

A NOVEL FUZZY BASED FRAMEWORK FOR QUANTIFYING INSTITUTIONAL ATTAINMENT OF MISSION AND VISION THROUGH OUTCOME BASED EDUCATION

Binu Thomas

Department of Computer Applications,
Marian College Kuttikkanam (Autonomous), Kuttikkanam, India

Abstract – The mission and vision statements of educational institutions constitute an abstract idea which every organization would prefer to achieve. Presently there is no mechanism to assess the success of institutions in achieving their vision and mission. Outcome Based Education (OBE) is a recent development in student-centered teaching-learning model that emphasizes on measuring student performance through outcomes. Outcomes include knowledge, skills and attitudes suggested in Bloom's Taxonomy. The OBE approach encourages institutions to assess and quantify certain predefined targets which could have been otherwise intangible. The level of the attainment of Course Outcomes (COs) is the indicator of the skill, knowledge and behavior that students acquired at the end of the course. In Outcome Based Education every activity performed in the class room is linked with the measurable course outcomes. In this paper, we present an effective fuzzy based approach to assess the attainment of outcomes by mapping every assessment activity performed in the class room with the Course Outcomes (COs) and eventually to Program Outcomes (POs). Finally the attainment of vision and mission of the institution is quantified from POs using fuzzy mappings. The entire work is based on the OBE implementation case study of Marian College Kuttikkanam, (MCK)

Keywords: *fuzzy sets, course outcomes, programme outcomes, outcome assessment.*

1. INTRODUCTION

Student Centered Innovative Teaching Learning is one of the key components in quality assurance and enhancement in the higher education envisioned by accreditation agencies like National Assessment and Accreditation Council (NAAC) [1]. "Outcome-Based Education" (OBE) framework is considered as a substantial leap forward to improve higher education in India and help Indian students contest with their global counterparts [2]. The student centered learning OBE method stimulates more involvement of students through responsible participation in teaching learning process [3], [4]. In OBE, skill or knowledge acquired by the students is more important than what is taught in the classroom by the teacher.

According to Heywood [5], "Education that is outcome-based is a learner-centered, results-oriented system founded on the belief that all individuals can learn". The key points in the Outcome Based Education (OBE) approach are [6], [7]:

- Student learning outcome are clearly mentioned.
- The student's progress is evaluated based on demonstrated achievement.
- Multiple instructional and assessment strategies need to be available to meet the needs of each student.
- Outcomes give a clear picture on the knowledge and the skill achieved.
- I achieved.

In OBE, the classroom activities are always planned well in advance and facilitated, based on the need and level of the learners [7]. The OBE approach along with Bloom's Taxonomy give a clear picture on the knowledge and the skill achieved by the student at the end of the course [8]. It does not depend on what is taught by the course teacher in the class but it depends on what knowledge and skill the learners have acquired through the completion of the course. It focuses on the best way for individuals and organizations to get self-knowledge about where they are and what they want to be [9, 10].

The concept of Fuzzy Logic was conceived at the beginning of the seventies by Lotfi A Zadeh, a professor at the University of California, Berkley. He presented it as a way of processing data by allowing partial set membership rather than crisp set membership or non-membership [11], [12]. In this approach to set theory, Zadeh reasoned that people do not require precise, numerical information input, and yet they are capable of highly adaptive control [13]. What Zadeh proposed is very much a paradigm shift and this concept first gained acceptance in the Far East.

This paper presents the concept of assessing the attainment of Mission and Vision of an institution in an OBE framework through the integration of fuzzy sets. The attainment of CO and PO can be assessed through various assessment activities given to students like assignments, seminars, examinations, group activities etc. Finally the attainment of mission and vision is quantified from POs. In this paper, Section 1 is the introduction and Section 2 gives the basic definitions. Section 3 deals with outcome assessment and Section 4 gives a special reference to outcome assessment at MCK. Section 5 deals with assessment methodology, 6 is discussions of results and finally Section 7 concludes the paper.

2. DEFINITIONS

2.1 Mission and Vision

A **mission statement** is a public declaration that educational organizations use to describe their founding purpose and major organizational commitments—i.e., what they do and why they do it. A mission statement may describe an organization's day-to-day operational objectives, its instructional values, or its public commitments to its students and community. A **vision statement** is a public declaration that educational organizations use to describe their high-level goals for the future—what they hope to achieve if they successfully fulfill their organizational purpose or mission [4].

2.2 Outcomes

Outcome based education (OBE) is student-centered instruction model that focuses on measuring student performance through outcomes [14]. Outcomes include knowledge, skills and attitudes the focus of which remains on evaluation of outcomes of the program by stating the knowledge, skill and behavior a graduate is expected to attain upon completion of a program [10], [15]

There are three levels of outcome such as Course Outcome (CO), Program Outcome (PO), and Programme Specific Outcome (PSO) [16].

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2.3 Course Outcome (CO)

Course outcomes are statements that describe significant and essential learning that learners have achieved, and can reliably be demonstrated at the end of a course [19].

2.3 Program Outcomes (PO)

POs are defined by Accreditation Agencies of the country (NBA and NAAC in India), which are the statements about the knowledge, skills, attitudes and graduate attributes of a formal educational program should have [17]. Program Outcomes could be viewed as the tangible skills developed by the students which establish the vision, purpose, and goals of a higher education institution through various programs offered by the institution [18].

2.4 Program Specific Outcome (PSO)

Program Specific Outcomes (PSOs) are the statements that assert what the graduates of a specific program should do and what they can able to do [1].

2.5 Fuzzy Sets and Memberships

In *fuzzy logic* based systems, the collection of data is considered as *fuzzy sets*. Traditional crisp sets include or do not include an individual element; there is no other case than true or false. But in the case of fuzzy sets, it allows partial membership [13]. A fuzzy set has, potentially, an infinite range of truth values between one and zero [20]. Propositions in fuzzy logic have a degree of truth, and membership in fuzzy sets can be fully inclusive, fully exclusive, or to some degree in between [11]. The fuzzy set is distinct from a crisp set in that it allows the elements to have a degree of membership. The core of a fuzzy set is its membership function: a function which defines the relationship between a value in the sets domain and its degree of membership in the fuzzy set [21]. The relationship is functional because it returns a single degree of membership for any value in the domain.

The fuzzy membership function is defined as:

$$\int \mu = f(s, x) \quad (1)$$

Where,

μ : is the fuzzy membership value for the element

s : the universe of discourse

x : is the value from the underlying domain.

The central idea in fuzzy systems is the use of *linguistic terms* to represent the revealed regularities and exceptions. The linguistic representation of the variables in such systems makes it to be much natural for human users to understand. An age group can be represented with four overlapping linguistic terms as very young, young, old and very old. Rather than grouping the values to discrete intervals, the fuzzy approach groups the data set into certain linguistic terms and these groups have ill-defined boundaries that smear

into the neighboring space often overlapping the limits of adjacent groups[22], [23].

3. OUTCOME ASSESSMENT

The attainment of these outcomes is evaluated through the assessment of various learning activities given to the students throughout courses [3]. The activities are mapped with course outcome on a fuzzy scale. We use the fuzzy linguistic variable low, medium and high to (Fig. 1.) associate each assessment activities with the course outcomes. The assessment activities can be assignments, seminars, examinations, and group activities etc., given to the students as part of the course. These activities are mapped with the course outcomes of the course so that by evaluating the assessment activities, the attainment level of course outcomes can be reached. The fuzzy mapping of marks obtained for different assessment activities to fuzzy linguistic variables is done as per the associations given in *table-1*. For calculation purpose, fuzzy weights are assigned to linguistic variables. These weights are also given in the table.

Table 1. Mapping of marks to fuzzy linguistic variable

Fuzzy linguistic variable	Percentage of marks for assessment activities	Fuzzy weights for linguistic variables
Nil	0%	0
Low	1-50%	1
Moderate	51-70%	2
Significant	71-100%	3

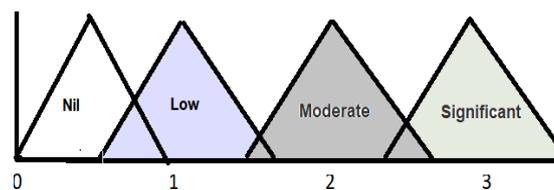


Fig. 1. Fuzzy linguistic variables

4. COURSE OUTCOMES AND PROGRAM OUTCOMES OF MCK

Mission and vision of Marian College Kuttikkanam helped to provide direction for creating program outcomes for the institution. Basically, those goals of the institution are translated into tangible, 'measurable' outcome statements. The nine programme outcomes of the college are listed in Fig. 2. All these program outcomes reflect the Mission and vision of MCK. The mission and vision of MCK is accomplished when the students attain these Program Outcomes.

Similarly, the course outcomes of Introduction To Computer Science (ITC, course code: BCA101) offered at MCK are given below. These course outcomes reflect measurable skills and knowledge attained by the students after completing the course. The program outcomes of the college are achieved through the course outcomes of all such courses. The Program Specific Outcomes of individual's programs of the institution can also be reached from course outcomes of all courses of the program. The course outcomes of ITC are;

- Explain how computing components may be combined to build computer systems.
- Describe the major components of applications software in the areas of word processing, spreadsheets, database management, presentation graphics, data communications, and Internet.
- Apply efficiently general problem-solving strategies to the development of computer algorithms.
- Describe the role of an operating system in managing and interacting with computer system components including main and secondary memory in Windows environment.
- Use Web browsers, search engines and e-mail in real time requirements with ethical concern.



Fig. 2. POs of MCK

5. ASSESSMENT METHODOLOGY

The assessment activities given to students are mapped with course outcomes in the next step. One activity may be mapped with more than one outcome as represented in Fig. 3. The activities are given marks as usual and the maximum marks for the activities is given in the given table. These activities are also mapped with one or more course outcomes and these course outcomes are assessed when the activities are evaluated.

Activity		Attainment
Seminar	4	CO1
Assignment	3.5	CO2
Video Presentation	4	CO1,CO2
Group Activity	3.5	CO2,CO4
Exam 1	5	CO1,CO2
Exam 2	7.5	CO3
Exam 3	7.5	CO4,CO5
Final Exam	60	CO1,CO2,CO3,CO4,CO5

Fig. 3. Activity mapping with more than one outcome

After activity mapping, these assessment activities are given to students. Based on the performance of students in these activities, they are assessed and marks are given to these activities as usual. Since these activities are mapped with one or more course outcomes, the fuzzy attainment levels of linguistic variables (Fig. 4) representing these activities are found. These calculations along with assessment marks and fuzzy attainment levels are represented in Fig. 4.

Activity		Cos	% Marks Awarded	Attainment
Seminar	4	CO1	40	low
Assignment	3.5	CO2	85	Moderate
Video Presentation	4	CO3	70	Moderate
Group Activity	3.5	CO2,CO4	85	High
Exam 1	5	CO1,CO2	55	Moderate
Exam 2	7.5	CO3	75	High
Exam 3	7.5	CO4,CO5	40	Low

Fig. 4. Fuzzy attainment levels of linguistic variables

5.1 Outcomes and Fuzzy Membership Values

The attainment level of course outcomes is calculated as a fuzzy membership and it is expressed using the linguistic variables. The fuzzy membership function used to calculate the attainment of course outcomes is given as equation (2).

$$\mu(CO_i) = \frac{\sum_{i=1}^n (AO)_i}{n_i} \quad (2)$$

Where:

$\mu(CO_i)$ = Fuzzy membership for i^{th} Course Outcome

AO_i = i^{th} Activity Attainment

n_i = Number of activities to assess i^{th} Course Outcome

In the next step, the fuzzy mapping between the Course Outcomes and Program Outcomes is done using a mapping table. The mapping table is developed based on the assessment methods and activities covered in assessing a course outcome. The mapping table entries indicate the fuzzy weight of relationship between the course outcomes and program outcomes. A sample mapping table derived for the course Introduction to Computer Science (BCA101) is given in Table 2.

Once the mapping table is developed, the POs are calculated from course outcomes. Fuzzy membership values of linguistic variables are used (given in Table 1.) for the calculations. The attainment levels POs are reached from the attainment levels of course outcomes. These calculations are made using the equation (3).

$$\mu(PO_i) = \frac{\sum_{i=1}^n (CO_i) * w_i}{\sum_{i=1}^n w_i} \quad (3)$$

Where;

$\mu(PO_i)$ = Fuzzy membership for i^{th} Program Outcome

$\mu(CO_i)$ = Fuzzy membership for i^{th} Course Outcome

W_i = CO-PO Mapping weight from the mapping table.

Table 2. A sample mapping table derived for the course Introduction to Computer Science (BCA101)

CO	PS01	PS02	PS03	PS04	PS05
CO101.1	Nil	Low	Nil	Nil	Nil
CO101.2	Nil	Nil	Nil	Low	Low
CO101.3	Moderate	Low	Moderate	Nil	Nil
CO101.4	Nil	Low	Moderate	Nil	Nil
CO101.5	Nil	Moderate	Low	Moderate	Low

5.2 Attainment of POs

Finally, the POs are calculated and the final attainment levels are converted into corresponding fuzzy linguistic variables. These PO attainment levels are calculated at the end of every semester and finally the PO attainment level of a student after the completion of a program is calculated by finding the average of PO attainments for all the semesters. The fuzzy weighted average method (Table 3) is used for calculating the final attainment of Program Outcomes.

Table 3. The fuzzy weighted average method used for calculating the final attainment of Program Outcomes

Contributing COs	CO Attainment level	Level of correlation to PO1	Attainment Level (PO1) (Weighted Value)
CO101.1	Low	High	Moderate
CO101.2	Moderate	Nil	
CO101.3	High	Moderate	
CO101.4	Moderate	High	
CO101.5	High	Low	
Calculation Method	Low = 1 Moderate = 2 High = 3	PO1 = (1*3+2*0+3*2+3*1)/(3+0+2+3+1) PO1=2	2=Moderate

5.3 Final Attainment of Vision and Mission

When the Program Outcomes (PO) are assessed then we move one more step ahead to evaluate the vision and mission of the institution. For this purpose, the POs are mapped with Vision and Mission of the institution as described in Table 4.

Table 4. Mapping of POs with Vision and Mission

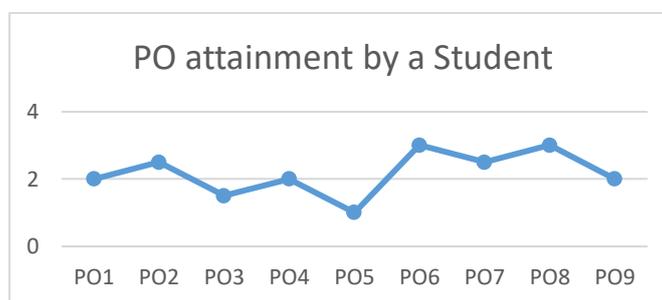
Programme Outcomes	Mapping Weights
PO1 Domain Knowledge	2
PO2 Communicative competence	3
PO3 Proficiency in using Modern Technologies	2
PO4 Reflective response to ethical and Social issues	3
PO5 Sustainability Valuesc	3
PO6 Critical thinking and Problem Solving	3
PO7 Entrepreneurship and Leadership	2
PO8 Team work	3
PO9 Self-Directed and Lifelong Learning	2

The mapping weights in the table shows the significance of the Program Outcomes in deciding the level of attainment of vision and mission of the institution. The vision and mission of the institution is quantified using the equation 4.

$$\mu(M, V) = \frac{\sum_{i=1}^n W_i * PO_i}{\sum_{i=1}^n W_i} \quad (4)$$

6. RESULTS AND DISCUSSIONS

The concepts on Outcome Based Education and attainment of COs and POs are implemented on a software platform developed in PHP. The attainment levels of CO, PO and PSO are assessed using the systems. The attainment levels of individual students, batches and PO attainment level for the entire institution are evaluated. This will finally help to assess the success of the institution in achieving the mission, vision and the purpose of its existence. The sample attainment of POs by student is demonstrated in Fig. 5 and the attainment of the institutional vision and mission by the students are given in Fig. 6.

**Fig. 5.** Attainment of PO by a student

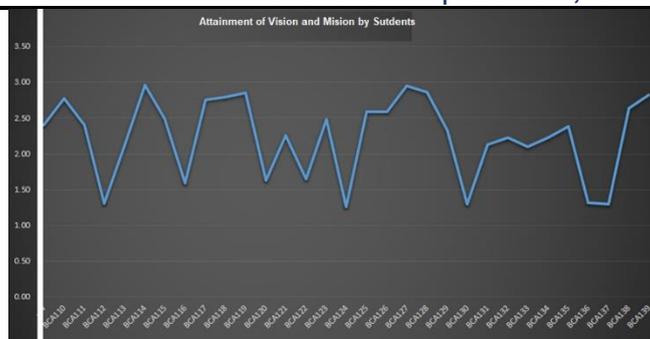


Fig. 6. Attainment of Mission and Vision by a batch of students

The attainment of Mission and Vision of the institution through different programs of the institution can also be assessed as shown in Fig. 7.

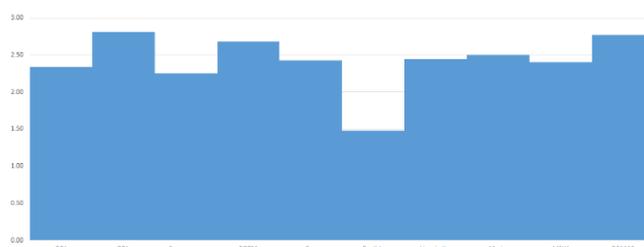


Fig. 7. Attainment of Vision and Mission by different programs of the institution

7. CONCLUSION

The concept of OBE is about developing the curricular structure based on what the learners are expected to achieve at the end of the education program [6]. The direction towards OBE implementation has been supported by the accreditation agencies in India. Various education models have been highlighted in support towards OBE implementation by different agencies [11]. A fuzzy based model for assessing the attainment of Mission and Vision of the institution through learning outcomes was proposed in this paper. Development of COs, POs and their assessments from different learning activities were introduced and finally the attainment of these outcomes, Mission and Vision were demonstrated with examples.

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