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Assessment of Cognitive Domain Course Learning Outcomes

B. L. Gupta

Former Professor, National Institute of Technical Teachers' Training and Research, Bhopal M. P., India (Bharat).
Email: *badrilalgupta72@gmail.com*(corresponding author)

Abstract

The outcome-based education philosophy (OBE) is being implemented in higher education of the country which is learner centric and relevant to work situation. The OBE philosophy stresses on development of work-related abilities and their demonstration in work situation or simulated work situations. The national education policy 2020 emphases on wholesome development of learners encompassing abilities related to core discipline, inter disciplinary, cross disciplinary and multidisciplinary abilities. The focus of educational programmes is to develop programme level outcomes, programme specific outcomes, programme educational objectives aligned to missions and vision of the institute. The paper advocates the development of course learning outcomes using engaging pedagogies and formative assessment approaches to ensure achievement of intended level of course learning outcomes. The paper stresses on shifting from norms reference assessment to criterion reference assessment. The principles of assessment, course learning outcomes, concept of assessment of course learning outcomes, types of assessment formative and summative and formal and informal, creation of learning portfolio, assessment tools, process of preparing question paper for assessment of course learning outcomes, specification table, and suggestions for setting outcome-based assessment are noted.

Keywords: Outcome based education, course learning outcomes, specification table, learning portfolio, formative assessment, assessment tools, assessment approaches.

INTRODUCTION

The national education policy (NEP) 2020 emphasises on use of formative assessment for ensuring learning and developing higher level of learning outcomes in a specific course (MHRD, 2020). The summative assessment contributes for certification of achievement of course learning outcomes (CLOs). The assessment is ultimately focused on certification of terminating abilities of the graduates such as

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domain specific, cross disciplinary, multidisciplinary, and transdisciplinary abilities in the learners as stated in the NEP 2020. The summative assessment should also certify the learning outcomes related to sustainable development goals, Indian knowledge system, entrepreneurial abilities, incubation abilities, and research abilities. Assessment is integrated in learning and development of learners with a focus on achievement of programme learning outcomes, programme educational objectives, mission, and vision of the institute as indicated in Figure 1.

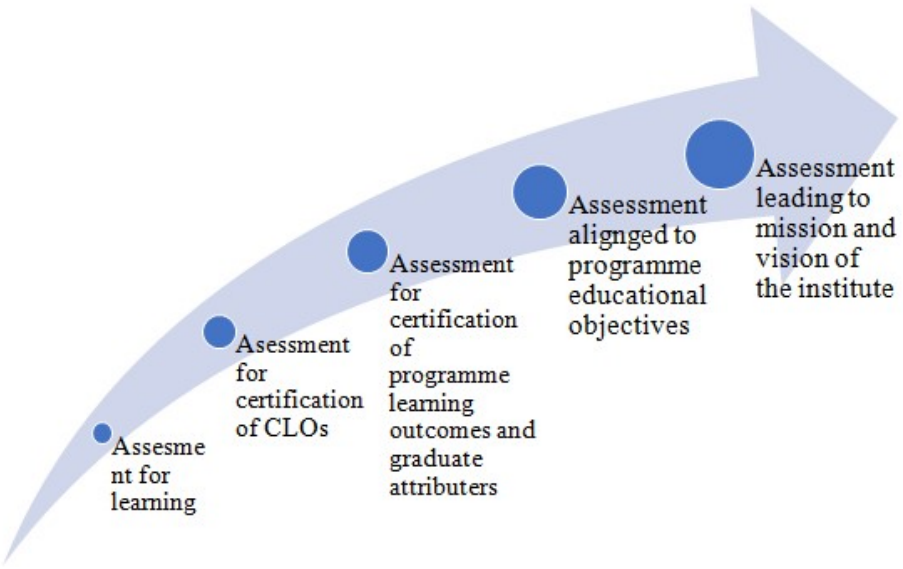


Figure 1: Focus of assessment; Source Author.

The NEP 2020 contemplates to develop higher levels of abilities such as creative thinking, critical thinking, investigative skills, complex problem-solving skills, communication skills, and collaborative skills in the learners. The NEP 2020 emphasises use of formative assessment for promoting learning and wholesome development of the learners.

PRINCIPLES OF ASSESSMENT

The assessment of CLOs is a scientific process in which principles of assessment are followed. The principles of assessment in outcome-based assessment are stated in Figure 2.

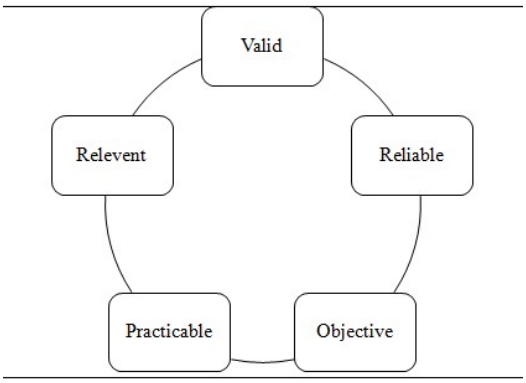


Figure 2: Principles of assessment; Source Author.

The cognitive domain CLOs are assessed using question papers and quizzes. The question paper contains the questions at the level of CLOs. The weightage to the questions is assigned as per specification table given in the course curriculum to ensure content validity of the assessment. The questions are framed and structured following the characteristics of the good questions to ensure construct validity.

The question paper is framed to ensure reliability in responses of the assesses and assessors. The objectivity, condition, and criteria of performance are defined in measurable terms to ensure reliability. The questions are framed to provide the pin pointed direction to the assesses to provide answer.

The question paper is framed to assess critical or core ability stated in the CLOs to save time of the assesses and assessors. The principle of significant and direct measurement is used while framing the question paper. The quantity, quality, and time parameters are used to bring the objectivity in the question paper.

The question paper is framed to assess the learning achievement at intended level of CLOs. The intended level of CLOs is always stated at highest level of learning aligned with work situations. Trained course facilitators design and implement assignments, activities, events, discussions, problem solving exercises, case studies, and other appropriate learning tasks for the learners. The output of these learner activities is maintained by learners in the form of learning portfolio (output of different types of assignments, essay writing, article writing, report writing, book review, article review, journal writing, case analysis, and seminar presentation) and submitted to course facilitators in hard or soft copy. The learning output is assessed using check list, rating scale, and rubrics.

CONCEPT OF COURSE LEARNING OUTCOMES IN COGNITIVE DOMAIN

A course is a basic unit of education (UGC, 2019). A course is a building block of education programme for which marks, grades, and credits appear in the marksheet. The structure of undergraduate programmes is suggested such as major, minor, multidisciplinary, ability enhancement, skill enhancement, value added, internship, research project and so on (UGC, 2022). For technical programmes the courses are basic sciences, basic engineering, humanities and social sciences, programme core, programme electives, open electives projects, internship, seminars, and the like (NBA, 2024). The courses which are having predominant cognitive component of learning are considered in this paper.

The CLOs are defined as specific to the learning for a given course of study related to a disciplinary or interdisciplinary/multidisciplinary area. CLOs are aligned to programme learning outcomes. The achievement of CLOs leads to achievement of programme learning outcomes (UGC, 2020). Similarly, for technical education programmes course outcomes are defined as narrower statements that describe what learners are expected to know, and able to do at the end of each course. These relates to the skills, knowledge, and behaviour that learners acquire in the progress through the course (NBA, 2019).

The NEP 2020 states that across the educational programmes creative thinking, critical thinking, investigative skills, communication skills, and problem-solving skills should be developed in the learners. The CLOs are formulated using action verbs which are terminal in nature. The CLOs should be observable, measurable, attainable, concrete, and worthwhile. The conditions and criteria are also stated in the course outcomes to provide specificity in assessment. The CLOs are stated in overt form and not in covert form to accurately assess the achievement of the CLOs at intended level.

The course outcomes are also formulated considering the requirements of programme learning outcomes, programme specific outcomes, graduate attributes, requirements of inter, cross, multi, and trans disciplinary learning. The course outcomes are also formulated in such a way that when appropriate

they can be mapped with the sustainable development goals. At least one CLO should be formulated which is the output of pedagogy and not the content. This CLO mapped with working in a team, self-learning, adherence to professional ethics, communication, leadership, collaboration, and the like. The course outcomes are also formulated to address the requirements of the sustainable development goals, programme learning outcomes, and programme specific learning outcomes.

Blooms taxonomy is commonly kept in mind while formulating the course outcomes. The verbs suggested in Blooms taxonomy should be used carefully while using them for formulation of course outcomes. For example, design verb may be used at remember level when it is simply put the value in the formulae and get the answer. The design verb may be used at creation level when it is a design of new product or process.

CONCEPT OF ASSESSMENT

Assessment is a process of collecting, recording, scoring, describing, and interpreting information about learning (UGC, 2019). The assessment results in authentication of achievement of CLOs. Assessment in cognitive domain CLOs is interrelated and aligned with the outcome-based course curriculum and pedagogy used to develop intended level of learning outcomes. The alignment of outcome-based assessment with pedagogy and CLOs is stated in Figure 3.

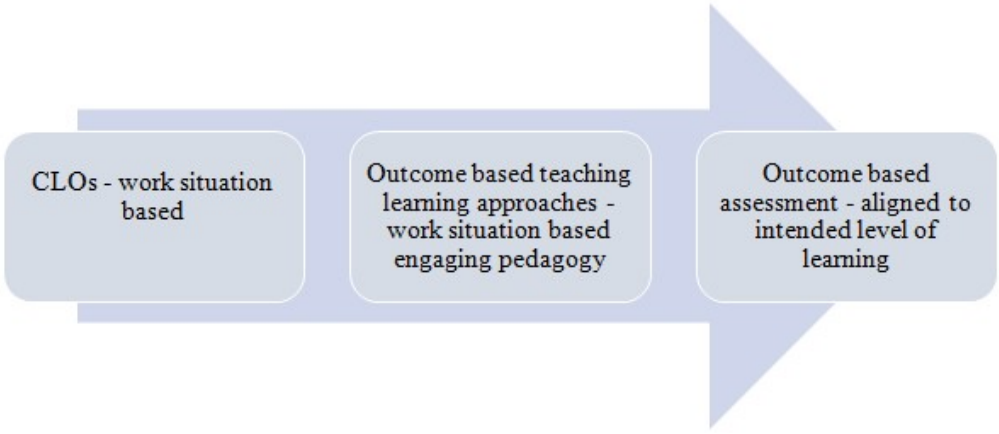


Figure 3: Alignment of assessment with teaching learning approaches and CLOs; Source Author.

CLOs are aligned with work situations. These are scientifically formulated using quantity, quality, and time parameters. The condition and criteria for performance are mentioned in the course curriculum document.

Outcome based teaching learning approaches are work situation based in which engaging pedagogy, scientific learner centric approaches, collaborative learning, experiential learning, project based and problem-based learning, investigation and enquiry-based learning, creativity based and research-based learning approaches are adopted to develop intended level of learning outcomes. The course facilitator facilitates the learning process using appropriate scaffolding, reflection, and feedback. The course facilitator uses scientific mentoring, guiding, and coaching approaches to develop the learning at intended level. The learners maintain the learning portfolio of learning outputs which result as byproduct of learning activities. Formative assessment is used for providing feedback for facilitating development of higher levels of learning outcomes.

Outcome based assessment encourages selection of appropriate work situations aligned with levels of CLOs. These work situations are well articulated to formulate various types of question.

TYPES OF ASSESSMENT

There are many types of assessment used in combination for assessing the achievement of CLOs and for producing higher level of learning. The assessment is used for causing learning during formative assessment and certifying the achievement of CLOs in summative assessment. Formative and summative assessments are aligned and integrated to achieve wholesome development of the learners as envisioned in NEP 2020.

Formative assessment of CLOs in cognitive domain

The NEP 2020 made a provision to focus on formative assessment of learning which is used for reinforcing the learning achievements, taking corrective and preventive actions to improve learning, and developing higher levels of abilities in the learners. The provision of flexible learning, self-learning, peer learning and self and peer assessment is made in the NEP 2020 encourages course facilitators to use formative assessment as tool for learning. The main purpose of using formative assessment is to promote autonomous learning, develop learning to learn and lifelong learning skills and empower the learners for assessment and learning. Formative assessment encourages to review previous learning, reflect on the process of learning, and receive feedback for continuously improving the learning and planning further learning. The formative assessment is used for receiving timely feedback with reference to achievement of intended learning outcomes. The level of outcome-based assessment and CLOs is same to use assessment tools as tools for learning. These tools are provided to learners along with the learning activity. Formative assessment is used as a tool for learning as indicated in Figure 4.

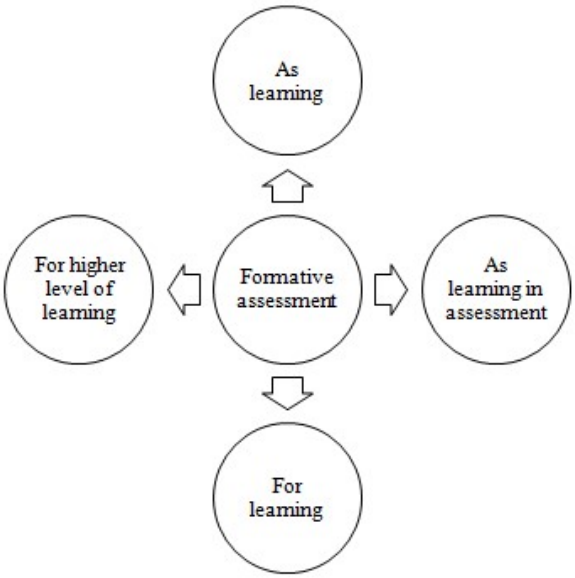


Figure 4: Purposes of formative assessment; Source Author.

In the process of formative assessment, assessment tools are used as tools for self-learning and peer learning. The learning in assessment takes place during the formative assessment. Assessment becomes the learning tool during formative assessment. There are many assessors in formative assessment as stated in Figure 5.

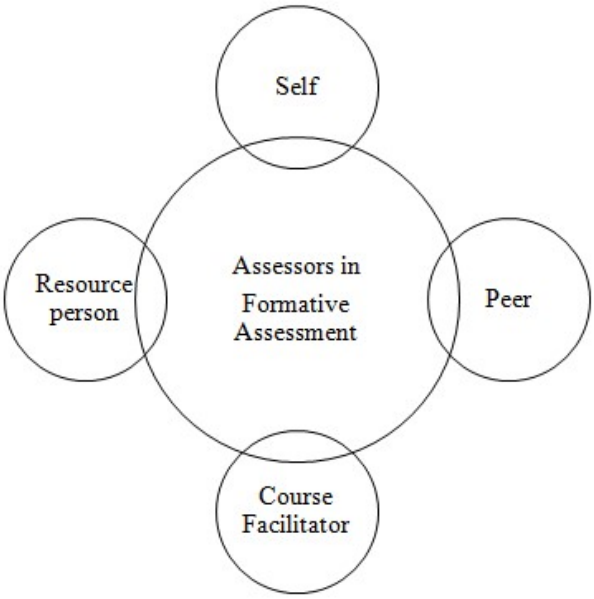


Figure 5: Assessors in formative assessment; Source Author.

Self-assessment and peer assessment is commonly used during formative assessment in criterion referenced assessment. The formal and informal assessment is also used during the formative assessment which is integrated with learning process. In formative assessment the reflection of previous learning and planning for further learning is integrated. It is used for receiving specific self and peer feedback for improving the learning.

Course facilitators are involved in formative assessment to ensure learning in right direction and right level with reference to CLOs. Based on the formative assessment course facilitators record diagnostic and prescriptive feedback. The characteristics of feedback are stated in Figure 6.

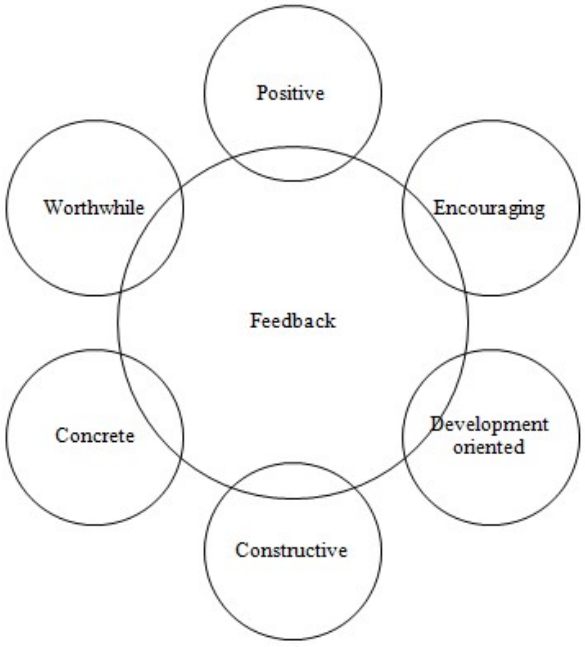


Figure 6: Characteristics of feedback; Source Author.

The course facilitators take corrective actions to fill the learning gaps or remove wrong learning using tutorial, giving additional assignments, pairing of weak learners with bright learners, assigning practice exercises, visit to world of work, interaction with resource persons and so on. The learners take proactive approach using self-learning and peer learning for improving learning and planning future learning process.

Various types of assessments are used for facilitating learning and development of learners with reference to intended CLOs. The core course outcomes, associated learning outcomes related to sustainable development goals and peripheral learning outcomes which are process byproduct are assessed using various combinations of formative and summative and formal and informal assessment approaches as indicated in Table 1.

Table 1: Combination of assessment approaches and their purposes

	Informal assessment	**Formal assessment**
Formative assessment	Used for removing learning gaps and mislearning	Used for taking corrective and preventive actions to achieve CLOs
Summative assessment	Used for planning to achieve CLOs	Used for certification of CLOs

Summative assessment of CLOs in cognitive domain

Summative assessment is carried out to certify achievement of intended CLOs. The summative evaluation is commonly carried out based on the examination policy of the institute. There are two approaches used in summative assessment with reference to outcome-based education. The proportion of marks are declared in the assessment policy of the institute for these two approaches. The proportion may vary for different courses depending upon nature of the courses.

The first approach is assessment of learning portfolio created by learners throughout the semester with reference to learning activities assigned by the course facilitator. These learning activities are the integral elements of course plan prepared by course facilitators at the beginning of the semester and declared to learners. The learning portfolio is compilation of output of learning activities of the learners throughout the semester. The learner activities are drawn from work situations and designed to involve learners in learning process, accept challenges of learning, develop work situation related abilities, receive timely feedback on improving learning, and plan further and higher level of learning. The learning portfolio is assessed using the assessment tools as stated in the Table 2.

The learning portfolio is assessed during formative assessment and feedback is provided to learners for bringing it to minimum intended level of learning. The improved version of the portfolio is assessed using check list, rating scale, and rubric. The assessment tool is provided to the learners by course facilitators along with the activities to be performed. The learners are encouraged to use the assessment tool for planning the learning process aligned with CLOs, self-assessment of progress of learning to take corrective and preventive actions to improve learning up to intended level of learning, and discuss the learning difficulties with the course facilitators for improvement in learning. The assessment tools are used for peer assessment and seeking guidance from the peers.

The second approach is traditional paper and pencil test commonly used by all higher education institutions for summative assessment to certify achievement of CLOs. The traditional paper and pencil test needs to be transformed in the form of outcome-based assessment aligned with CLOs which are

Table 2: Learning portfolio assessment tools

Learner activities	Activity outcome	Assessment tools
Case studies	Case analysis report	Check list, Rating scale, and Rubrics
Work scenerios	Scenario analysis or development	Check list, Rating scale and Rubrics
Anecdotes and incidences	Analysis report	Check list and Rating scale
Event	Event completion report	Check list and Rating scale
Task and activity	Task and activity performance report	Check list and Rating scale
Essay writing	Essay	Check list, Rating scale and Rubrics

formulated at higher levels of learning in cognitive domain of learning. The conventional type of questions will not serve the purpose of outcome-based assessment. A scientific method of assessment is required to be observed which is a transformation of conventional method of assessment. The process of preparing a question paper is described in next section.

PROCESS OF PREPARING QUESTION PAPER IN OUTCOME-BASED ASSESSMENT

The outcome-based assessment in cognitive domain of learning is criterion referenced assessment and not norm reference assessment. The theory of norm reference assessment may not be appropriate for criterion referenced assessment. A brief outline of process of setting paper and pencil test is given in Figure 7 for outcome-based assessment in cognitive domain.

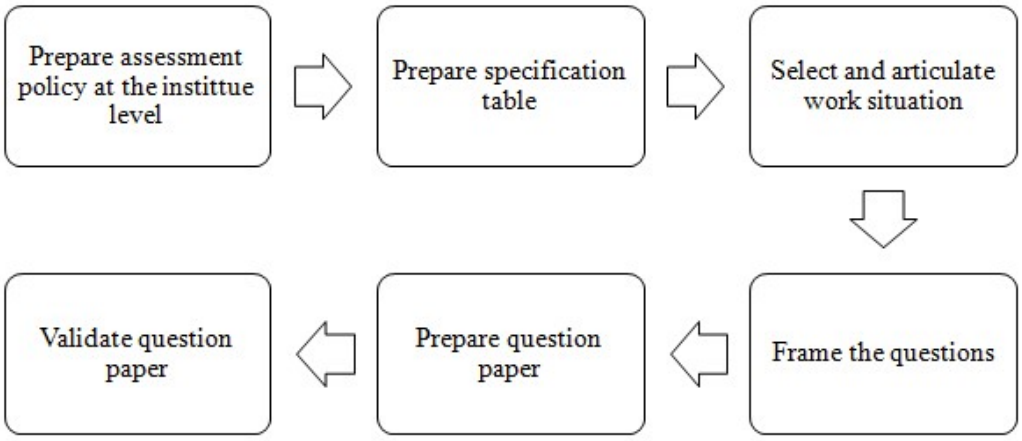


Figure 7: Process of preparing paper and pencil test.

Prepare assessment policy at the institute level

The higher education institutions are expected to formulate the assessment policy at institute level to assure the quality in assessment and communicate the level of CLOs assessed in the institute across the educational programmes and courses. The specification table is used to set the minimum level of benchmark in the assessment process and in assessment of theoretical courses. The assessment policy of the institute communicates quality of learning takes place in the institute. The specification table is prepared for course outcomes and not for theoretical units stated in the curriculum document.

Prepare specification table

Specification table is a scientific assessment tool used for assessing cognitive domain CLOs. The course facilitators prepare the specification table based on the level of CLOs formulated in the course curriculum. The CLOs should be formulated at application and above level as stated in the previous section. The specification table is used for assuring the validity of the outcome-based assessment, reliability among the assessors and improving the quality of assessment year by year. A sample specification table is given in table 3 for a particular course that guides the summative assessment using paper and pencil test.

Table 3: Specification table

CLOs	Remembering	Understanding	Applying	Analysing	Evaluating	Creating	Total
I	3	2	5				10
II	2	2	2	4			10
III	1	2	2	3	2		10
IV	2	1	6	6	5		20
V	1	2	4	4	9		20
VI	1	1	1	3	9	15	30
Total	10	10	20	20	25	15	

- The specification table of theoretical courses is mentioned in the course curriculum document so that course facilitators and learners are aware about the assessment process and assessment standards.
- Marks distribution in specification tables for different courses would be different at different levels of hierarchy of learning in cognitive domain.
- The distribution of marks for a particular course depends on the nature of the course. If it is a terminal course focused on developing analytical and creative ability, the specification table will be skewed towards right and create level outcome may have even 40% weightage.
- The basic courses specification table will have more concentration of marks for applying and analysis levels.
- Where the associative course is integral element of the programme structure, it will have skewed distribution of marks towards left.
- The discipline specific course having focus on application, analysis, and evaluation will have 60% marks distribution for these three levels.
- The continuous improvement in assessment is assured taking the marks concentration towards right side of the specification table year by year.
- The specification table helps the question paper setter and moderators to adhere to assessment policy of the institute.

Select and articulate work situation aligned to CLOs

The assessment of application and above levels of CLOs is based on the current world of work situations. The world of work situations is selected in the form of activities stated in Figure 8.

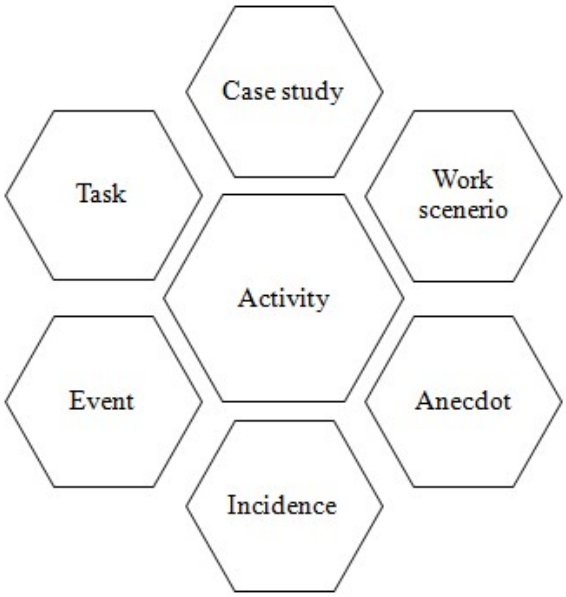


Figure 8: Forms of work situations.

The question paper setter draws the situation from world of work which is matching with the well-articulated CLOs. The work situation is selected in such a way to align with the highest of level of course outcome or so broad that align with more than one course outcomes. The work situation should satisfy the characteristics stated in Figure 9.

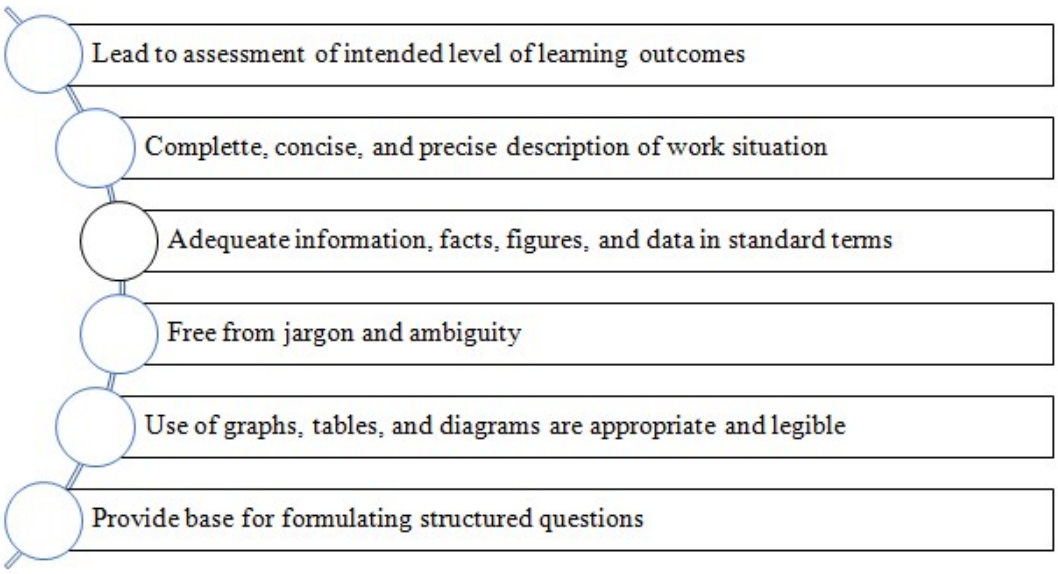


Figure 9: Characterises of work situation.

The work situation is articulated from assessment point of view. The articulation of situation should lead to framing the questions on the work situation on one hand and use of theory in other hand.

Characteristics of questions in outcome-based assessment

The questions in outcome-based assessment are not direct questions asked on the theory as it will be limited to remembering and understanding levels and not focus on assessment of CLOs. In outcome-based education philosophy the focus is to develop work relevant abilities and harness full potential of learning and development of learners. In outcome-based assessment questions are formulated to satisfy the characteristics as stated in Figure 10.

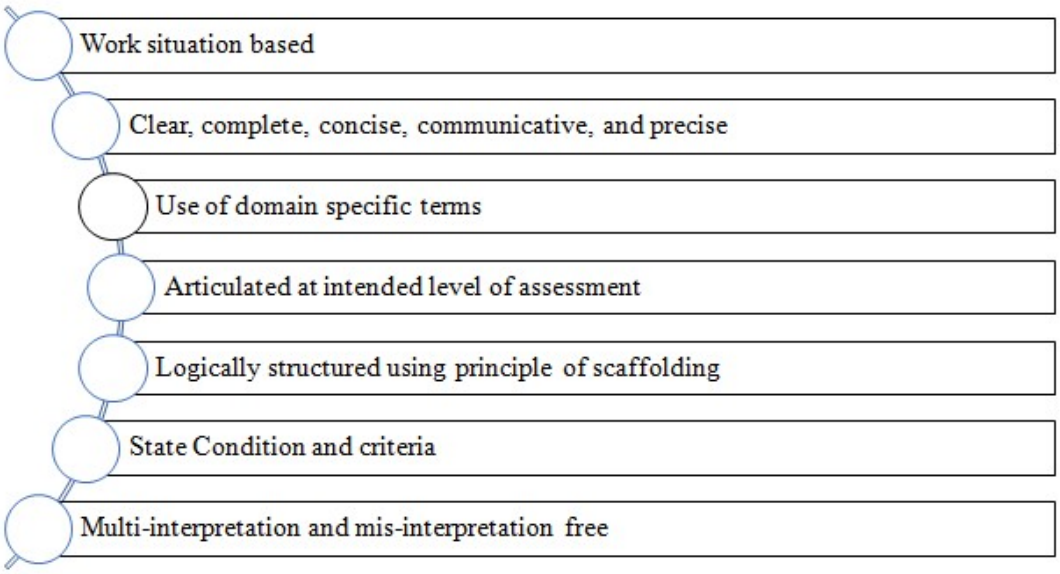


Figure 10: Characterises of outcome-based questions.

Work situation based

The questions are drawn from work situations leading to programme learning outcomes and graduate attributes. The sustainable development goals are incorporated in the questions where ever possible.

Clear, complete, concise, communicative, and precise

The questions are clarity articulated to satisfy the assessment requirements. The complete question is articulated to give the cue for writing answer. The questions are concise and precise to avoid multi-interpretations and mis interpretations. The questions communicate the stimulus for writing the answers. For example, define the problem in the given situation. The assesses will not be able to define the problem unless they know the application of theory they learned.

Use of domain specific terms

In the question formulation process only domain specific universally accepted terms should be used to give same meaning of the question to assesses and assessors. The expectations of the assessors should be crystal clear in the question formulation. The non examples of non-clarity are; write short notes, identify any five components, through light, compare between A and B, what do you think, write an essay, and so on.

Articulated at intended level of assessment

The significant and direct questions aligned with CLOs in each situation should be asked instead of asking many indirect and trivial questions and making the question paper lengthy on time line for writing the answer. Significant and direct questions assess the intended level of learning expected in course outcomes.

Logically structured using principle of scaffolding

There are many courses in which CLOs are development sequentially and logically. In a given work situation questions are framed in logical sequence and not in a causal way.

Condition and criteria

Condition and criteria related to environment, sustainability, quality, standards, professional ethics, economy, and benchmarks are stated. The questions formulation should mention condition and criteria if needed to answer the questions in given situation. For example; using IS code, without compromising the safety provisions, using steam table, and the like.

The universal principle of validity (construct and content) and reliability should be kept in mind while formulating the questions in a given situation.

Each type of work situation-based question (true- false, multiple choice, short answer, long answer, fill in the blank, matching type) has strengths and limitations so selection of type of question should be appropriate from validity, reliability, relevance, and practicability point of view. The norm referenced assessment policy such as three questions multiple choice, 5 questions short answer type and two questions essay type should not be used in outcome-based assessment for preparing the question paper.

For example, the sample questions may be framed in following way.

In a given situation

- define the problem;
- analyse the situation and identify likely causes of the defined problem;
- show the causes of the problem on Cause-and-effect diagram;
- formulate hypothesis and test it to remove the causes which could not be the real causes;
- prioritize the causes according to their intensity;
- prioritize the causes according to their contribution to problem;
- suggest alternative solutions for each cause identified in causes according to their contribution to the problem;
- state the implications if the problem is not solved;
- suggest strategy to overcome the situation and justify the strategy;
- suggest strategy for implementing the decision;

Prepare question paper

The question paper is prepared according to the accepted specification table given in the curriculum document of the course. The weightage to different CLOs is stated in the specification table and same is used to pick up the work situation and formulate the questions accordingly.

Validate question paper

The questions formulated on the given situation are validated for ensuring content and construct validity. The validation of question paper is carried out by other than the question paper setter facilitating learning in the same course. The question paper is set at par with the CLOs. The questions are not repeated in subsequent years of batches of the learners otherwise the level of questions will come down to remembering or understanding levels in revised Blooms Taxonomy.

As mentioned in Figure 11, there could be many questions based on one situation contributing to assessment of many CLOs. Similarly, there could be many questions from different situations contributing for assessment of one CLO.

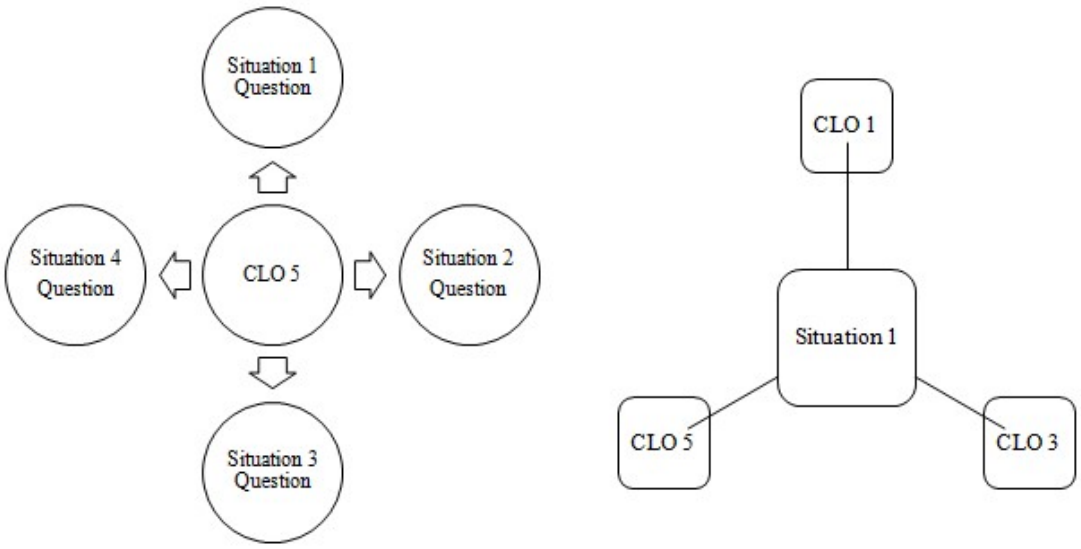


Figure 11: Work situation-based questions and their contribution to CLOs.

The structured questions are assigned marks according to level of CLOs. The terminal question may be assigned more marks in comparison to previous questions on the same situation. The specific CLO should not be assessed using alternative situations and questions in the same question paper. It saves the time of assesses in writing answer and time of assessors in assessing the answer.

SOME SUGGESTIONS FOR SETTING QUESTION PAPER FOR ASSESSMENT OF COGNITIVE DOMAIN COURSE LEARNING OUTCOMES

Assessment policy interventions

At institute level a comprehensive assessment policy should be declared by all institutes involved in assessment of learning achievements of the learners. The policy should contain benchmarks for assuring quality in assessment across the educational programmes. The assessment policy should be aligned with curricular provisions, levels in national higher education credit framework and pedagogy used for developing the intended CLOs. The policy should be translated into action and put in the course curriculum of all types of courses theory, practical, learner project work, internship, apprenticeship, seminar, and the like.

Standard systems, processes, and templates

Assessment system and processes should be designed and implemented at institute level to ensure learning, development and assessment of achievement of CLOs. The assessment system and processes should be implemented in letter and spirit with adequate flexibility without compromising with quality of assessment.

Transform from norm referenced assessment to CLO-based assessment

For certification of achievement of CLOs criterion referenced assessment should be used and not the assessment of rote learning of theory. The criterion referenced assessment is a comprehensive assessment incorporating formative assessment and summative assessment, learning portfolio-based assessment, and performance-based assessment. The assessment questions used in norm reference assessment which are theory-based questions need to be scaled up to outcome-based assessment. In other words, application of theory in work situation is assessed at application, analysis, evaluation, and creation levels.

Use of digital technology

The criterion referenced assessment rely on learning portfolio-based assessment so use of online digital platform, artificial intelligence-based assessment and learning management system should be used to achieve paper less assessment. The digital assessment will contribute for prevention of environment and sustainability. It will enhance transparency, fairness, and credibility of the education system.

Capacity, capability, confidence, and commitment building

The transformation in assessment in the context of educational innovations require capacity building of course facilitators, assessors, and other stakeholders. Capacity building is carried out using multiple approaches such as orientation, training, workshops, discussions, meetings, conferences, and mentoring of stakeholders. The users of assessment results are made aware about the outcome-based assessment and its use for providing employment to graduates.

Audit of assessment system

At institute level audit of the assessment system, process, question papers, assessment tools, answer scripts and marking done by assessors should be carried out to know the strengths and weaknesses and to take corrective and preventive actions for improving the next cycle of assessment. The audit of assessment should also be carried out for quality, relevance, transparency, credibility, timely declaration of result, pull of assessors, infrastructure availability, budget availability, digitization, and fairness.

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