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ALIGNING ASSESSMENT METHODS WITH COGNITIVE LEVELS: AN ANALYSIS OF QUESTION PAPER DESIGN USING BLOOM'S TAXONOMY AND STUDENTS PERFORMANCE IN PRIVATE UNIVERSITIES

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Abstract

The research collaborates the study of Blooms Taxonomy to understand its applications in the information sector proposing an efficient framework of assessment methods for the learners. This facilitates the knowledge Professionals to effectively design the Learning objectives and design questions papers that accurately gauge student skill levels.

***Value**: This approach emphasizes the importance of accurately assessing student skills for individual achievement as well as means to identify educational gaps, promote continuous learning and ultimately contribute to a sustainable future by fully realizing human capital potential. This will not only benefit the individuals but also enhances the diversity and resilience of the broader societal fabric.*

Keywords: *Bloom' Taxonomy, Knowledge Industry, Learning Objective, Assessment Methods, Skills enhancement of the learners*

1. INTRODUCTION

One of the primary obstacles in education is assisting students in cultivating efficient learning strategies. Students in educational institutions must commit significant amounts of time, spanning hours, days, and years, to acquire the essential knowledge, skills, and attitudes needed for successful integration into a civilized society and meaningful engagement in a democratic system. Learning encompasses the process of acquiring novel behavior patterns or altering pre-existing ones through deliberate practice. It includes a wide spectrum of behavioral modifications, which can be observed in explicit behaviors or in an individual's internal storehouse of thoughts. Motivations or drives are essential components of the learning process.

The lower-order cognitive domains encompass knowledge (the ability to recall specific facts), understanding (the capacity to describe information in one's own words), and application (the utilization of existing knowledge to attain desired outcomes). The higher-order thinking domains consist of analysis (recognizing connections between facts and concepts), synthesis (generating creative work), and evaluation (judging and expressing one's position). (Deller) (Freahat and Smadi).

Academics have employed Bloom's taxonomy to examine and classify test questions, differentiating between those that require lower-level thinking (LLQs) and those that demand higher-level thinking (HLQs). (Ramirez). Lower-level questions (LLQs) primarily involve the retrieval of basic concepts and procedures, but higher-level questions (HLQs) are more sophisticated and challenging, necessitating more profound and analytical cognition. (Assaly and Smadi) (Pendergast and Swain) (The Learning Center).

Creating well-crafted tests that include both high-level questions (HLQs) and low-level questions (LLQs) is crucial for aiding students in attaining targeted learning goals and evaluating their ability in a particular subject. (Wachiuri , Ongeti and Mugo). HLQs facilitate students in exploring learning materials at a deeper level and promote the development of critical thinking and creativity.

1.1 Bloom's Taxanomy

Bloom's Taxonomy, initially formulated by Benjamin Bloom and his associates in 1956, is a hierarchical framework employed to categorize educational learning objectives based on their levels of intricacy and precision. The taxonomy categorizes cognitive learning into six distinct categories: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. The categories are sometimes represented as a pyramid, with Knowledge at the bottom and Evaluation at the top. This signifies a transition from simple memorization of information to more advanced cognitive abilities like critical analysis and creative problem-solving.

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In 2001, Anderson and Krathwohl made revisions to Bloom's Taxonomy by updating the categories with more active verbs and making structural changes to better represent the learning process. The updated taxonomy has the following levels: Remember, Understand, Apply, Analyze, Evaluate, and Create. This revised version highlights a heightened emphasis on an active approach to learning, wherein students are not merely passive users of information but rather active architects of knowledge. The revision further emphasizes the significance of connecting educational evaluations with these cognitive processes to guarantee a thorough and significant evaluation of student learning.

1.2 Importance of Bloom's Taxonomy in Assessment Design.

Bloom's Taxonomy offers a systematic framework for educators to create exams that assess student knowledge and promote the growth of advanced cognitive abilities. By ensuring that assessment questions are in line with the different levels of the taxonomy, educators may develop a more equitable and demanding examination that pushes pupils to exhibit a more profound comprehension and utilization of the subject matter.

1. **Recollection**: The initial stage entails the recollection of factual information and fundamental principles. Assessment questions at this level are generally uncomplicated and consist of multiple-choice, true/false, and short-answer questions. Although crucial for building a basic understanding, questions that simply concentrate on this level fail to effectively evaluate higher cognitive abilities.

Level two of understanding is the task of pupils elucidating ideas or concepts. Assessment methods may encompass the tasks of summarizing, describing, and explaining using one's own language. These types of questions go beyond just memory to ensure that students fully understand the meaning of the information.

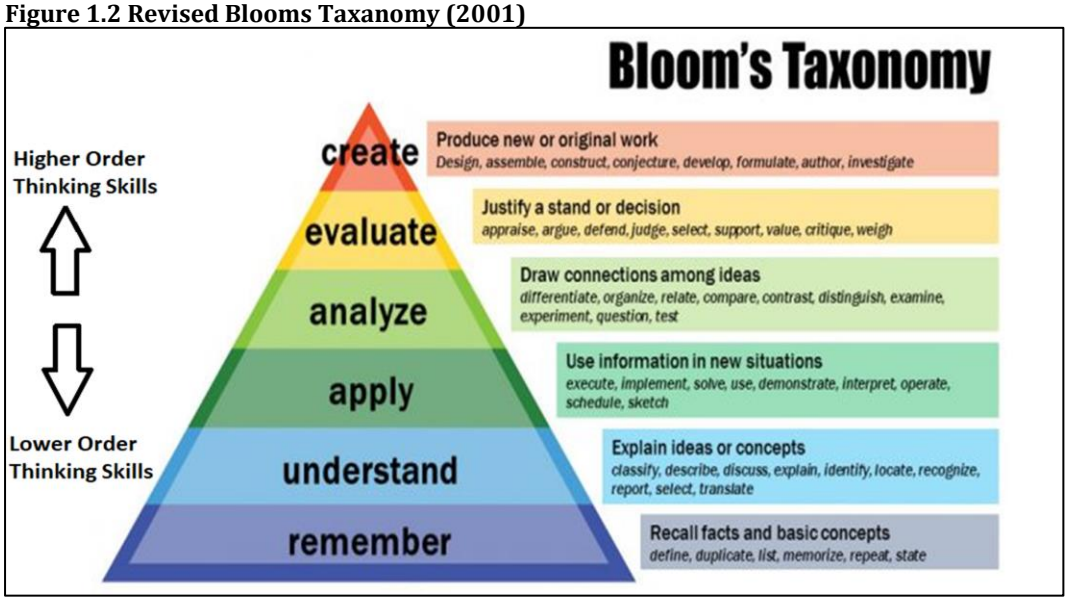
3. **Applying**: At this stage, students utilize information in novel and tangible scenarios. Questions may encompass tasks related to analytical thinking, mathematical computations, and the practical application of principles in real-life situations. This level is vital for disciplines that prioritize the practical application of information.

4. **Analyzing**: The fourth stage is dissecting information into components in order to investigate comprehensions and connections. Assessment methods encompass the activities of differentiating, scrutinizing, and deducing. These inquiries necessitate pupils to engage in critical thinking and comprehend the organization of the material.

5. **Evaluating**: Level five of the evaluation process is providing a rationale or justification for a choice or course of action. Questions may prompt students to evaluate theories, contrast concepts, and analyze approaches. This level is crucial for cultivating and honing critical thinking and discernment abilities.

6. **Generating**: The most advanced stage entails the production of novel or innovative work. Assessment procedures encompass activities such as creating, constructing, and hypothesizing. These inquiries promote ingenuity and originality, compelling students to integrate their understanding in innovative manners.

Figure 1.2 Revised Blooms Taxanomy (2001)



2. Design Approach and Methodology:

2.1 The methodology section describes the methodical technique used to carry out the research and accomplish its goals. This section outlines the methodologies, protocols, and approaches used to gather, examine, and evaluate data, ensuring clarity and precision in the research process.

Section I: Theoretical Exploratory Research

During this stage, the study employed secondary data to investigate Bloom's Taxonomy and its various aspects. The researcher analyzed secondary data sources such as academic journals, books, research reports, and educational databases to obtain a thorough comprehension of Bloom's Taxonomy. This included studying its historical evolution, theoretical framework, and its practical use in educational environments. The research focused on the hierarchical organization of Bloom's Taxonomy, which classifies cognitive processes into six levels, spanning from lower-order thinking skills (LOTS) to higher-order thinking skills (HOTS). In addition, the study investigated the application of Bloom's Taxonomy in guiding the development of curriculum, instructional design, and assessment methods in different educational settings.

Section II: Practical Research

During this phase, the research concentrated on implementing the ideas of Bloom's Taxonomy to create learning objectives and establish a theoretical framework that assisted teachers in designing curriculum and delivering teaching. Expanding on the theoretical investigation carried out in Part I, distinct tactics were determined for harmonizing learning objectives with the levels of Bloom's Taxonomy. The task entailed building a structured framework or template that educators could utilize to formulate learning objectives that address various cognitive processes, ranging from basic recall and comprehension to higher-level skills such as analysis, evaluation, and creation. The model theory offers practical guidance and illustrations to aid teachers in transforming theoretical concepts into practical teaching methods. It emphasizes the cultivation of advanced cognitive abilities in students through carefully crafted learning goals and instructional activities.

Section III: Empirical Investigation

During this phase, the research utilized an experimental methodology, specifically employing a stratified random sampling technique, to examine the correlation between Bloom's Taxonomy and learning objectives, as well as the construction of question papers in courses offered by two private colleges. The sample used for mapping Bloom's Taxonomy levels to the cognitive difficulty of learning objectives and the structure of assessment items consisted of question papers from selected courses. The study investigated the extent to which Bloom's Taxonomy was accurately represented in the cognitive requirements of assessment tasks, and whether there was consistency between stated learning objectives, assessment items, and desired educational outcomes. The findings offered valuable insights into the practical application of Bloom's Taxonomy in assessment methods and provided informed suggestions for improving the alignment of curriculum, instruction, and assessment in higher education environments.

In summary, this research design took a thorough approach to studying the fundamental concepts of Bloom's Taxonomy, applying them to curriculum design and instructional practice, and empirically evaluating their implementation in assessment processes. This study sought to enhance educational theory and practice by combining theoretical analysis, applied research, and experimental investigation. Its goal was to promote higher-order thinking skills and facilitate effective teaching and learning processes.

2.2 Objectives of Study:

1. To explore the Blooms Taxonomy.
2. To develop the correlation between the Blooms Taxonomy and the assessment methods.
3. To develop a framework for the design of the question papers.
4. Develop a template for the evaluation criteria along with the marks distribution based on the principles of Blooms Taxonomy.
5. Mapping of attainment of the leaning outcomes through the question paper analysis.

2.3 Sampling Strategy

By employing a combination of stratified, convenience, and random sampling methods, the study aimed to gather comprehensive data that reflected both theoretical insights and practical applications of Bloom's Taxonomy in educational settings. The multi-phase sampling approach facilitated a nuanced understanding of how Bloom's Taxonomy is conceptualized, implemented, and evaluated across different stages of the research process.

At the end of the Odd Semester End-Term examinations, a random set of results of these streams were analyzed. The random courses were selected within these streams, with average student strength over 40 to 45 per course. The analysis looked at 21 randomly selected courses to identify the percentage of students scoring equal-to or over 70% marks in the selected question OR in other words students who were closer to the right answer for the randomly selected question.

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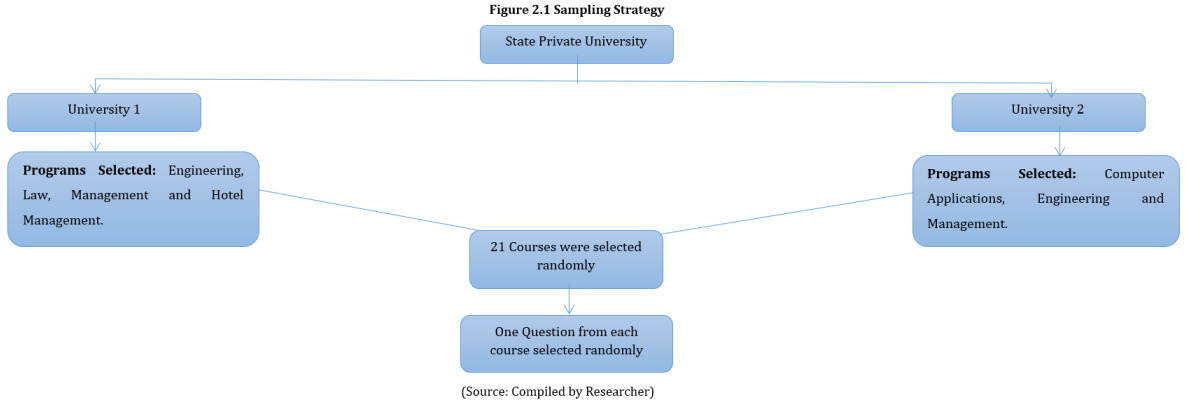
Figure 2.1 Sampling Strategy



(Source: Compiled by Researcher)

Table No. 2.1 Sampling Units

Item Analysis Summary Report (AY Odd 2023-24)		
School Name	**Sem**	**Total course**
SOE	I	5
SOE	III	8
SOE	V	3
SOL	III	1
SOL	V	1
SOL	IX	1
SOM	I	2
Total courses		**21**

(Source: Compiled by Researcher)

3. Data Analysis

Table No. 3.1: Question paper mapping with Blooms level
Sample QP-MBA SEM II- Course: Entrepreneurial Ethics & CSR

Q.1		**Answer the following (Any Two)**	**Marks**	**Blooms Level**
	a)	"CSR is not just about ticking a box, it is about hitting the bottom line"- Do you agree with the statement? If yes, Elaborate the importance of CSR in detail.	10	3
	b)	"Unethical behavior significantly increases the cost of doing business" Elaborate the statement and explain the main reasons of unethical behavior in business environment.	10	3
	c)	"Some acts are morally obligatory regardless of their consequences for human welfare" Determine which approaches of business ethics this statement is representing and elaborate the approach in detail.	10	4
Q.2		**Answer the following (Any Two)**		
	a)	"Sustainability is not the Goal to be achieved, but it is a way of thinking, a way of being". Explain the statement in detail with suitable examples.	10	2
	b)	Discuss the legal provisions made in India with respect to Corporate Social Responsibility.	10	2
	c)	Explain the Cost-Benefit analysis of Environment Management System.	10	2
Q.3		**Answer the following short notes (Any Two)**		
	a)	Write a short note on-Transparency and CSR	5	1
	b)	Write a short note on- OECD Guidelines for Multinational Enterprises.	5	1
	c)	Write a short note on- Sustainable Development Goals	5	1
		Total Marks	**50**	

(Source: Compiled by Researcher)

In the first instance, all the sampled question papers were mapped with Blooms Taxanomy Levels and accordingly the level wise marks distribution was calculated. This was repeated with all the programs and course respectively. Mapping ensures that the assessment methods used in the question papers are aligned with Bloom's Taxonomy, which categorizes cognitive processes into hierarchical levels ranging from lower-order to higher-order thinking skills. By mapping the questions to Bloom's Taxonomy levels, educators can assess whether the assessment adequately covers a range of cognitive skills, from simple recall and comprehension to

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critical thinking and creativity. Mapping question papers with Bloom's Taxonomy levels allows educators to evaluate the extent to which the assessed learning objectives align with the intended cognitive skills. It helps ensure that the assessments accurately reflect the learning outcomes specified for the course or program.

Table no. 3.2 Blooms Taxonomy Levels in % of Total End Sem Examination Paper (Suggested University Standard)

		Level					
Sr. No	**Program**	**L1**	**L2**	**L3**	**L4**	**L5**	**L6**
1	FY BTECH	30	40	25	5		
2	SY BTECH	20	40	30	10		
3	TY BTECH	20	30	30	10	10	
4	MTECH		20	40	20	10	10
5	MBA		20	40	20	10	10
6	SY BBA	30	40	25	5		
7	FY BBA	30	40	25	5		
8	TY BBA	30	30	25	5	10	
9	FY BCOM	30	40	25	5		
10	SY BCOM	30	40	25	5		
11	TY BCOM	30	30	25	5	10	
12	FY BSC	25	40	30	5		
13	SY BSC	25	40	30	5		
14	TY BSC	25	30	30	5	10	
15	MSC	10	30	30	15	10	5
16	FY BAJMC	30	40	25	5		
17	SY BAJMC	20	30	30	10	10	
18	TY BAJMC	10	30	30	10	10	10
19	FY B.Arch	20	40	30	10		
20	SY B.Arch	20	30	30	10	10	

Note : The percentage level is calculated based on the appropriate verbs, context the verbs are used and the total marks for respective level based on the question paper

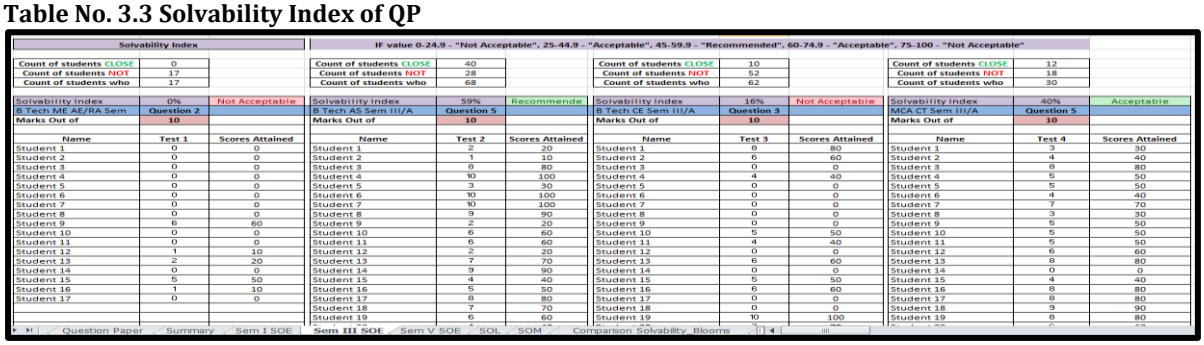
(Source: Compiled by Researcher)

The table provides a comprehensive overview of the distribution of courses across different levels within each academic program, offering insights into the curriculum structure and progression of learning within these program.

The distribution of courses across different levels reflects the progression of learning within each program. Typically, introductory or foundational courses (L1-L2) provide students with basic knowledge and skills, while intermediate (L3-L4) and advanced (L5-L6) courses build upon this foundation to develop more specialized and advanced competencies. The distribution of courses across different levels should be aligned with the program goals and learning outcomes. Programs aiming to provide students with a broad-based education may have a more balanced distribution of courses across all levels, while programs focusing on specialization may have a higher concentration of courses at advanced levels.

Programs with a higher percentage of advanced-level courses may better prepare students for specialized careers or advanced academic pursuits, while programs with a stronger emphasis on foundational and intermediate-level courses may provide a broader educational foundation for diverse career paths.

Table No. 3.3 Solvability Index of QP



(Source: Compiled by Researcher)

Once we understand the distribution of Blooms level throughout various courses, we then calculate the 'Solvability Index' of each course Question Paper.

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The Solvability Index of a question paper refers to a metric used to gauge the difficulty level of the questions within it. It helps in assessing how easily or difficultly students can solve the questions presented in the paper. The index is often calculated based on various factors such as the complexity of the questions, the depth of knowledge required to answer them, and the time available for the examination.

A higher Solvability Index indicates that the questions are relatively easier for students to solve, while a lower index suggests that the questions are more challenging. Educators and examiners use this index to ensure that the question paper maintains an appropriate level of difficulty that aligns with the students' knowledge and the objectives of the assessment.

Upon calculating the Solvability Index, the tolerance levels are designed to determine whether the questions framed were “acceptable” or “not acceptable”. For the current study the tolerance levels were as follows:

Table No. 3.4 Tolerance Level for Solvability Index

Solvability Index	Tolerance Level
0-24.9	Not Acceptable
25-44.9	Acceptable
45-59.9	Recommended
60-74.9	Acceptable
75-100	Not Acceptable

(Source: Compiled by Researcher)

Not Acceptable: A lower level of solvability index indicates that the questions within the question paper are more challenging for students to solve. When the solvability index is low, it suggests that a significant portion of the questions may be beyond the current abilities or knowledge level of the students.

A higher level of solvability index indicates that the questions on the paper are more easily solvable by the average student. Higher level of solvability index suggests that students might not be sufficiently challenge students or assess their true understanding of the material.

Acceptable: An average level of solvability index indicates that the questions on the paper are moderately challenging and should be within the reach of students with an average level of proficiency in the subject matter. This means that students with a basic grasp of the subject should be able to attempt and answer most questions within this range, although they may still encounter some difficulties. However, the questions should not be so difficult as to discourage attempts or significantly hinder progress.

Recommended: The "recommended" level of solvability index typically indicates that the questions on the paper are designed to be challenging but not excessively difficult. In essence, this range suggests that the questions are carefully crafted to stimulate thinking and test comprehension beyond basic knowledge recall. They may require students to analyze information, make connections between concepts, and demonstrate a deeper understanding of the subject matter.

Table No. 3.5: Comparison between Solvability Index and Level of Bloom Taxanomy

Sr. No.	Program	Subject	Semester	Question No.	Level of Blooms Taxanomy	Solvability Index	Status
1	B.Tech (FY)	Basic Electronics and Electrical Engineering	Sem I	2	1,2,3,4,5	11%	Not Acceptable
2	BCA	Web Technology	Sem I	3	2	17%	Not Acceptable
3	B Tech	Engineering Mechanics	Sem I	6	2,3	13%	Not Acceptable
4	BCA	Knowledge Representation and Reasoning for AI	Sem I	4	2,3	81%	Not Acceptable
5	MCA	Java Programming	Sem I	2	5	40%	Acceptable
6	B Tech	Strength of Materials	Sem III	2	3	0%	Not Acceptable
7	B Tech	Fundamentals Of Thermodynamics	Sem III	5	5	59%	Recommended
8	B Tech	IPP	Sem III	3	5	16%	Not Acceptable

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9	MCA	Amazon Web Services	Sem III	5	2	40%	Acceptable
10	B Tech	Biomedical Sensors and measurements	Sem III	2	2,3	0%	Not Acceptable
11	B Tech	AIDS	Sem III	3	5	9%	Not Acceptable
12	B Tech	HEM	Sem III	1	4,3	11%	Not Acceptable
13	B Tech	AT	Sem III	5	4,5	53%	Recommended
14	B Tech	Software Engineering & Design	Sem V	4	2,3	47%	Recommended
15	B Tech	Data Mining and machine Learning	Sem V	7	1,4,2	40%	Acceptable
16	B Tech	Advance data analytics using SQL	Sem V	4	2	47%	Recommended
17	LLB	COMPANY LAW	Sem III	3	3,5,6	67%	Acceptable
18	LLB	FAMILY LAW II	Sem V	3	4	60%	Recommended
19	LLB	Alternative Dispute Resolution	Sem IX	2	2	29%	Acceptable
20	MBA	Excel Applications for Business	Sem I	5	3,4,5	28%	Acceptable
21	MBA	Organizational Behaviour	Sem I	1	1	92%	Not Acceptable

(Source: Compiled by Researcher)

Solvability Index helps the examiner understand the expected level of learning that will take place at the end of every course. The above table depicts the comparison between multi-domain courses and their solvability index's. Examiner can take previous year's student performances into consideration while designing the current semester's assessment tools.

4. KEY FINDINGS

After examining the data on student performance and the utilization of Bloom's Taxonomy in assessment tools, the following findings were uncovered:

The research validated the efficacy of Bloom's Taxonomy as a framework for developing assessment methods that correspond to different levels of student learning abilities. This paradigm enables the assessment of students' cognitive abilities across several levels, ranging from simple recollection to more advanced critical thinking.

By correlating the question papers with the levels of Bloom's Taxonomy, the study discovered a diverse distribution of cognitive levels throughout various programs and courses. The mapping process unveiled the degree to which question papers focus on lower-order thinking skills (LOTS), such as remembering and understanding, as well as higher-order thinking skills (HOTS), such as analyzing, evaluating, and inventing.

The process of mapping question papers and analyzing the distribution of marks at different levels served as a measure to ensure quality. It guaranteed that assessments were impartial, accurate, and consistent measures of student learning, therefore upholding the credibility of the evaluation process.

5. CONCLUSION

The instructor consistently amplifies the achievements of the learners and tailors the evaluation techniques or question papers accordingly. The proposed methodology instructs educators to align assessments with students' comprehension levels while adhering to the university's established difficulty requirements.

This project aims to combine academics and the evaluation system by linking instructors' academic efforts with the development of a suitable assessment system. This approach is designed to fulfill the instructors' requirements and effectively involve learners as planned. Furthermore, it will empower teachers to investigate diverse assessment methodologies through the utilization of innovative digital technologies.

The research provides evidence that Bloom's Taxonomy is a highly successful framework for establishing assessment methods that are in line with students' learning skills. This method simplifies the assessment of students' ability to understand information at different degrees of cognitive complexity and assists in classifying pupils into categories based on their learning speed: slow, average, and rapid. The researcher also proposes a model guide for instructors to align their evaluations with the students' comprehension levels while adhering to the university's norms. This might also be utilized to quantify the precise published results of these courses, by harmonizing the evaluations with the OBE principles delineated in the NEP 2020.

REFERENCES

[1] Assaly , I. R and O. M Smadi. "Using Bloom's Taxonomy to Evaluate the Cognitive Levels of Master Class Textbook's Questions." Journal of Education and Practice (2015): 139-151.
[2] Daggett, W. R. "Preparing Students for Their Future." International Center for Leadership in Education. (2016).
[3] Deller, R. "An Overview of Bloom's Taxonomy of Learning Objectives." Educational Psychology Review (2019): 1-13.
[4] Freahat , N. M and O. M Smadi. "Lower-order and Higher-order Reading Questions in Secondary and University Level EFL Textbooks in Jordan." Theory and Practice in Language Studies (2014): 1804-1813.
[5] Hewitt, D. "Understanding Effective Learning: Strategies for the Classroom." Educational Psychology in Practice (2008): 63-66.
[6] Jones , L, R Jones and T Hargrove. "The Impact of Teacher Professional Development on Student Achievement." Educational Research and Reviews (2009): 436-443.
[7] Nykowanna, L. "The Role of Assessment in Enhancing Learning." Journal of Education Assessment (2019): 99-112.
[8] Pendergast , D and L Swain. "Developing Assessment Capable Students." Educational Leadership (2013): 28-34.
[9] Ramirez, C. "Applying Bloom's Taxonomy in Assessments." Journal of Educational Strategies (2017): 43-51.
[10] Song, Y. "Teacher Questioning and Students' Critical Thinking." Journal of Education Research (2019): 112-118.
[11] The Learning Center. "Higher-Level and Lower-Level Questions." Learning and Instruction Journal (2020): 33-45.
[12] Wachiuri , D, K Ongeti and J Mugo. "Assessment Practices and Students' Learning Outcomes in Higher Education." Journal of Educational Research and Reviews (2017): 1-8.
[13] Wagner, T. The Global Achievement Gap: Why Even Our Best Schools Don't Teach the New Survival Skills Our Children Need and What We Can Do About It. Basic Books., 2011.
[14] Wilson, D. M, A Suthagar and L Narasuman. "Investigating teachers' implementation and strategies on higher order thinking skills in school-based assessment instruments." Journal of Education and Learning (2020): 23-34.