Assessment Technique to address the Diversity of Students

Salman Abdul Moiz
School of Computer and Information Sciences
University of Hyderabad
Hyderabad, INDIA
https://orcid.org/0000-0001-9294-0275

***Abstract*— The innovative practice full paper presents an Assessment mechanism that caters to diverse students in a Higher Education System. Assessment poses challenges in evaluating a student in the higher education system. The students are generally from various social, economic, and educational backgrounds. Measuring the course outcomes will neither help the student pass the course nor help achieve the stated targets by the teacher. This paper presents an assessment mechanism that helps attain course outcomes based on the diversity of students and their level of understanding. The proposed assessment mechanism is implemented in an undergraduate course, and the results are compared in a detailed and comprehensive manner with the traditional outcome-based assessment. It is observed that the proposed assessment mechanism is suitable for higher education institutes in dealing with various types of students and helps improve their performance in a given course.**

Keywords—Assessment, Course outcomes, Diversity, Attainment, Expected targets, Higher education.

I. INTRODUCTION

The transformation from a teacher-centric to a learner-centric education system resulted in an outcome-based education (OBE) system in line with the Washington Accord [1]. In outcome-based education (OBE), the course delivery, assessment, and other activities are planned to achieve the stated course outcomes or goals.

The global adoption of outcome-based education can be traced back to a significant event in 1989-the establishment of the Washington Accord[1] . This landmark agreement was designed to promote undergraduate education that aligns with OBE principles. Since then, OBE has gained traction and is now a standard in many educational institutions, including Technical Education Institutes in India that are required to be accredited by the National Board of Accreditation (NBA)[2].

In general, assessment is more mechanical. There is generally no SMART(Specific, Measurable, Achievable, Relevant, Time-bound) way to determine whether the student has achieved the desired course outcomes. The outcome-based education system defines the course outcomes before the course is offered. The course instructor specifies the expected targets of each outcome based on one's expectations. Based on the learning complexity of achieving a given course outcome, the instructor may set the expected targets. This may vary from one-course outcome to the other. However, it is noted that the targets for formative and summative assessment are different. It is also noted that the expected targets of each course outcome are the same irrespective of their complexity. Giving equal weight to all outcomes has several limitations. Firstly, it does not help in dealing with the inherent diversity of students in a class. Secondly, it impacts the student's performance in achieving expected targets in subsequent course outcomes. Hence, there is a need for an assessment mechanism that helps attain the expected targets of course outcomes and realize the learner-centric mechanism.

This paper addresses the following research questions

RQ1: What is the role of pre-requisites in understanding a course

RQ2: Whether the expected targets can be the same for all outcomes in a given grading scale

RQ3: Is there any effect of targets achieved from one outcome to another in a course

The above research challenges are addressed by proposing an assessment mechanism that aims at holistic student evaluation and helps achieve the desired outcomes.

The paper is organized as follows: Section II presents the assessment mechanisms used in the literature. Section III presents the proposed assessment methodology that helps realize the course outcomes as per the targets planned. Section IV presents the results achieved while implementing the assessment mechanism in an undergraduate course and compares the outcomes achieved with different assessment mechanisms for the same course over the years, and Section V concludes the paper.

II. BACKGROUND

Assessment in the education system documents the measurable facets of teaching and learning, including knowledge, skills, and ethics. The outcome of the assessment is to motivate students and guide the instructor in improving the teaching methods and pedagogies. Generally, there are three modes of assessment: Diagnostic, Formative, and Summative. Diagnostic assessment aims to assess students' knowledge at the start of the course. *Formative assessment* is a regular evaluation process that is carried out while learning the course. This helps in assessing the progress of both students and the instructor. Summative assessment takes place at the end of the course to identify learning capability.

A wide variety of assessment techniques have been proposed in the literature. Krishna et al. [3] stated the role of formative

assessments and their role in optimizing the student's performance. It also suggested adaptable formative strategies for assessment. Costa et al. [6] analyzed assessment methods' impact on student achievements. It is proposed to consider the external factors that influence academic success. Bloxham et al.[7] presented several stages of assessment, which include assessment design, preparing students for assessment, marking and moderation, and providing feedback. Bryna et al. [8] highlighted the need to evolve the assessment mechanisms by addressing modern-day challenges such as technological advancements, changing student demographics, and evolving learning styles.

The American Association of School Administrators [4] provided insights into the critical aspects of outcome-based education, including issues related to defining of the course outcomes, and highlighted the need of effective implementation. Antonio et.al [10] proposed that there is a need for alternative assessment methods to evaluate a broader range of competencies and skills such as critical thinking, problem-solving, and creativity. The authors emphasize the need for pluralism in teaching and assessment that cater to different learning styles .

In [11], assessment metrics are presented to study students' perceptions of higher education institutions. The results specify a need to upgrade assessment strategies and ensure ethical academic practices.

Costa et al. [12] present a study that analyses the impact of assessment methods on students. It is observed that the use of laboratories, presentations, and group-based activities has a higher impact as compared to other activities. It is also noted that socioeconomic, motivation, etc, also impact academic success.

Loureiro[13] et al. present the results of a study that aims to analyze the perceptions of higher education students. Students consider the online peer assessment as an appropriate assessment strategy that helps develop cognitive, metacognitive, and digital skills.

Davidovitch[14] et al. present a study that analyzes knowledge control and evaluation methods and the roles of these methods in assessing the knowledge of the students. The study recommends using standardized and non-standardized methods to ensure effective assessments. However, the scope of most of the studies is confined to holistic assessment in general.

The National Education Policy -2020 [5] also highlighted the need for innovative assessment mechanisms to achieve the desired outcomes and to address the diverse class groups. There must be a need for an assessment mechanism that truly inspires every student to achieve the desired outcomes and enhances the teaching-learning process.

III. ASSESSMENT METHODOLOGY FOR HIGHER EDUCATION SYSTEM

There is a need for assessment mechanisms to address the student's diversity and avoid the mechanical way of evaluating a student. The proposed Assessment methodology is depicted in Figure 1.

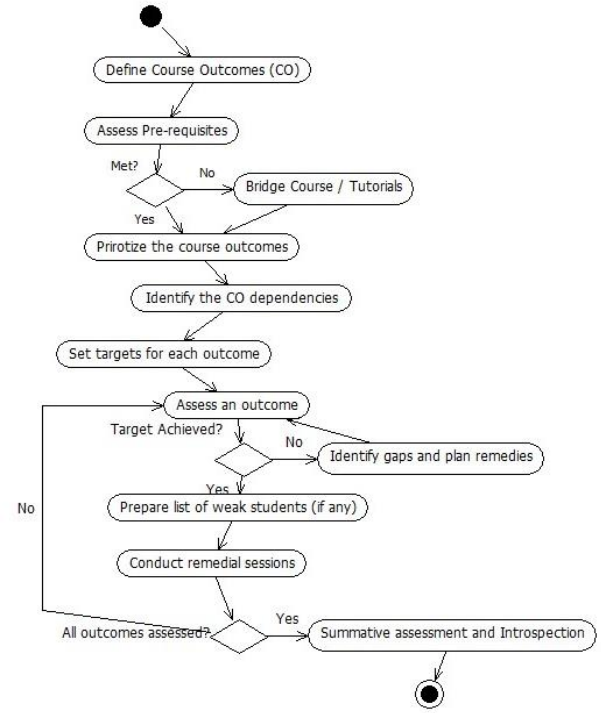

Fig. 1. Assessment mechanism for Outcome Based Education.

A. *Define course outcomes and assess pr-requisites.*

The instructor defines the course outcomes for a given course. The course roster includes the prerequisites. Students who completed the prerequisites are expected to register for the course. However, as the students are from different academic backgrounds and institutions, it is sometimes difficult to understand a particular course. Hence, it is suggested that the prerequisites of the students be assessed.

The first assessment is for the prerequisites. Its purpose is to identify students who do not meet the desired targets and must take a bridge course. This assessment and remedial process, which must be completed before the formal commencement of the course offering, is a crucial part of the course planning. It also helps the instructors to know the knowledge of the students in the prerequisite courses..

B. *Specify course dependencies and set targets.*

Before starting the course, the course outcomes must be prioritized based on the dependencies, if any. For example, if the first-course outcome(CO-1) is required to understand the second(CO-2), CO-1 has a higher priority than CO-2. Furthermore, the expected targets for assessing these course outcomes are different. In the above scenario, CO-1 is required to understand CO-2. Hence, the target for assessing CO-1 has to be set higher. In a traditional outcome-based education system, the set targets are the same for all course outcomes. The targets for primary course outcomes should be higher, and advanced course outcomes (apply or create) may be lower in an undergraduate course.

Each course outcome is assessed based on the expected targets during formative assessment. A remedial mechanism must be implemented if the set target is not reached. Even if the targets are reached, the students who did not achieve the desired target have to be identified and may be asked to take the remedial mechanism. This process is repeated for each defined course outcome. This mechanism will also help identify slow learners.

As the foundation of learning is possible by making solid fundamentals, the targets for such outcomes should be high. The advanced course outcomes targets may be less. However, the priority of course outcomes will also help in realizing the advanced course outcomes.

The attainment level for each course outcome is determined based on the rubrics. These rubrics provide a clear and objective framework for evaluating student performance, ensuring a fair and consistent assessment process.

For example, assume that the expected target in one of the course outcomes is 80%, i.e., a student is expected to secure 80% in the given course outcome. If 40% of students score above the target, the attainment level is set to one (1). Similarly, if 60% of students score more than the set target, the attainment level is set to two (2), and if 80% of students score more than the target, the attainment level is set to three (3).

C. Summative Assessment and Introspection

The course outcomes for a particular course are evaluated during the formative assessment phase. The remedial mechanism is executed if the expected target of a particular course outcome is not achieved. Once all the formative assessments are completed, the summative assessment is realized.

In the summative assessment, all course outcomes are assessed generally with a common target. However, in an autonomous degree-awarding institution, the institution's unique approach to education is reflected in the varied targets for the outcomes, similar to formative assessments. Attainment levels verify the overall assessment of course outcomes and program outcomes. The desired attainment level of total assessment, both formative and summative, is arrived. If the desired attainment level is not reached, then introspection is done to identify the gaps in pedagogy, and the suggested improvements are documented. The changes to the curriculum and the course outcomes are also the outcomes of the introspection phase.

IV. RESULTS AND ANALYSIS

The proposed assessment methodology was used in Software Engineering course offered to undergraduate students in 2023. The impact of the same is compared with the same course offerred in previous year (2022).

A. Assessment of Software Engineering Course

Software Engineering course is offered to undergraduate students. The six-course outcomes are specified in the course roster (for the year 2023) as given below:

CO-1: Explain software development models (Understand)

CO-2: Apply requirements engineering to software systems (Apply)

CO-3: Describe Software Architectures (Understand)

CO-4: Apply object-oriented paradigm to design software systems (Apply)

CO-5: Apply structured paradigm to design software systems (Apply)

CO-6: Apply testing mechanisms to test software systems (Apply)

It is expected that, as a prerequisite, the student should have completed a programming course at any level. An evaluation assesses the students' basic programming knowledge in 2023. Out of 32 students who registered for the course, it is noted that three students could not meet the set targets. To ensure their success, they were provided with the opportunity to take a bridge course on an online platform within two weeks. This effective intervention helps address the diverse group of students and ensures they start the course on an equal footing.

When offered in 2021 and 2022, the same course had few students who could not pass. Upon assessing the prerequisites, it was found that the same students could not reach the desired targets and were asked to take a bridge course. It is observed that an assessment of the prerequisite is required before taking a course, and an appropriate bridge course, as demonstrated by the students' improved understanding, is instrumental in helping the students grasp the course material.

To answer RQ1: The prerequisites are required to understand and help students complete the course. Furthermore, it helps in dealing with the diversity of the students.

The course outcomes are arranged as per the priority. It was decided that CO-1 of the Software Engineering course is of higher priority as it deals with the fundamentals of the course. The assessment of the CO-1 sample is depicted in Table 1.

TABLE I. ASSESSMENT OF CO-1

Enrollment number	***Marks Secured (Max:20)***
101	15
102	16
103	13
104	17
105	17
106	12
107	19
108	18
109	16
110	11

As CO-1 is a vital course outcome, a student needs to perform better in CO-1 to realize other outcomes. The desired targets are set high (70%).for CO-1. The attainment level for CO-1 for a 2023 batch is specified in Table II.

TABLE II. ATTAINMENT LEVELS

Attainment Level	***Criteria***
1	40% of the students scoring more than the target
2	60% of the students scoring more than the target
3	80% of the students scoring more than the target

As an instructor, one desires to achieve at least attainment level 2. However, for primary course outcomes, attainment level 3 is desired.

With a desired target of 70% for CO-1, it's evident from Table I that 70% of students have achieved this. The attainment level is 2 for CO-1 in this case. However, students with enrollment numbers 103, 106, and 110 have not met this target. It's crucial to recommend a remedial class for them, and as it's a formative assessment, another evaluation should be conducted to gauge their performance.

The CO-2 was then assessed with a desired target of 65%. The results of a sample of 10 students with performance in CO-1 and CO-2 are specified in Table III.

TABLE III. ASSESSMENT OF CO-1 AND CO-2 (2023)

Enrollment number	***CO-1***	***CO-2***
	Marks Secured (Max:20)	***Marks Secured (Max:20)***
101	15	18
102	16	17
103	13	16
104	17	17
105	17	18
106	12	15
107	19	18
108	18	18
109	16	11
110	11	14
Attainment Level	***2***	***3***

It is observed that 90% of the students have achieved more than the target (60%) in CO-2, thereby achieving attainment level 3. It was observed that the student's performance improved from CO-1 to CO-2. This also concludes that, as opposed to the traditional outcome-based assessment, the targets of each outcome cannot be the same.

B. Assessment of SE-2022 course

The outcome-based assessment was also adopted earlier in the SE-2022 course. However, the targets were the same for all course outcomes, which is 50%, and accordingly, the attainment levels were computed. The sample of ten students for CO-1 to CO-3 is given in Table IV.

TABLE IV. ASSESSMENT OF CO-1, CO-2 AND CO-3 (SE-2022)

Enrollment number	***CO-1***	***CO-2***	***CO-3***
	Marks Secured (Max:20)	***Marks Secured (Max:20)***	***Marks Secured (Max:20)***
401	12	14	12
402	10	10	11
403	11	10	8
404	9	7	8
405	10	9	7
406	8	7	7
407	10	9	12
408	11	10	11
409	10	12	9
410	13	14	10
Attainment Level	***3***	***2***	***1***

As the set target is the same (50%) for all outcomes, there is an effect on student's performance in other outcomes, though the attainment level is high (Table IV).

To answer RQ2: The set targets should differ for all course outcomes. The primary course outcomes require high targets as they represent the fundamentals of the course. It is also noted that computing only the attainment level, based on the same target of 50% is misleading. It shows greater attainment but does not contribute to holistic course assessment.

Furthermore, when we compare Table III and Table IV, it is clear that as more emphasis is given to the initial course outcomes, which are the foundational concepts and skills that students need to master at the beginning of the course, there is an effect on the other outcomes.

To answer RQ3: If tthe targets for primary outcomes are high, and a student cannot achieve the desired target, a proper remedial mechanism is implemented. It is observed that the performance in subsequent outcomes attainment has generally improved.

C. Summative Assessment

Summative Assessment includes the evaluation of students for all course outcomes. The final attainment of the course is compared with the desired attainment level of each course outcome; wherever the attainment is not reached, necessary steps and suggestions are taken through feedback and self-appraisal to improve the course in the next offering. The

outcome will also help identify whether there is a need for modification in the course outcomes.

D. *Threats to validity*

The proposed assessment mechanism was tested in several courses, with an enrollment ranging from 35 to 60. The diversity of students was also analyzed based on their traits, and it is observed that the proposed mechanism of assessment is well-suited for a diverse group. Importantly, the varied targets for each outcome continue to be effective even for a larger population, reinforcing the potential of the mechanism.

The desired targets of all outcomes are the same as in the existing outcome-based assessment. However, this shows a higher level of attainment of course outcomes, but more is needed to ensure that the primary outcomes that deal with the fundamentals of a core are made strong. Furthermore, in the traditional outcome-based assessment, the dependency between one-course outcome and another course outcome must be ascertained.

V. CONCLUSION

The outcome-based education system is being implemented across the globe. However, assessment mechanisms still need to improve in assessing students from various economic and social backgrounds who have studied at different institutes. This paper proposes an assessment mechanism that helps deal with diverse students by adding a prerequisite assessment stage. This helps identify the need for bridge courses for weaker students. Unlike traditional outcome-based assessment, it is proposed that the targets for primary course outcomes should be higher. This helps the students perform better in subsequent course outcomes, which are observed by comparing the same course offerings in different years.

If adopted globally, this mechanism helps achieve a standard assessment method and facilitates the seamless transfer of students from one institute to another. The proposed assessment mechanism will be suitable for implementing the National Education Policy -2020 in India, which implements multiple entry, multiple exit, and credit transfers across institutes.

ACKNOWLEDGMENT

The work was supported by Institution of Eminenc(IOE), University of Hyderabad, Hyderabad, India.

REFERENCES

[1] Washington Accord. International Engineering Alliance, Abet Inc. 2001-2007.

[2] www.nbaind.org

[3] Krishna, C.B., Kiran, G.R., Ravindar, B., Reddy, R.A. (2021). Assessment Techniques in Engineering Education—Tools and Strategies of the Faculty. In: Reddy, K.A., Devi, B.R., George, B., Raju, K.S. (eds) Data Engineering and Communication Technology. Lecture Notes on Data Engineering and Communications Technologies, vol 63. Springer, Singapore. https://doi.org/10.1007/978-981-16-0081-4_50.

[4] William G. Spady (1994), “Outcome-Based Education Critical Issues and Answers”. The Americal Association of School Administrators.

[5] National Education Policy-2020, India (https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf).

[6] Costa, J.M., Araújo, S., Soliman, M., Sousa, M.J. (2022). Assessment Methods Determining the Higher Education Students’ Academic Success. In: Primo, T.T., Gomes, A.S., Moreira, F., Collazos, C. (eds) Advanced Virtual Environments and Education. WAVE 2021. Communications in Computer and Information Science, vol 1425. Springer, Cham. https://doi.org/10.1007/978-3-031-07018-1_7

[7] Pete Boyd, Sue Bloxham (2007). Develoing assessment in higher education: a practical guide. McGraw Hill, Open University Press.

[8] Cordella Bryan, Karen class (2006): Innovative Assessment in Higher Education. Routledge Taylor & Francis Group, London & Newyork.

[9] Andreatos, Antonios S. "Designing Alternative Assessment Activities and Adaptive Learning Scenarios to Cover Various Learning Styles in Higher Education." *Fostering Pedagogy Through Micro and Adaptive Learning in Higher Education: Trends, Tools, and Applications*, edited by Ricardo Queirós, et al., IGI Global, 2023, pp. 287-305. https://doi.org/10.4018/978-1-6684-8656-6.ch013.

[10] Andreatos, Antonios S. "Designing Alternative Assessment Activities and Adaptive Learning Scenarios to Cover Various Learning Styles in Higher Education." *Fostering Pedagogy Through Micro and Adaptive Learning in Higher Education: Trends, Tools, and Applications*, edited by Ricardo Queirós, et al., IGI Global, 2023, pp. 287-305. https://doi.org/10.4018/978-1-6684-8656-6.ch013.

[11] Mustaq, S., Siraj, D., Akhtar, S., & Ismaeel, G. (2024). Assessment Metrics: Insights into Students’ Perceptions across Higher Education Institutions. *Pakistan Journal of Humanities and Social Sciences*, *12*(1), 537–544. https://doi.org/10.52131/pjhss.2024.v12i1.2064.

[12] Costa, J.M., Araújo, S., Soliman, M., Sousa, M.J. (2022). Assessment Methods Determining the Higher Education Students’ Academic Success. In: Primo, T.T., Gomes, A.S., Moreira, F., Collazos, C. (eds) Advanced Virtual Environments and Education. WAVE 2021. Communications in Computer and Information Science, vol 1425. Springer, Cham. https://doi.org/10.1007/978-3-031-07018-1_7.

[13] Loureiro P, Gomes MJ. Online Peer Assessment for Learning: Findings from Higher Education Students. *Education Sciences*. 2023; 13(3):253. https://doi.org/10.3390/educsci13030253.

[14] Davidovitch N, Gerkerova A, Kyselyova O. Comparative Analysis of Knowledge Control and Evaluation Methods in Higher Education. *Education Sciences*. 2024; 14(5):505. https://doi.org/10.3390/educsci14050505