exam results slip is printed with a list of subjects and scores obtained by the students, while the back page is the results of the psychometric, co-curricular and sports activities.

"Most parents and students are more focused on the front page which has the subjects and grades, but they often ignore the back page which is equally important," he said after witnessing the signing of a Memorandum of Understanding ceremony between the ministry and the Malaysian Administrative Modernisation and Management Planning Unit (MAMPU), today.

Mahdzir advised parents not to look only at academic achievements, but to also see the holistic development and potential of their children.

RECOMMENDED

Roma coach believes in Champions league comeback

Malaysia is key market for Airbus

May 02: Bursa Malaysia lower at opening

Anti-China sentiments are dangerous to Malaysia’s future

Najib: Malaysia economically stable, not bankrupt as claimed by opposition

Revenue receives Bursa Malaysia’s nod for ACE-listing
Life is about more than getting straight 'A's in exams

Ng Shu Tsung | Published on 4 Dec 2017, 12:18 pm | Modified on 4 Dec 2017, 12:21 pm
INTRODUCTION

• The Best Student Award is one of the incentives initiated by an institution to identify potential students who not only are excellent academically but also possess great leadership skills.

• One of the greatest challenges faced by the evaluators in the selection process is uncertainty and imprecise data in measuring the students’ leadership competencies.

• Thus, this paper proposes the development of Initiative-Systematic Performance Evaluation (I-SPE) as an initiative tool to measure student’s competencies based on Fuzzy Logic Approach.

• A case study at Universiti Teknologi MARA (UiTM) Mukah Campus is presented in this study to demonstrate the applicability of the proposed developed system, I-SPE based on Fuzzy Logic Approach.
Fuzzy logic

- Fuzzy logic is an extension of multivalued logic which deals with approximate rather than precise modes of reasoning (Zadeh, 1988)
  - It is employed to handle the concept of partial truth where the truth values of variable may be any real number range between 0 and 1 instead of using precise value 0 or 1 which represent true or false respectively

- It has an ability of dealing with degree of uncertainty, vagueness, and imprecise data in decision making, its application has a wider scope of applicability in the field that involves pattern classification and information processing (Zadeh, 1965)

- Assesses the attributes studied as human logical reasoning that will be express in human linguistic form which then is converted into computerize qualitative measurement.
Conventional Method (Current Practice) for Selection of Best Student Award

Advisors recommend few candidates who qualify for Best Student Award from Faculty of Business and Management and Faculty of Plantation and Agrotechnology in UiTM Mukah.

The panels of evaluators who normally consist of Head of Centre, Coordinator of Student Leadership Unit and PKPB facilitators later discuss among themselves to decide on the recommendation of 20 candidates sent by advisors in a meeting (express their judgement in linguistic form such as poor, bad, average, good, very good and excellent.)

Candidates are then screened out to select the finalists (based on each panel opinion and perception)

The two most outstanding students representing two faculties respectively will be chosen as finalists.

Those two students are compared against each other to determine the overall best candidate for the award.
Problem with the current practice:

- Often, this conventional method is subjective and leads to tie and time consuming since different evaluators might have different point of view and opinions. This decision-making has become more complicated because there are many aspects need to be considered such as leadership, communication, teamwork, discipline and CGPA. Consequently, this kind of practice might lead to issues of biasness such as prejudice, favouritism and stereotype in determining the final candidate. Ultimately, there will always be a risk of unfairness and biasness that could influence evaluators thus leading to inaccurate decision by selecting less performing candidate instead. **Therefore, development of a more systematic approach is significant to measure and help in deciding for the best recipient for the award in Best Student for Leadership and Curriculum Award, in which it is able to represent human logical sense and opinion and recommendation.**
This paper proposes the development of Initiative-Systematic Performance Evaluation (I-SPE) as a tool to measure student’s performance based on Fuzzy Logic Approach with inclusion of non-academic criteria in selecting the most qualified recipient of the Best Student Award hence improve the existing system of student performance evaluation employed by MARA University Technology (UiTM) Mukah Campus.
Scope

• The study focuses on the selection of the best student based on Student’s CGPA and data collected from leadership programme, Program Kepimpinan Pewaris Bangsa (PKPB) at MARA University Technology (UiTM) Mukah Campus.

• The proposed I-SPE model was tested with 20 students (recommended by advisors) from all faculties at UiTM Mukah.
**Significant Findings**

**Pazil et al. (2018)** conducted a research in 17 selected preschools in Johor where Fuzzy logic approach was implemented to evaluate the performance and Quality of Preschool. Four major factors were used as an input parameter in their study namely physical, socio-emotional, spiritual and intellectual of the preschool children in their learning process. Output obtained through this study showed five selected schools to be identified as successful in their learning process.

**Gran et al. (2019)** conducted a case study at one of the secondary schools in Mukah, Sarawak. The objective of the study was to propose an alternative for a systematic students performance evaluation tool based on fuzzy logic approach to identify the most qualified student to be awarded as the Best Student in this school. It was found that Fuzzy logic approach was useful and beneficial to the school by providing an efficient tool in solving the problems encountered by the evaluators during the evaluation process.
Yadav et al. (2011) introduced academic performance evaluation using soft computing technique where the development of their model includes the combination of fuzzy logic techniques. Subsequently, Yadav et al. (2014) proposed New Fuzzy Expert System (NFES) as an alternative to be used by the educators to evaluate students’ academic performance and their proposed method is contributed to better decision making when compared with the existing statistical method. Both of these studies were based on academic assessment.

Barlybayev et al. (2016) also proposed the application of fuzzy logic model to evaluate student’s performance. Their study was based on academic assessment such as mark scores in lecture, practical lesson, studio sessions, self-work of students and laboratory work to represent the overall students’ performance.

Aziz et al. (2019) proposed an application of Fuzzy Inference System (FIS) to evaluate students performance by considering the continuous assessment in their learning programme. Their method includes the students’ attendances, total time spent by the students in class and also their test marks in class and final exam result as an input to determine the students’ performance.

In fact, many institutes honour a student by granting the Best Student Award based on their all-round performance (Patil et al., 2012). Additionally, Patil et al. (2012) focused on the application of fuzzy logic to evaluate the students’ performance according to their academic and this includes three criteria namely hardworking, depth of knowledge and technical knowledge.
The study conducted by Tarmudi et al. (2015) discussed the comprehensive evaluation of student performance based on both academic performance and soft skill for university recognition purpose. This evaluation system may not reflect the genuine qualities of student performance without using a rubric. As a matter of fact, it is difficult for the evaluator to determine the parameter values as an input in fuzzy logic system without giving them the range of a score and assigning meaning for each score of the criteria.

Tay et al. (2009) presented a novel Fuzzy Inference System-based CRA model that provided an aggregated score as a measure of overall achievement where subjectivity was involved. The study included assessment of students’ activities in Electronic Circuitry Design, Electronic Circuitry Development and presentation. This studies investigated student performance evaluation based on application of fuzzy logic model that involved the designing of scoring rubrics input criteria.

Rao et al. (2017) proposed an application of Fuzzy Inference System (FIS) to evaluate student performance including designing scoring rubric criteria and the 5-input used in their study are identify, understand, apply, analyse and design. Although both studies employed scoring rubrics in an input process of fuzzy logic approach to evaluate the student performance, their criteria in evaluation were only based on academic performance.
• Hence, this paper proposed a development of evaluation system based on an **application of fuzzy logic** to evaluate student performance by **not emphasizing merely on academic criteria (CGPA) but also to include non-academic criteria** such as leadership, discipline, teamwork and communication skill.

• In addition, the **present scoring rubric assessment** was designed specifically to provide evaluators with a clear guideline.

• The development of I-SPE in this study is aimed to **solve the uncertainty problem frequently faced by the evaluators** in selecting the best student by providing them with an improved systematic student performance evaluation system **based on fuzzy logic approach**.
METHODOLOGY
Flow Chart for Research Framework

- Start
- Gap analysis
- Data collection
- Implementation of Fuzzy Logic Approach in Evaluation of Student's Performance
- Development of Model I-SPE & Designing Rubrics Scoring Template
- Computational Result using Matlab Fuzzy Logic Toolbox
- Comparison of Results between the Classical Method and Fuzzy Logic Approach
- Data Recording & Analysis
- End
# Rubric Scoring Template for Input Value

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Sub attribute</th>
<th>1-2</th>
<th>3-4</th>
<th>5-6</th>
<th>7-8</th>
<th>9-10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leadership</strong></td>
<td>Knowledge and skills in leadership</td>
<td>POOR</td>
<td>UNSATISFACTORY</td>
<td>SATISFACTORY</td>
<td>VERY SATISFACTORY</td>
<td>OUTSTANDING</td>
</tr>
<tr>
<td></td>
<td>No clear evidence of knowledge and understanding skills in leadership</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Very clear evidence of knowledge and understanding demonstrated in leadership</td>
</tr>
<tr>
<td></td>
<td>Able to demonstrate knowledge and understanding in leadership but require improvements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Very clear evidence of knowledge and understanding demonstrated in leadership</td>
</tr>
<tr>
<td><strong>Teamwork</strong></td>
<td>Foster good relationship</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>High ability to foster relationship and work together effectively with other group members towards goal achievement</td>
</tr>
<tr>
<td></td>
<td>No clear evidence of ability to foster good relationship and work together effectively with other group members towards goal achievements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>High ability to foster relationship and work together effectively with other group members towards goal achievement</td>
</tr>
<tr>
<td><strong>Group participation</strong></td>
<td>Not able to collaborate, contribute and cooperate in group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to collaborate, contribute and cooperate well in group</td>
</tr>
<tr>
<td></td>
<td>Limited ability to collaborate, contribute and cooperate in group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to collaborate, contribute and cooperate well in group</td>
</tr>
<tr>
<td><strong>Respect and accept opinions</strong></td>
<td>Not able to respect and accept opinion of others that leads to conflicts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to very well respect and accept opinion of others in achieving group’s objective</td>
</tr>
<tr>
<td></td>
<td>Limited respect and acceptance of others opinions in achievement group’s objective</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to very well respect and accept opinion of others in achieving group’s objective</td>
</tr>
<tr>
<td><strong>Discipline</strong></td>
<td>Practice of self-restraint and follow course of action</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to very well practice self-restraint and learning to follow the best course of action towards goal achievement</td>
</tr>
<tr>
<td></td>
<td>Not able to practice self-restraint and learning to follow the best course of action towards goal achievements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to very well practice self-restraint and learning to follow the best course of action towards goal achievement</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>Clear delivery of ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to deliver ideas with great clarity</td>
</tr>
<tr>
<td></td>
<td>Not able to deliver ideas clearly and require major improvement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to deliver ideas with great clarity</td>
</tr>
<tr>
<td><strong>Confident delivery of ideas</strong></td>
<td>Not able to deliver ideas confidently</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to deliver ideas with great confidence</td>
</tr>
<tr>
<td></td>
<td>Able to deliver ideas with limited confidence and require further improvements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to deliver ideas with great confidence</td>
</tr>
<tr>
<td><strong>Effective and articulate delivery of ideas</strong></td>
<td>Not able to deliver ideas effectively</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ability to deliver ideas with great effect and articulate</td>
</tr>
<tr>
<td></td>
<td>Able to deliver ideas with limited effect and require further improvements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ability to deliver ideas with great effect and articulate</td>
</tr>
<tr>
<td><strong>Understand and respond to question</strong></td>
<td>Not able to understand and respond to a question</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to fully understand and respond to questions very well</td>
</tr>
<tr>
<td></td>
<td>Able to understand and answer questions but not able to accurately answer the question</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to fully understand and respond to questions very well</td>
</tr>
<tr>
<td><strong>Adapt delivery to audience level</strong></td>
<td>Not able to deliver appropriately to the audience level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to fully deliver ideas appropriately very well.</td>
</tr>
<tr>
<td></td>
<td>Able to deliver ideas with limited appropriateness to the target audience and require further improvements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Able to fully deliver ideas appropriately very well.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CGPA</th>
<th>POOR</th>
<th>UNSATISFACTORY</th>
<th>SATISFACTORY</th>
<th>VERY SATISFACTORY</th>
<th>OUTSTANDING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.00 - 1.99</td>
<td>2.00 - 2.49</td>
<td>2.50 - 2.99</td>
<td>3.00 - 3.49</td>
<td>3.5 - 4.00</td>
</tr>
</tbody>
</table>
The Stages Of Fuzzy Logic Evaluation

- Input
- Fuzzification
- Inference process (Fuzzy Rule)
- Defuzzification
- Output
### Table 1. Linguistic expressions and intervals for input criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Linguistic expressions (Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>Unsatisfactory (0, 0, 0.5)</td>
</tr>
<tr>
<td></td>
<td>Satisfactory (0.25, 0.5, 0.75)</td>
</tr>
<tr>
<td></td>
<td>Very Satisfactory (0.5, 1, 1)</td>
</tr>
<tr>
<td>Teamwork</td>
<td>Unsatisfactory (0, 0, 0.5)</td>
</tr>
<tr>
<td></td>
<td>Satisfactory (0.25, 0.5, 0.75)</td>
</tr>
<tr>
<td></td>
<td>Very Satisfactory (0.5, 1, 1)</td>
</tr>
<tr>
<td>Discipline</td>
<td>Unsatisfactory (0, 0, 0.5)</td>
</tr>
<tr>
<td></td>
<td>Satisfactory (0.25, 0.5, 0.75)</td>
</tr>
<tr>
<td></td>
<td>Very Satisfactory (0.5, 1, 1)</td>
</tr>
<tr>
<td>Communication</td>
<td>Unsatisfactory (0, 0, 0.5)</td>
</tr>
<tr>
<td></td>
<td>Satisfactory (0.25, 0.5, 0.75)</td>
</tr>
<tr>
<td></td>
<td>Very Satisfactory (0.5, 1, 1)</td>
</tr>
<tr>
<td>CGPA</td>
<td>Unsatisfactory (0, 0, 2)</td>
</tr>
<tr>
<td></td>
<td>Satisfactory (1, 2, 3)</td>
</tr>
<tr>
<td></td>
<td>Very Satisfactory (2, 4, 4)</td>
</tr>
</tbody>
</table>

### Table 2. Student’s Performance

<table>
<thead>
<tr>
<th>Linguistic expression</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>(0 0 0.25)</td>
</tr>
<tr>
<td>Average</td>
<td>(0 0.25 0.5)</td>
</tr>
<tr>
<td>Good</td>
<td>(0.25 0.5 0.75)</td>
</tr>
<tr>
<td>Very Good</td>
<td>(0.5 0.75 1)</td>
</tr>
<tr>
<td>Excellent</td>
<td>(0.75 1 1)</td>
</tr>
</tbody>
</table>
Application of MATLAB (Fuzzy Logic Toolbox)
Result
Output Result & Discussion

The **highest output value** obtained in this study was **0.912**.

- indicated the student had the highest achievement and that value belonged to “excellence” in the membership function of the student’s performance output.

- degree of membership function did not achieve value 1 as the student did not achieve the highest CGPA.

The **lowest value** obtained among the 20 students evaluated was **0.324**

- belonged to “Average” student performance

- lack in term of non-academic criteria.

**I-SPE development** was **not emphasizing merely on students with academic criteria** which was CGPA but **most importantly possessed great leadership skills** which qualified the student to be the recipient of the Best Student Award.
Result Comparison Between I-SPE and Conventional Method

• The result of student performance evaluation obtained using I-SPE that was based on Fuzzy Logic Approach was compared to the result obtained using the current classical method practice.

• Our study revealed that the student selected using the proposed model, I-SPE was the same recipient of the Best Student Award using the current practices.

• Therefore, this indicates that the outcome obtained using I-SPE for evaluating student performance is valid and reliable.

• The comparison result has shown that the usage of I-SPE in this study is able to mimic human logical sense, opinion and recommendation such as discussion in the meeting, which requires human judgement and also aids in deciding for the best recipient of the Best Student Award.
CONCLUSION

• Qualitative evaluation involving assessment is usually subjective, which can lead to difficulties in opinion and thus arising difficulties in term of deciding student with better performance when there is a range of criteria involved in the evaluation.

• Based on the result of this study, the proposed model, I-SPE has shown its ability to overcome several difficulties faced by the evaluators.

• Simplifies the tasks of evaluators because they do not need to perform the complicated and time-consuming operation, compared to the current existing traditional method practices.

• Ensure the fairness and transparency during the evaluation of student performance.

• Avoid any unfavourable and unethical conducts of evaluators (biasness, favouritism, stereotype, unfairness and prejudice).

• Objective of this study, which is to solve the issues of uncertainties faced by the evaluator during the selection of the Best Student Award, is achieved.

• Designation of rubric assessment has enhanced the efficiency of the implementation of fuzzy logic approach used in this study.
REFERENCES


