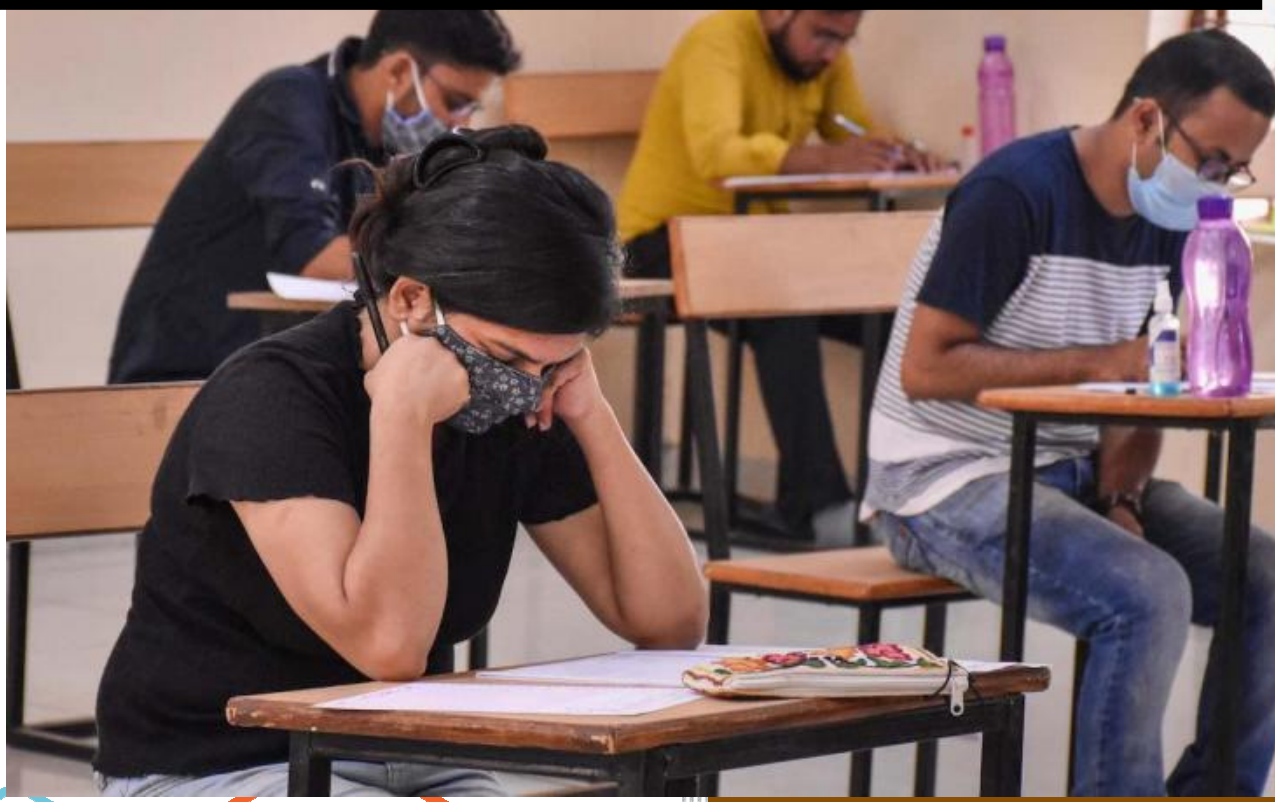
REPORT on

Examination Reforms in State Universities



The Kerala State Higher Education Council

Thiruvananthapuram

June 2021

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Equity Excellence

Foreword

Reports on Examination Reform have been too oft-repeated to be strikingly new. However, the Report of the present Committee does make a difference in concept and design. It has addressed Examination as a decentralised and multi-pronged process, distinct for its openness and transparency. There is wide consensus about making all academic examinations decentralised and continuous rather than centralised and continual. Ideally speaking, examinations must shift from the teacher centric system to that of the learner and peer groups centric. Technology enhanced assessment is relatively objective, efficacious and transparent as distinguished from the over-centralised and confidential exercise.

However, in the existing setup, it is not feasible at a stretch. We have to introduce it gradually in a phased manner. It is extremely important that the evaluation system should repose trust and responsibility on teachers. Simultaneously, it should enhance its credibility and acceptance in the minds of students. An examination has been viewed as a sincere and self-critical activity for the teachers and a natural and least teasing process for the students. According to the Committee all examinations must be meant for assessing the student's progress in the attainment of learning outcomes at different levels of cognition.

Therefore, the Committee recommends a via media approach, which combines both the continuous and continual methods in a ratio optimising the merits of both. It is a detailed account of the means and measures of assessment, which are suitable and feasible to our system, but significantly fruitful.

Prof. Rajan Gurukkal P.M.
Vice Chairman
The Kerala State Higher Education Council

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Member

Report on Examination Reforms in State Universities

1. The Context of Examination Reforms

Examination Reforms are interpreted as reforming current practices in summative assessments as practiced in autonomous and non-autonomous Institutions and Universities of Kerala. Reform of the examination system was always a prominent theme in any discourse on education for several decades. Some of the major problems currently faced by the higher education system in India include:

- Fragmented higher education system.
- Neglect of cognitive skills and learning outcomes.
- Limited academic autonomy.
- Absence of merit-based career management and progression of faculty and institutional leaders.
- Neglect of research at universities and colleges, and research funding.
- Problems of governance and leadership in Universities and Colleges.
- Unwieldy expansion of affiliating system and neglect of undergraduate education.

Several examination reforms were suggested at State and National level, with hardly any impact on examination. There is a slow and continuous deterioration in the quality of summative assessment instruments (question papers). This undoubtedly led to a further reduction in the quality of learning. While everyone seems to acknowledge the unsatisfactory State of examinations, there have been no noticeable systemic or process changes. The reasons for this are many.

- The system of centralized examinations at a University is enormous and will have huge inertia, and any large system generally resists change.
- Any significant change to an extensive system will involve a tremendous amount of work, which everyone concerned will be reluctant to perform.
- All the stakeholders complain about examinations but expect the system to change.

- As there are no major objections and demands coming from the employers/industry and Governments other than expressing dissatisfaction occasionally, there has not been any motivation for the system to change.

In the name of confidentiality and transparency, the centralized system of examination and evaluation has evolved into a very rigid system.

- Standard responses to any item (question) in the examination paper are expected from students to facilitate centralized evaluation. It is impossible to include items that test critical thinking. However, everyone talks about critical thinking in Humanities, Social Sciences, and Arts courses.

- Over time, because of the requirement of standard responses, many are merely items that test memory to reproduce material in a particular manner or carry out any activity in a specific way. This further led to the generation of guides for preparing students for such examinations.

- There is always the danger of some minor or major event disrupting the conduct of examinations.

- The centralized control of curriculum design and examinations has devalued the role of teachers.

- In western countries, most of the Universities and Institutions of higher education assess the students wholly on internal evaluation methods following the principle "those who teach should evaluate." The whole world has accepted the system followed in the western countries. The students coming out of those countries are valued higher than the degree holders of the Indian Universities (from Examination Reforms in Higher Education Institutions in India – Recommendations of UGC). Kerala State should also move towards the goal "those who teach should assess and evaluate." This will be vehemently objected to by the majority in the name of transparency. It should be noted that this transparency led to the current State.

Two major practices got entrenched into the Kerala State Education system.

- There has been no proper acceptance of the 'credit' system though it is appropriately accepted in the rest of India and the World. A survey of curricula in different Universities of Kerala indicates no correspondence between the number of credits,

number of teaching hours per week, and the course content. For example, a 3-credit course may have five classroom sessions per week over a semester. Most of the courses have overloaded content resulting in superficial learning and confining to lower cognitive levels in examinations.

- The administrative interpretation of the workload of a faculty member resulted in some strange practices and overloaded curricula. Any changes suggested in any context somehow seem to threaten the job security of the faculty.

The policy decisions made to date were either treated as opinions of a few or considered too far from the existing practices. There were no accepted references or standards. In the last few years, several things happened, and some of them started gaining traction.

- Revised Bloom's taxonomy of learning, teaching, and assessment is becoming familiar to all faculty and Institutions across the country.

- Outcome Based Education (OBE) officially became a necessity in India and many other countries. OBE requires the system (Institutions, Departments, and Teachers) to state what it expects students should be able to do because of learning and communicate the same to the students in advance. While this appears to be a fair and straightforward requirement, some teachers around the World consider this as an imposition and constitutes a constraint even become a straitjacket. They believe it is against the spirit of education. Unfortunately, without stating what the students are expected to do, a teacher cannot plan instruction and assess their learning. There has been considerable research done that established that the simple act of communicating to the students what they should be able to do at the end of a course can significantly improve their performance.

  Many HEIs have been writing outcomes, though not very well, for all courses and instituted mechanisms to compute the attainment of these outcomes.

- Many technical programs like Engineering are being accredited by the National Board of Accreditation (NBA).

- All higher education institutions must be accredited by the National Assessment and Accreditation Council (NAAC).

- Evaluation of student responses to summative assessment instruments consists of awarding marks at the level of individual items and aggregating them into a single 'percentage mark' or a Letter Grade.

- The UGC recommends a 10-point grading system with the following letter grades:

Letter Grade	Grade Point
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B+ (Good)	7
B (Above Average)	6
C (Average)	5
P (Pass)	4
F (Fail)	0
Ab (Absent)	0

The Universities can decide on the grade or percentage of marks required to pass in a course and the CGPA needed to qualify for a degree, taking into consideration the recommendations of the statutory professional councils such as AICTE, MCI, BCI, NCTE, etc.,

- The majority of HEIs follow the 'absolute grading system' also known as the Criterion-Referenced System. In this system, there is no need to arrange the students' performance on a bell curve. The relative grading is followed only when rank ordering among candidates from a given cohort is required.

- Covid-19 forced all educational institutions across the World to conduct all academic activities using ICT tools. Many of these ICT tools were available for more than fifteen years. There was not much acceptance till now by most HEIs to make the ICT tools an integral part of teaching-learning, assessment, and evaluation activities,

despite strong recommendations of the national regulatory and accreditation bodies.

- Several government initiatives like Swayam and NPTEL and private service providers can offer a range of ICT services to HEIs on teaching-learning, assessment, evaluation, proctoring examinations, and accreditation.
- All HEIs are establishing IQACs (Internal Quality Assurance Cells) as required by the NAAC and the UGC.

2. Conceptual and Technology Preamble: Interpreting the Mandate

Educational assessment can be focused on the individual learner, groups of individuals, a specific program, or an Institution. According to the National Institute on Learning Outcomes Assessment (NILOA) concerning the learners, educational assessment is the systematic process of documenting and using empirical data on students' knowledge, skills, attitudes, and beliefs. (https://www.learningoutcomesassessment.org/). Assessment of learning is documenting knowledge, skills, attitudes, and learners' beliefs in measurable terms. It is a mechanism for providing instructors with data for improving their teaching methods for guiding and motivating students to be actively involved in their learning. As such, the assessment provides essential feedback to both instructors and students. The assessment gives us necessary information about what our students are learning and about the extent to which we are meeting our teaching goals. But the real power of assessment comes in using it to give feedback to students. In addition to providing the instructors with valuable information about students' learning, assessment should help them diagnose their learning. That is, assessment should help students "become more effective, self-assessing, and self-directed learners." (Angelo & Cross, 1993)

There is considerable evidence showing that **assessment drives student learning**. More than anything else, our assessment tells our students what we consider to be necessary. They will learn what we guide them to learn through our assessments. Traditional testing methods have been limited measures of student learning, and equally important, of little value for guiding student learning. These methods are often inconsistent with the increasing emphasis being placed on students' ability to think analytically, understand, and communicate at both detailed and "big picture" levels, and acquire life-long skills that

permit continuous adaptation to workplaces in constant flux. Moreover, in many respects, assessment is the glue that links a course's components - its content, instructional methods, and skills development.

Assessment is often divided into formative and summative categories to consider different objectives for assessment practices. Formative assessment is carried out throughout a course or project. In an educational setting, formative assessment is used by teachers to consider approaches to teaching and the next steps for individual learners and the class. It would not be used for grading purposes. Formative assessment, also referred to as "assessment for learning," is used to aid learning. Assessment for learning is defined as "all those activities undertaken by teachers or students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged" (Black and William 2004). Summative assessment is intended to measure learning outcomes and report those outcomes to students, parents, and administrators. It generally occurs after a class, a course, a semester, or an academic year in an educational setting. In the context of a course, summative assessments are typically used to assign students a course grade. It is also referred to in a learning context as an "assessment of learning."

Formative assessment is not practiced extensively for improving the quality of learning as the time available to the teacher is limited and can lead to a significant increase in his/her load. It is challenging to reach every student. However, with the availability of very cost-effective ICT solutions, it becomes possible to use formative assessment.

Technology: The available ICT tools can address many issues of teaching and learning, assessment and evaluation, administration, admissions, and placement. At present, both students and most teachers feel comfortable using internet devices for various daily needs. If the educational Institutions can significantly improve their ICT infrastructure, many of the current education problems can find solutions. This should be a joint effort of the Institutions, Universities, State Government, and Central Government. Covid 19 brought this need into sharp focus.

ICT can be effectively used both for formative and summative assessments and evaluations. The existing summative assessments (examinations) and evaluations are unsatisfactory as acknowledged continuously, at least informally, by all the concerned. These practices are majorly responsible for reducing the quality of learning by the students. ICT tools and services are available for

- designing dynamic item (question) banks that facilitate computation of attainment of all course outcomes, consisting of MCQ/MSQs and items requiring written short and extended responses,
- generating question papers (summative assessment instruments) can be automated using ICT tools with the paper setters' supervision,
- securely communicating examination papers (assessment instruments) to all the examination centers on the internet,
- automatically evaluating student responses to MCQ/MSQs and aggregating marks, and
- centralized evaluation of written responses, which can be a logistical nightmare every semester, can be resolved using ICT tools to enable the evaluators to do their work from their homes securely.

3. Suggested Reforms

No aspect of education can be addressed in isolation, as every aspect of an education system will influence every other. There are systemic, curriculum, technology, and assessment (examination) issues that require reforms.

1. Systemic

1. All higher education programs in Kerala are required to be conducted in Outcome Based Education (OBE) using the Taxonomy of Revised Bloom for the cognitive domain and Pierce-Gray taxonomies of Affective and Psychomotor domains where required. OBE represents the desirability of Learner Centricity.
2. Higher education undergraduate and post-graduate technical programs (Engineering, Pharmacy, MCA, and Management) should be conducted as per the guidelines given by the AICTE and seek the NBA accreditation.
3. Higher education undergraduate and post-graduate general programs (BA, BSc, BCom, and their equivalents) should be conducted as per the UGC guidelines. The Institutes offering those programs should seek NAAC accreditation.

4. The NAAC accreditation process recognizes and requires a higher education institution to perform several roles besides teaching and learning. Faculty members are responsible for fulfilling these roles, which include research and interaction with society. A faculty member's workload should be identified in this context, recognizing that a faculty member's pattern can change from year to year as required by the Department/Institute. The State level administration should recognize this.

5. The administrative interpretation of a faculty member's workload should suitably be altered to ensure meeting NAAC accreditation requirements, ensuring the existing faculty's job security, and ensuring Student-Faculty Ratios and Faculty Cadre Ratios.

6. All Colleges and Universities should immediately adopt ICT tools for all operations and communications related to planning and conducting examinations and evaluation.

2. Curriculum

1. The UGC's credit definition should be strictly followed, which happens to be followed across the World. A Credit is defined as a one-hour classroom session per week over a semester, one-hour tutorial session per week over a semester, and two hours of laboratory/fieldwork per week over a semester.

2. The course content should be designed to fit into the above definition of Credit.

3. There is need for developing multidisciplinary undergraduate education. This can be best achieved if curricula are designed as per the guidelines given by Prof. M. Vijayan's Committee of 2008, which the Kerala State Higher Education Council also constituted.

4. All programs should be designed and conducted to attain the Program Outcomes identified by the University/Institute in case of general programs or Program Outcomes identified by the NBA in case of technical programs, and the Program Specific Outcomes identified by the Department offering the program.

3.3 Technology

1. It has been established that using ICT can facilitate better learning while reducing the drudgery and open many ways of instruction in all subjects, which were not possible

earlier. All HEIs must immediately acquire Academic Management systems and create adequate internet connectivity on the campus.

2. All HEIs must work with Government and Private agencies to establish reliable connectivity to all students at their homes.

3. All HEIs, through their IQACs, should organize training programs on integrating ICT into teaching, learning, and assessment for faculty, staff, and students regularly. While they could be in face-to-face mode, they can also be in online asynchronous mode.

4. Every HEI must have a dedicated cell focusing on Technology for Education encompassing the entire teaching/learning life cycle.

3.4 Summative Assessment (Examinations)

It is considered important by everyone that the graduates should acquire the ability to attain higher cognitive, affective, and psychomotor levels, think critically, and learn by themselves. These abilities need to be expressed in terms of Outcomes. The summative assessments should be designed to be in alignment with these Outcomes. The regulatory and accreditation processes only can facilitate the creation of good, higher education institutions. Technology and training hold the keys in this regard.

1. Technology has provided us ways to enable lifelong learning, and it can augment traditional classroom practices and revolutionize learning and evaluation methods. The use of technology for learning management systems and assessment (formative and summative) is strongly recommended. (from Examination Reforms in Higher Education Institutions in India – Recommendations of UGC)]

2. The weightage given to Continuous Internal Evaluation (CIE) should be increased to 50%. The Department should decide the distribution marks under different assessments (tests, assignments, reports/term papers, fieldwork, laboratory work, projects, etc.). This gives considerable scope to the Departments to differentiate themselves. It also provides capacity for addressing higher cognitive levels, particularly in Humanities, Social Sciences, and Arts courses.

3. All course outcomes should be written as per a commonly established structure in the frameworks of Revised Bloom's taxonomy of cognitive domain and Pierce-Gray taxonomies of affective and psychomotor domains.

4. Assessment should be in alignment with the course outcomes. Well written course outcomes appropriately tagged with the addressed POs and PSOs, Cognitive Level, Knowledge categories, and the number of classroom/laboratory sessions taken is the starting point for designing summative assessment.

5. Every course should prepare an assessment plan for CIE that ensures addressing all course outcomes.

6. All courses should prepare item (question) banks for formative assessments, quizzes, tests, and local use of assignments.

7. University should create a large (say at least 1000 items) dynamic item (question) bank that addresses all course outcomes appropriately for every course from which SEE assessment instruments (examination papers) can be generated using software tools. The designated committees or individuals can moderate the assessment instruments generated by the software tool. Processes should be in place to ensure that the item bank remains dynamic.

   [Question banks provide an attempt to integrate both teaching and evaluation. The document stresses the implementation of the question bank system as many experts' collaborative efforts will lead to the setting of good quality question papers. (from Examination Reforms in Higher Education Institutions in India – Recommendations of UGC)]

8. The design of SEE assessment instruments should be a two-step process: designing the assessment instrument's structure and generating similar multiple assessment instruments. The assessment instruments with whatever choice-structure chosen should ensure the computation of attainment of course outcomes.

9. The controller of examinations at the University should make item wise marks obtained by each student available to the Colleges. Commercial tools are available for performing this task automatically.

10. The objective part of assessment instruments (MCQs and MSQs) should be evaluated using the technologies available.

11. The process of Question Paper validation by Board of Examiners should be streamlined. Appropriate resources including syllabus copies, textbooks must be made available to the BoE.

12. Periodic review of the Semester End Question Papers by a separate committee of domain experts is desirable. The report of such a committee may be made available to all the stake holders.

13. Provision must be made for periodic upgrading of the ICT infrastructure including security related to the Examination Processes.

14. Examination related work, innovations, research, publications must be officially recognized as legitimate part of the workload of a teacher.

15. Institutions should establish electronic classrooms to conduct proctored examinations as there will be an increasing need for students to get certified on various knowledge and skillsets to improve placements.

16. HEIs must embrace "Learning Analytics" as a critical source of input in overall learning management and facilitate their graduates' placement. We can use this data to enable the State to assess the State's human capital's strengths and weaknesses and create its vision for its future.

4. Schedule for Implementation

The required knowledge and open source and commercial ICT tools are available at present. All the proposed changes cannot happen across the State in a short period. It is necessary to work out a time plan to bring changes and work towards mobilizing the resources. The first two stages are suggested in the following. Based on the experience with Stage 1 implementation, Stage 3 can be planned.

Stage 1 (Expected duration: Two years)

- All Universities of Kerala implement credit system strictly by adjusting the content of all courses.

- Teacher's workload definition should be suitably redefined in consultation with the administration in the NAAC accreditation framework, ensuring job security of the existing faculty, Student-Faculty Ratios, and Faculty Cadre Ratios.

- Identify all the activities of the office of Controller of Examinations that can be performed online at Institutions and Universities and prepare a requirement specification document for ICT tools needed for software tools for all activities related to examinations at multiple centers simultaneously and for teaching-learning activities.

- Create technology units in the IQACs of all Colleges and Universities to support faculty and students on all issues concerning online teaching-learning processes, assessment, and evaluation.

- Educate Managements of Institutions, Faculty, and Students on the need and the importance of suggested Examination Reforms to improve the placement opportunities.

- Create a faculty team, with one or two selected from each Department, at all Colleges to be trained in OBE, online teaching-learning processes, and assessment.

- Define what constitutes quality summative assessment.

- Create sample item (question) banks for courses for both formative and summative assessments from several programs.

- Define mechanisms for making the item banks dynamic and setting semester-end examination papers from the created item banks.

Stage 2 (Expected duration: Two years)

- Initiate performing all the online activities of the office of the Controller of Examinations using the procured software services.

- Establish mechanisms for creating autonomous clusters of Colleges.

- Design curricula of programs at some sample clusters of Colleges in the UGC Credit framework and redefined teachers' workload.

- Deign assessment instruments for end-semester examinations for the courses with item (question) banks developed in Stage 1. Based on these experiences, streamline the process of designing examination papers and maintaining the quality.
- Every College creates its plan for using ICT for all its academic activities.
- All newly recruited faculty will go through online training in pedagogy, OBE, NAAC accreditation, and ICT for education under the Faculty Development Center of the KSHEC and HRD Centers in Universities.

Several resource documents on OBE, Assessment, Course Design, Program Outcomes, and Curriculum Design are included as Annexures.

Annexures

Annexure 1

Recommendations of Examination Reforms Committee of Kerala State Higher Education Council in 2011

Provision of a syllabus-based framework for improved assessment practice

1. A suitable template with guidelines relating to the scope and structure of the syllabus statement of each separate course should be prepared, and its use made mandatory by the University. The syllabus statement for each course (issued by the relevant Board) should include a detailed note on the recommended assessment scheme, especially the internal component.

2. a) The duties and responsibilities of Boards of Studies in each area should be amended to include a definite provision for syllabus preparation in keeping with the guidelines and regular reviews.

   b) Administrative and financial provision should be made for workshop-type sessions for syllabus development, with the option of including qualified resource persons as special invitees. Manuals and library resources and secretarial assistance should be available at the workshop venues. Final committee-mode decision making (if needed) must be based on workshop output.

3. Members of Boards should be given orientation/training relating to curriculum design and educational technology. A permanent facility for this purpose should be set up by the University.

Upgrading the technical support and personnel resources at the college level

4. All teachers need to be given training in the areas of assessment and educational technology. A long-term strategy for training teachers in assessment with a special focus on the internal/ in-term component should be developed and implemented using both face-to-face and distance modes. The specific needs of different subject areas should be recognised and addressed. The relevant boards should be associated with the overall planning of these programmes. The process needs to be envisioned as becoming self-supporting over time.

5. College departments should maintain an up-to-date reference file relating to assessment rules and guidelines. The approved schemes of Internal Assessment of various

departments should be available to students in a clear form. The facility for dealing with difficulties/grievances relating to IA should be accessible to students.

6. College libraries should have a collection of manuals and reference books, CDs on assessment, curriculum, and educational technology for the use of teachers. Subject-wise collections of question papers and IA tasks (along with notes, critical comments) should also be obtained, and made accessible to teachers.

Improving the external final examination

7. Boards should undertake a review of models and recent question papers, giving priority to compulsory courses. Useful improvements can be made without waiting for the training workshops to achieve wide coverage. A plant to review all question papers over the next several months should be prepared by each Department. Reports on this exercise should be required by the Academic Council.

8. Variations in the design and physical structure of question papers (and answer booklets) should be tried out. These may include separate sections for objective-type questions, short answer and essay questions, restricted response space to encourage precision, timed sections, flip reduced answer sheets.

9. Paper setting by teams through modularized setting, and section-wise marking by markers in teams should be introduced in a phased manner.

10. Small-scale and experimental question banks should be set up in selected departments for selected courses. A task force to plan a centralized question bank with a state-level component and separate components for individual universities may be set up.

11. Measures to maintain the integrity of the system should be reviewed and extended at the CoE level. These may include parallel versions of question papers, conducting examinations in-camera, videorecording of opening packets of question papers, and packing of answer books. Video recording of viva-voce examinations should be considered and initiated in a phased manner.

Bar-coding of answer books and response sheets should be taken up. Delivery of question papers in an electronic mode for printing at local canters on the day of the examination should be explored.

12. A clear policy for dealing with unfair practices relating to Internal Assessment should be evolved and put in place at the college level. Prevention through ensuring transparency in grading, attending to convenience aspects, and education regarding plagiarism should also be attended.

13. Under the head of student welfare, a component specifically concerned with examination-related issues (especially stress and anxiety) should be established. Accessibility to students should be a priority for counselling activities. Support from the community, including student volunteers, could be canvassed.

14. A scheme to support innovation and experimentation in assessment at various levels, administratively and financially, should be formulated. Potential awardees should be reached through vigorous publicity. Support of an academic nature through accessible resource person/institution should also be provided. The presentation of reports at a suitable forum should be a requirement. The implication of findings from such experiments for improving assessment practice on a much wider scale should be noted and acted upon.

15. Research on various aspects of examinations should be taken up at each University and selected colleges, according to an overall plan developed through consultation to avoid duplication. The Departments of Education should take the lead. Research scholars in the social sciences could be encouraged to participate by offering access to databases in examination branches.

Annexure 2

Outcome Based Education

N.J. Rao

March 2021

1. What is Outcome Based Education?

Learning is supposed to have occurred when we can do something that we could not do earlier. Learning leads to acquiring new knowledge, behaviors, skills, values, preferences, or understanding and sometimes involves synthesizing different information types. According to Kolb, learning is the process whereby knowledge is created (knowledge production) through the transformation of experience. Outcomes of Learning or 'learning outcomes' are what the student should do at the end of a learning experience. Learning experiences in formal higher education programs can be identified as learning units. A unit of learning maybe a few hours of self/classroom learning activity, a one-semester course, or a formal program of two to four years.

The outcomes of learning are also referred to as Outcomes, Learning Outcomes, Intended Learning Outcomes, Instructional Objectives, Educational Objectives, Behavioural Objectives, Performance Objectives, Terminal Objectives, Subordinate Skills, Subordinate Objectives, General Instructional Objectives, Specific Learning Outcomes, and Competencies.

An outcome of education is what the student should do at the end of a program/ course/ instructional unit. An outcome is also defined as an effective ability, including attributes, skills, and knowledge, to successfully carry out some identified activity.

Outcome Based Education (OBE) was introduced by William Spady in the early 90s for the American School system. It was eventually adopted by higher education systems shifting the focus from what is taught to what is learned. Outcome-based education is an approach to education in which decisions about the curriculum and instruction are driven by the exit learning outcomes that the students should display at the end of a program or a course. It facilitates establishing the conditions and opportunities within the system that enable all

students to achieve those essential outcomes. A system based on outcomes gives priority to ends, purposes, learning, accomplishments, and results.

There are several advantages to working with Outcome Based Education (Davis 2015).

- Relevance—Outcome-based education promotes fitness for practice and education for capability.
- Discourse (Controversy)—Identifying the outcomes within an institution promotes discussion of fundamental questions, such as what type of graduates we aim to train and the core issues.
- Clarity—An explicit statement of what the educational process aims to achieve clarifies the curriculum for both students and teachers and focuses on teaching and learning.
- Provision of a Framework—Outcome-based education provides a robust framework for the integration of the curriculum. The outcomes provide benchmarks against which the curriculum can be judged.
- Accountability—By providing an explicit statement of what the curriculum is set out to achieve, outcome-based education emphasizes accountability. The outcomes provide details against which the graduates of the curriculum can be measured and facilitate the quality-assurance process.
- Self-Directed Learning—If students are clear about what they are required to achieve, they can take more responsibility for their learning. Outcome-based education thus promotes a student-centered approach to learning and teaching.
- Flexibility—Outcome-based education does not specify educational strategies or teaching methods. What is essential is that the students achieve the outcomes and not how they get there. Innovation in teaching is possible and is also encouraged by this approach that can accommodate different learning styles.
- Guide for Assessment—As it is the outcomes that are assessed, planning the examinations is clarified.

The outcomes provide the framework for student assessments. Conducting teaching-learning processes in any framework is not acceptable to some teachers and is against the spirit of education. Any framework presented is immediately branded as a straitjacket. If the teacher is a 'subject expert sage' and the students are highly cognitively competent, there need not be any framework. Such a combination of stages and students is very rare in higher education institutions of India. Even the top-ranked institutions must follow the procedures related to positive discrimination and be concerned with equity and access issues. OBE merely asks the teacher to communicate at the beginning of the semester what students are expected to do at the end of a semester (course outcomes) rather than the mere list of topics. It has been established through systematic research and field studies that communicating the course outcomes to students at the beginning of the semester makes a significant difference to the students' performance. Outcome based education does not interfere with the academic freedom of the teacher. It merely asks the teacher to follow a process in offering a course. The process consists of writing course outcomes (what the students should be able to do), design assessment (how to measure the ability of students to do what they are expected to do), and instruction (how the teacher proposes to facilitate the students to acquire the ability to do what they are expected to do). The teacher makes all the decisions in all three steps of the process. That is certainly not a definition of a straitjacket. The accreditation agencies require that all institutions write the outcomes, communicate them to stakeholders, particularly to students, and determine the attainment levels of these outcomes.

This note presents a method of writing outcomes for General (Sciences, Social Sciences, Humanities, and Arts) undergraduate (3-year and 4-year) degree programs. The proposed method is in the framework of current pedagogical theories and was heavily field tested through faculty development workshops. Material from the indicated references was used liberally in preparing this document.

2. Outcomes

Outcomes are the abilities the students acquire and demonstrate at the end of a learning experience. The learning experience can be an instructional unit that involves a small number of hours of instructional activity, a course of one-semester duration, or a two to four-year formal undergraduate program. Outcomes serve as the basis for effective interaction among concerned stakeholders. The outcome being the product of learning, it may be called a learning product. Therefore, "the product defines the process" in OBE. It is

results-oriented thinking and is the opposite of input-based education. The emphasis is on the educational process and where we are happy to accept whatever is the result. However, it should be remembered that Outcome-based education is not merely producing outcomes for an existing curriculum.

Outcomes can be defined at three different levels in the case of general undergraduate programs.

Program Outcomes: POs (Program Outcomes) are statements that describe what the students graduating from general programs should be able to do.

Program Specific Outcomes: PSOs (Program Specific Outcomes) are statements that describe what the graduates of a specific program should be able to do.

Course Outcomes: COs (Course Outcomes) are statements that describe what students should do at the end of a course.

The general undergraduate degree is the terminal degree for the majority of graduates (>80%). They get into employment not necessarily related directly to the discipline of the program they graduated from. Whatever be the profession the graduates get into, they need to have some abilities and attitudes that make them good employees and contribute to the wealth generation and service activities of the organization they work for. In any organization, the employees have to work as teams arranged in some hierarchy, communicate well in verbal and written form with peers and customers, understand the impact of what they do on society, etc. Program Outcomes (POs) represent the knowledge, skills, and attitudes that all students are required to attain at the time of graduation from any program. POs need to be identified by the University/Institute offering general programs. POs are non-specific to the discipline of the program. Sometimes these are referred to as liberal education and common core competencies. Some sample POs are:

Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and one Indian language, and make meaning of the world by connecting people, ideas, books, media, and technology.

Program Specific Outcomes (PSOs) are outcomes that are specific to a program. They characterize the specificity of the core (core courses) of a program. PSOs of a general program can only be two to four in number. Sample PSOs for BSc (Zoology) are

1. Understand the nature and basic concepts of cell biology, Biochemistry, Taxonomy, and ecology.
2. Analyze the relationships among animals, plants, and microbes
3. Perform procedures as per laboratory standards in the areas of Biochemistry, Bioinformatics, Taxonomy, Economic Zoology, and Ecology
4. Understand the applications of biological sciences in Apiculture, Aquaculture, Agriculture, and Medicine

The PSOs need to be written by the concerned Board of Studies.

Course Outcomes (COs) represent what the students should be able to at the end of a course. They will be discipline and subject-specific. Some sample COs from different courses are

- Understand human development aspects, including pregnancy, parturition, birth control, infertility, developmental defects, and miscarriage.
- Synthesize specified chemicals and characterize them and interpret spectral data to elucidate the structure of a synthesized chemical compound.
- Write programs for one-dimensional and two-dimensional array manipulation and string handling functions

Course Outcomes are to be written by the teacher(s) offering the course or the Board of Studies of the concerned program.

3. Taxonomy of Learning

3.1 What is Taxonomy of Learning?: In 1956, Benjamin Bloom headed a group of educational psychologists who developed a classification of intellectual behavior levels important in learning, which became a taxonomy including three overlapping domains: the cognitive, psychomotor, and affective. Cognitive learning is demonstrated by knowledge recall and intellectual skills: comprehending information, organizing ideas, analyzing and synthesizing data, applying knowledge, choosing among alternatives in problem-solving, and evaluating ideas or actions. This domain on the acquisition and use of knowledge is predominant in the majority of courses. Bloom identified six levels within the cognitive domain, from the simple recall or recognition of facts, as the lowest level, through increasingly complex and abstract mental levels, to the highest order, classified as evaluation. The six progressive stages of cognitive thinking are identified as knowledge (recall), comprehension, application, analysis, synthesis, and evaluation. Bloom's initial work was followed up with research that resulted in a list of Action Verbs representing intellectual activity on each cognitive domain's respective level.

Krothwhol (1964) took the lead to produce a parallel taxonomy explaining the development of attitudes, principles, codes, and human values. Affective learning is demonstrated by behaviors indicating attitudes of awareness, interest, attention, concern, responsibility, ability to listen and respond in interactions with others, and the ability to demonstrate those attitudinal characteristics or values appropriate to the test situation and the field of study. This domain relates to emotions, attitudes, appreciations, and values, such as enjoying, conserving, respecting, and supporting. Six progressive stages constitute personal growth in the affective domain: affective perceiving, reacting, conforming, validating, affective judging, and affective creating. Verbs applicable to the affective domain include accept, attempt, defend, dispute, join, judge, praise, question, share, support, and volunteer.

Kibler et al. (1970) completed the trilogy of taxonomies with the physical dimensions of behavior as it develops from gross to fine movements and nonverbal to verbal activities. Psychomotor learning is demonstrated by physical skills including coordination, dexterity, manipulation, grace, strength, speed; actions that demonstrate the fine motor skills such as the use of precision instruments or tools, or actions that evidence gross motor skills such as the use of the body in dance or athletic performance. The categories include psychomotor perceiving, activating, executing, maneuvering, psychomotor judging, and psychomotor creating. Verbs applicable to the psychomotor domain are bend, grasp, handle, operate,

reach, relax, shorten, stretch, write, differentiate (by touch), express (facially), perform (skilfully).

Together, these taxonomies for cognitive learning, social interaction, and physical development are the recognized building blocks for creating measurable learning outcomes, planning instruction, and measuring the attainment of outcomes.

Bloom's taxonomy has been revisited several times by educational psychologists, and several variants of the original taxonomy were proposed. L.W. Anderson, D.R. Krathwohl, and others presented a revision of Bloom's taxonomy of educational objectives in 2001. They re-established the relevance of the ideas in Handbook (1956) and incorporated new knowledge and thought that had been produced since 1956. The revised framework was intended to broaden the typical set of learning outcomes that promote 'retention' and 'transfer.' This framework consists of six cognitive processes.

There exist several other taxonomies: SOLO, Fink, Gagne, and Marazano & Kendall. All taxonomies are attempts to structure the processes involved in learning based on observations of learning behaviors and the limited understanding of how the brain functions. Our focus will be on Revised Bloom Taxonomy, also referred to as Revised Bloom's Taxonomy.

3.2 Cognitive Processes

3.2.1 Cognitive Processes: Cognitive processes are attention, perception, comprehension, calculation, judgment, storing in memory, reasoning, retrieval from memory, learning, planning, problem-solving, self-monitoring, and speech formation. Cognitive learning is demonstrated by knowledge recall and intellectual skills: comprehending information, organizing ideas, analyzing and synthesizing data, applying knowledge, choosing among alternatives in problem-solving, and evaluating ideas or actions. This domain on the acquisition and use of knowledge is predominant in the majority of courses. As per the revised Bloom's taxonomy, the taxonomy of cognitive processes involved in learning are

- Remember
- Understand
- Apply

- Analyze
- Evaluate
- Create

There are several subprocesses associated with each one of these cognitive processes.

The four categories of knowledge considered by the Revised Bloom taxonomy are

- Factual
- Conceptual
- Procedural
- Metacognitive

Let us consider the cognitive processes.

3.2.2 Remember

When the objective of instruction is to promote retention of the presented material in much the same form as it was taught, the relevant process category is Remember. Remembering involves retrieving relevant knowledge from long-term memory. The two associative cognitive processes are recognizing and recalling.

To assess student learning in recognizing activity, the student is given recognition or recall-task under conditions very similar to those they learned the material. Little, if any, extension beyond those conditions is expected. If, for example, a student has learned the symbols for different logical functions, then the test of remembering could involve requesting the student to match the logical functions given in one list with symbols shown in a second list. The recall test could include asking the student to provide the symbols for specified logical functions.

Remembering knowledge is essential for meaningful learning and problem solving as the knowledge is used in more complex tasks. When teachers focus on meaningful learning, however, remembering knowledge is integrated within the larger task of constructing new knowledge or solving new problems.

Recognizing involves retrieving relevant knowledge from long-term memory to compare it with the presented information. In recognizing, the student searches long-term memory for a piece of information that is identical or very similar to the given information. Three main methods of presenting a recognition task for assessment are verification, matching, and forced-choice.

Recalling (retrieving) involves retrieving relevant knowledge from long-term memory when given a prompt to do so. The prompt is often a question. In recalling, a student searches a long-term memory for a piece of information and brings that piece of information to working memory where it can be processed.

Remembering, therefore, is retrieving relevant knowledge from long-term memory. The relevant knowledge may be factual, conceptual, procedural, or some combination of these. Remembering knowledge is essential for meaningful learning and problem-solving. Some action verbs associated with remembering activity include recognize, recall, list, tell, locate, write, find, mention, state, draw, label, define, name, describe, prove a theorem.

Some sample Remember activities are:

- What percentage of Kerala state income comes from foreign remittances?
- What is the occupational structure of the Kerala population?
- What is confessional poetry?
- Who gave the call, "Swaraj is my birthright, and I shall have it"?

Some generic questions related to Remember activity are:

- What happened after...?
- How many...?
- Who was it that...?
- Can you name the...?
- Describe what happened at...?

- Who spoke to...?
- What is the meaning of...?
- What is...?

3.2.3 Understand

Students understand when they can construct meaning from instructional messages, including oral, written, graphic communications. These messages are presented to students during lectures, in books, or on computer monitors. Examples of instructional messages also include laboratory demonstrations, observations during field trips and role-playing sessions, results of computer simulations, as well as verbal, pictorial, and symbolic representations on paper. Students understand when they build connections between the new knowledge to be gained and their prior knowledge. Since concepts are building blocks for these schemas and frameworks, conceptual knowledge provides a basis for understanding. Cognitive processes in this category of Understand and the associated action verbs are

- Interpret: Translate, paraphrase, represent and clarify
- Exemplify: Illustrate and instantiate
- Classify: Categorize and subsume
- Summarize: Generalize and abstract
- Infer: Find a pattern
- Compare: Contrast, match, and map
- Explain: Construct a model

Interpreting occurs when a student converts information from one representative form to another. Interpreting may involve converting words to words (paraphrasing), pictures to words, words to pictures, numbers to words, words to numbers, and the like. Alternative terms for interpreting are translating, paraphrasing, representing, and clarifying.

Exemplifying occurs when a student gives a specific example or instance of a general concept or principle. Exemplifying involves identifying the defining features of the general

concept or principle and using these features to select or construct a specific instance. Alternative terms are illustrating and instantiating.

Classifying occurs when a student recognizes that something belongs to a specific category (concept or principle). Classifying involves detecting relevant features or patterns that fit both the specific instance and concept or principle. Classifying is a complementary process to exemplifying. Alternative terms for classifying are categorizing and subsuming.

Summarizing occurs when a student suggests a single statement that represents presented information or abstracts a general theme. Summarizing involves constructing a representation of information, such as the meaning of a scene in a play, and abstracting a summary from it, such as determining a theme or main points. Alternate terms are generalizing and abstracting.

Inferring involves finding a pattern within a series of examples or instances. Inferring occurs when a student abstracts a concept or principle that accounts for a set of examples or instances by encoding the relevant features or each instance and, most important, by noting relationships among them. A student can distinguish a pattern in the series of numbers 1, 2, 3, 5, 8, 13, 21,…. The process of inferring involves making comparisons among instances within the context of the entire set. A related process is using the pattern to create a new instance (e.g., the next number on the series is 34, the sum of 21 and 13). This is an example of executing, which is a cognitive process associated with Apply. Inferring and executing are often used together on cognitive tasks.

Comparing involves detecting similarities and differences between two or more objects, events, ideas, problems, or situations, such as determining how a well-known event (e.g., the recent creation of Telangana state) is like or unlike a less familiar event (e.g., creation of States on the linguistic basis). Comparing includes finding a one-to-one correspondence between elements and patterns in one object, event, or idea and those in another object, event, or idea. When used in conjunction with inferring (e.g., first, abstracting a rule from the more familiar situation) and implementing (e.g., second, applying the rule to the less familiar situation), comparing can contribute to reasoning by analogy. Alternative terms are contrasting, matching, and mapping.

Explaining occurs when a student constructs and uses a cause-and-effect model of a system. The model may be derived from formal theory (as is often the case in the natural

sciences) or maybe grounded in research or experience (as is often the case in social sciences and humanities). A complete explanation involves constructing a cause-and-effect model, including each significant part in a system or each major event in the chain, and using the model to determine how a change in one part of the system or one "link" in a chain affects a change in another part. An alternate term for explaining is constructing a model.

Some sample Understand activities are:

- Identify the characters of Phylum Annelida with its classification
- Compare the Indian Freedom Movement with other Asian and African Freedom Movements.
- Understand the agriculture commodity price fluctuations using Cobweb Theorem.
- Illustrate the exclusion of marginalized populations from the fruits of development.
- Explain financial statements using fund flow and cash flow.
- Estimate marginal utility from the total utility.

Some generic questions related to Understand activity are:

- Provide an example of . . .?
- What was the main idea expressed in . . .?
- Write in your own words...?
- Write a brief outline...?
- What do you think could happen next...?
- Who do you think...?
- What was the main idea...?
- Who was the principal character...?

- Distinguish between...?
- What differences exist between...?
- Provide an example of what you mean...?

3.2.4 Apply

Apply involves using procedures to perform exercises or solve problems. Thus, apply is closely linked with *Procedural Knowledge.* An exercise is a task for which the student already knows the proper procedure to use, so the student has developed a routinized approach. A problem is when the student initially does not know what procedure to use, so the student must locate a procedure to solve the problem. The apply process consists of two cognitive processes: *executing* – when the task is an exercise (familiar) – and *implementing* – when the task is a problem (unfamiliar).

In **executing**, a student routinely carries out a procedure when confronted with a familiar task (exercise). The familiarity of the situation often provides clues to guide the choice of the appropriate procedure to use. Executing is more frequently associated with the use of *skills* and *algorithms* than with the *techniques* and *methods*. Skills and algorithms have two qualities that make them particularly amenable to executing. First, they consist of a sequence of steps that are generally followed in a *fixed order*. Second, when the steps are performed correctly, the result is a predetermined answer. An alternative term for *executing* is *carrying out*.

Implementing occurs when a student selects and uses a procedure to perform an unfamiliar task. Because selection is required, the student must possess an understanding of the type of problem encountered as well as the range of procedures that are available. Thus, implementing is used in conjunction with other cognitive process categories, such as *Understand* and *Create*. Because the students face an unfamiliar problem, they do not immediately know which of the available procedures to use. Furthermore, no single procedure may be a "perfect fit" for the problem; some modifications to the procedures may be needed. Implementing is more frequently associated with the use of techniques and methods than with skills and algorithms. Techniques and methods have two qualities that make them particularly amenable to implementation. First, the procedure may be more like a "flow chart" than a fixed sequence; that is, the procedure may have "decision points" built into it. Second, there often is no single, fixed answer that is expected when the procedure is

applied correctly. The notion of no single, fixed answer is especially applicable to objectives that call for applying *conceptual knowledge* such as theories, models, and structures where no procedures have been developed for the application. An alternative term for *implementing* is *using*.

Some sample Apply activities are:

- Trace the historical background of American Literature
- Determine the correctness of English pronunciation over a range of recognized International accents.
- Compute the Energies and Wave functions of the Hydrogen atom using the Schrodinger equation.
- Prepare scripts for radio talks, newspaper articles, and television talks on health, nutrition, and family living for tribal, rural, and urban groups.
- Carry out the transcription of the given dialogue
- Compute the trend from financial statements
- Do you know another instance where . . .?

3.2.5 Analyse

Analyse involves breaking material into its constituent parts and determining how the parts are related to one another and an overall structure. This process category includes the cognitive processes of *differentiating* (determining the relevant and important elements of a message), *organizing* (determining how the components of the message are arranged), and *attributing* (determining the underlying purpose of the message). Learning to analyze maybe as an end itself. Educationally it is considered as an extension of *understanding* or as a prelude to *Evaluating* and *Creating*. A teacher may wish to develop in his/her students the ability to:

- Distinguish fact from opinion (or reality from fantasy)
- Connect conclusions with supporting statements

- Distinguish relevant from extraneous material
- Determine how ideas are related to one another
- Ascertain the unstated assumptions involved in what is said
- Find evidence in support of the author's purposes

The processes of Understanding, Analysing, and Evaluating are interrelated and often used iteratively in performing cognitive tasks. At the same time, however, it is essential to maintain them as separate process categories. A person who understands communication may not be able to analyze it thoroughly. Similarly, someone who is skilful in analyzing a communication may evaluate it poorly.

Differentiating involves distinguishing the parts of a whole structure in terms of their relevance or importance. *Differentiating* occurs when a student discriminates relevant from irrelevant information, important from unimportant, and then attends to their significance and essentiality. *Differentiating* differs from *comparing* in using the broader context to determine what is relevant and essential. In comparing, all factors are equal irrespective of their relevance and importance. Alternate terms for *differentiating* are *discriminating*, *selecting*, *distinguishing*, and *focusing*.

Organizing involves identifying the elements of communication or situation and recognizing how they fit together into a coherent structure. In organizing, a student builds systematic and coherent connections among the pieces to the presented information. *Organizing* usually occurs in conjunction with *differentiating*. The student first identifies the relevant or essential elements and then determines the overall structure within which the elements fit. *Organizing* can also occur in conjunction with *attributing*, in which the focus is on determining the author's intention or point of view. Alternative terms for *organizing* are *structuring*, *integrating*, *findingcoherence*, *outlining*, and *parsing*.

Attributing occurs when a student ascertains the point of view, biases, values, or intentions underlying communications. *Attributing* involves a process of deconstruction, in which a student determines the intentions of the author of the presented material. In contrast to interpreting, in which the student seeks to *understand* the meaning of the presented material, *attributing* involves extension beyond basic *understanding* to infer the

intention or point of view underlying the presented material. An alternative term is *deconstructing*.

Some sample Analyse activities are:

- refining generalizations and avoiding oversimplifications
- developing one's perspective: creating or exploring beliefs, arguments, or theories
- clarifying issues, conclusions, or beliefs
- developing criteria for evaluation: clarifying values and standards
- evaluating the credibility of sources of information
- questioning deeply: raising and pursuing root or significant questions
- clarifying arguments, interpretations, beliefs, or theories
- reading critically: clarifying or critiquing texts
- examining or evaluating assumptions
- distinguishing relevant from irrelevant facts
- making plausible inferences, predictions, or interpretations
- giving reasons and evaluating evidence and alleged facts
- recognizing contradictions
- exploring implications and consequences

Some generic questions related to Analyse activity are:

- Structure evidence into for and against a historical description?
- Determine the point of the author of an essay in terms of his or her political perspective?
- Identify the cause and effect of advertising in FMCG?

- Analyze given literature from feminist and post-colonial approaches?
- Identify the historical development of Sanskrit plays?
- What is the theme . . ..?
- What evidence can you find . . .?
- What motive is there . . .?
- How is … is related to . . .?

3.2.6 Evaluate

Evaluate is defined as making judgments based on criteria and standards. The criteria most often used are quality, effectiveness, efficiency, and consistency. The student or others may determine them. The standards may be quantitative or qualitative. *Evaluating* includes the cognitive processes of *checking* (judgments about internal consistency) and *critiquing*(judgments based on external criteria). However, all judgments are evaluative. Most cognitive processes require some form of judgment. What most differentiates Evaluate from other judgments made by students is the use of standards of performance with clearly defined criteria. Is this machine or software working as efficiently as it should be? Is this method the best way to achieve the goal? Is this approach the most cost-effective than other approaches?

Checking involves testing for internal inconsistencies or fallacies in operation or a product. For example, *checking* occurs when a student tests whether a conclusion follows its premises, whether data support or disconfirm a hypothesis, or whether presented material contains parts that contradict one another. When combined with *planning* (a cognitive process in the category *Create*) and *implementing* (a cognitive process in the category *Apply*), checking involves determining how well the plan is working. Alternative terms for *checking* are testing, detecting, monitoring, and coordinating.

Critiquing involves judging a product or operation based on externally imposed criteria and standards. *Critiquing* lies at the core of what has been called critical thinking. An example of *critiquing* is judging the merits of a solution to acid rain in terms of likely effectiveness and its associated costs. An alternate term is judging.

Some sample Evaluate activities are:

- Select the factor among the following that has maximum impact on climate change
    - Carbonated soft drinks like Pepsi and Coke
    - Automobiles
    - Cell phones
    - Fast food
- What would you recommend . . .?
- What would you cite to defend the actions . . .?
- What choice you would have made . . .?
- How would you rate the . . .?

3.2.7 Create

Create involves putting elements together to form a coherent or functional whole. Objectives classified as *Create* have students make a new product by mentally reorganizing some elements or parts into a pattern or structure not present before. Although Create requires creative thinking on the part of the student, this is not entirely free creative expression unconstrained by the demands of the learning task or situations. To some persons, creativity is the production of unique products, often due to some special skills. The "create" process, as used here, includes objectives that call for unique production, also refers to objectives calling for production that all students can and will do. If nothing else, in meeting these objectives, many students will create in the sense of producing their synthesis of information or materials to form a new whole, as in a circuit, a software unit, a mechanism, a structure, and so on.

Although the process categories of *Understand*, *Apply*, and *Analyse* may involve detecting relationships among presented elements, *Create* is different because it also involves constructing an original product. Unlike create, the other categories involve working with a given set of elements that are part of a given whole; that is, they are part of a larger structure the student is trying to understand. In creating, on the other hand, the student

must draw upon elements from many sources and put them together into a novel structure or pattern relative to his or her prior knowledge. Create results in a new product that is something that can be observed, and that is more than the student's beginning materials. A task that requires Create is likely to require aspects of each of the earlier cognitive process categories to some extent, but not necessarily in a specific order.

The creative process can be broken into three phases: problem representation, in which a student attempts to understand the task and generate possible solutions; solution planning, in which a student examines the possibilities and devices a workable plan; and solution execution, in which a student successfully carries out the plan. The creative process can, therefore, be thought of as starting the divergent phase in which a variety of possible solutions are considered as the student attempts to understand the task (*generating*). This is followed by a convergent phase, in which the student devises a solution method and turns it into a plan of action (*planning*). Finally, the plan is executed as the student constructs the solution (*producing*). It is not surprising that the *Create* is associated with three cognitive processes: *generating*, *planning*, and *producing*.

Generating involves representing the problem and arriving at alternatives or hypotheses that meet specific criteria. Often, the way a problem is initially represented suggests possible solutions; however, redefining or coming up with a new representation of the problem may suggest different solutions. When generating transcends the boundaries or constraints or prior knowledge and existing theories, it involves divergent thinking and forms the core of what is called creative thinking.

Generating is used in a restricted sense here. Understand also requires generative processes included in translating, exemplifying, summarizing, inferring, classifying, comparing, and explaining. However, the goal of Understand is most often convergent (that is, to arrive at a single meaning). In contrast, the purpose of generating within Create is divergent (that is to come at various possibilities). An alternative term for generating is hypothesizing.

Planning involves devising a solution method that meets a problem's criteria, developing a plan for solving the problem. *Planning* stops short of carrying out the steps to create the actual solution for a given problem. In *planning*, a student may establish sub-goals or break a task into subtasks to be performed when solving the problem. An alternative term is *designing*.

Producing involves carrying out a plan for solving a given problem that meets the given specifications. *Producing* can require the coordination of the four types of knowledge. An alternative term is *constructing*.

Some sample Create activities are:

- Design a flowchart showing the energy flow in the Western Ghats.
- Create a plan to conserve the wetland ecosystem.
- Create awareness on issues related to health, nutrition, and family using audio, visual, and audio-visual technologies.
- Design a marketing mix for fairness cream among working women in Tamilnadu during summer.
- Produce a 30-minute movie out of a 2-hour feature film using specified techniques of editing.

3.2.8 Critical Thinking

Critical thinking involves cognitive processes including 1) identifying the assumptions that frame our thinking and determine our actions, 2) checking out the degree to which these assumptions are accurate and valid, 3) looking at our ideas and decisions (intellectual, organizational, and personal) from several different perspectives, and 4) based on all this taking informed actions. The basic typology of the assumptions that critical thinking unearths and scrutinizes includes paradigmatic, prescriptive, and causal (Brookfield, 2012). Paradigmatic assumptions are the hardest of all assumptions to uncover. They are the structuring assumptions we use to order the world into fundamental categories. Usually, we do not even recognize them as assumptions, even after being pointed out to us. Prescriptive assumptions are assumptions about what we think ought to be happening in a given situation. They are the assumptions that are surfaced as we examine how we think we/others should behave, what good learning and educational processes should look like, and what obligations students and teachers owe to each other. Inevitably they are grounded in, and extensions of, our paradigmatic assumptions. Causal assumptions are assumptions about how different parts of the world work and about the conditions under which these can be changed. Of all the assumptions we hold, causal ones are the easiest to uncover.

Approximately 80% of assumptions covered in any conversation, class, course, or workshop will be causal. Causal assumptions are usually stated in two ways: when those assumptions govern future behavior, and the second ones are stated retroactively or historically. Assumptions are rarely right or wrong; they are contextually appropriate.

There are five distinct intellectual traditions shaping understandings of critical thinking. These are

1. Analytic philosophy and Logic: Detecting Language Tricks
2. Natural Sciences: The Hypothetico-Deductive Method
3. Pragmatism: The Experimental Pursuit of Beautiful Consequences
4. Psychoanalysis: Living an Integrated, Authentic Life
5. Critical theory: Speaking Truth to Power

These traditions are distinct but are not mutually exclusive.

We do critical thinking to take informed actions - actions that are grounded in evidence, can be explained to others, and stand a good chance of achieving the results we desire. Revised Bloom taxonomy addresses critical thinking through its core cognitive activities Analysis and Evaluate.

3.2.9 Problem Solving

The problem-solving process consists of

- Identification of the problem (Analyse)
- Explore and develop alternative solutions (Create)
- Select the best alternative (Evaluate)
- Implement (build and test the selected solution) (Apply)
- Evaluate the result (Evaluate)

The problem-solving process, therefore, involves all the Revised Bloom cognitive processes. One proposed taxonomy of Problem Solving

- Routines (Apply)
- Diagnosis (Selecting a method: Apply and Analyse)
- Strategy (Order of using methods: Analyse and Evaluate)
- Interpretation (Multiple higher cognitive levels)
- Generation (Multiple higher cognitive levels)

The Revised Bloom taxonomy subsumes critical Thinking and Problem-Solving processes. The classification of cognitive processes, as proposed by Revised Bloom, or any other taxonomy of cognitive processes, should only be considered approximate. For example, it is difficult to draw a line between Understanding and Analysis. According to some neurologists, the Revised Bloom taxonomy appears to be not in contradiction with the processes taking place in the brain.

The analysis of cognitive processes presented here has implications for both teaching and assessing. On the teaching side, two of the cognitive processes help to promote *retention* of learning, whereas 17 of them help to foster the transfer of learning. Thus, when the goal of instruction is to promote *transfer*, objectives should include the cognitive processes associated with *Understand, Apply, Analyse, Evaluate,* and *Create*. On the assessment side, the analysis of cognitive processes is intended to help broaden their assessment of learning. When instruction is to promote transfer, assessment tasks should tap cognitive processes that go beyond remembering.

4. Categories of Knowledge

4.1 Introduction

While the word 'knowledge' is extensively used by all, there is no single agreed definition of 'knowledge' at present, nor any prospect of one. Knowledge is a term that has been actively and continually defined. Knowledge is a complex of several related ideas. Consider some of the definitions.

Knowledge is relationships, facts, assumptions, heuristics, and models derived through the formal and informal analysis or interpretation of data. (Information Society Technologies http://cordis.europa.eu/ist/ka1/ administrations/publications/glossary.htm).

Knowledge is defined as remembering previously learned material. This may involve the recall of specific facts or complete theories, but all that is required is the rote memory of the appropriate information. Knowledge represents the lowest and most basic level of learning. www.drdan.org/Hnadout%2017.htm

Knowledge is the internalization of information, data, and experience
home.earthlink.net/~ddstuhlman/defin1.htm.

Knowledge is the psychological result of the perception of learning and reasoning
http://wordnetweb.princeton.edu/perl/webwn?s=knowledge.

Knowledge is accumulated external and explicit information belonging to the community, being leveraged by tacit intrinsic insights that originate within individuals who then may act alone or cooperatively in order to control or integrate with their environment.

http://www.pacrimcross.com/kmguidelines/ defknow.html.

Knowledge is defined (Oxford English Dictionary) variously as expertise and skills acquired by a person through experience or education; the theoretical or practical understanding of a subject what is known in a field; facts and information awareness or familiarity gained by experience of a fact or situation

A branch of philosophy, called 'epistemology,' is dedicated to the study of knowledge, and its sources, varieties, and limits. In any branch of philosophy, there are at least two competing views. In epistemology, one view referred to as 'empiricism' holds that knowledge is derived from experience, whereas 'apriorism' considers that knowledge is innate. The extreme form of empiricism is referred to as 'positivism' or 'logical positivism.' It holds that nothing is innate and that only that which can be measured is worth worrying about. The extreme form of apriorism denies the very idea of knowledge existing outside the individual mind. The conventional attitude adopted by non-philosophers is a kind of truce between the two extremes.

The Second half of the twentieth century has witnessed many new turns in the epistemic scenario, the latest among which is a turn towards situated knowledge/cognition. In stark contrast to the traditional epistemology where knowledge was and still is construed as individual, rational, abstract, a perspectival, and value-neutral situated epistemology upholds knowledge to be social, not insulated from emotion, concrete, perspectival and value-endowed. More specifically, the concept of situated cognition is a cluster-concept, and its degree of situatedness depends on how many traits of 'situatedness' have been reflected in a piece of cognition. The said cluster includes three theses: (a) cognition depends not just on the mind/brain but also on the body (the embodiment thesis), (b) cognitive activities routinely exploit structures of the natural and social environment (the embedding thesis), and (c) the boundaries of cognition extend beyond the boundaries of an individual organism (the extension thesis).

The perspective of knowledge, as considered here, is based on the current perspectives in cognitive science and cognitive psychology on knowledge presentation. We do not adhere to a simple behaviorist view that knowledge is best represented as an accumulation of association between stimuli and responses or merely a quantitative increase in bits of information. Instead, our perspective reflects the idea that knowledge is organized and structured by the learner in line with a rationalist-constructivist tradition. Based on cognitive science research on the development of expertise, expert thinking, and problem-solving, our perspective is that knowledge is domain-specific and contextualized. Our understanding of knowledge should reflect this domain specificity and the role that social experiences and context play in the construction and development of knowledge.

4.2 Types of Knowledge

There are many different types of knowledge, and seemingly even more terms are used to describe them. Some of the terms are conceptual knowledge, conditional knowledge, content knowledge, declarative knowledge, disciplinary knowledge, discourse knowledge, domain knowledge, episodic knowledge, explicit knowledge, factual knowledge, metacognitive knowledge, prior knowledge, procedural knowledge, semantic knowledge, situational knowledge, sociocultural knowledge, strategic knowledge, and tacit knowledge. Some of the different terms signify essential differences among the varieties of knowledge, whereas others are just different labels for the same knowledge category. Considering several constraints to categorization and the need for simplicity and ease of use, we

propose four general types of knowledge (Anderson et al., 2001) relevant across all disciplines:

- Factual Knowledge
- Conceptual Knowledge
- Procedural Knowledge
- Metacognitive Knowledge

Factual knowledge refers to specific content elements such as terms and facts (bits of information). Conceptual knowledge refers to more general concepts, principles, models, or theories. Procedural knowledge is the "knowledge of how" to do something. The "something" might range from completing routine exercises to solving novel problems. Current cognitive and social constructivist models of learning emphasize ideas such as consciousness, awareness, self-reflection, self-regulation, and thinking about and controlling one's thinking and learning, which were generally excluded by behaviorist psychology models. Because these activities focus on cognition itself, the prefix meta is added to reflect that metacognition is 'about' or 'above' cognition. Both cognitive and constructivist models agree on the importance of facilitating students' thinking about their thinking. Here we define "metacognitive knowledge" as "knowledge about cognition." Learners can activate the relevant situational, conditional, or cultural knowledge for solving a problem in a specific context.

These four categories of knowledge apply to all disciplines, but do not constitute a complete set. There are categories of knowledge specific to Engineering, Social Sciences, Computing, Management, Economics, etc. While categories of knowledge specific to Social Sciences, Computing, Management, and Economics are not enunciated definitively, the categories of knowledge specific to Engineering have been identified (Vincenti 1990).

The four types of knowledge and their sub-types are explored further in the following sections.

4.2.1 Factual Knowledge: Factual knowledge contains the basic elements students must know if they are to be acquainted with the discipline or solve any of the problems in it. The elements are usually symbols associated with some concrete referents, or "strings of

symbols" that convey essential information. For the most part, Factual Knowledge exists at a relatively low level of abstraction. As our knowledge increases in all fields of inquiry, even experts in these fields have difficulty keeping up with all the new elements. Consequently, some selection for educational purposes is almost always required. The two subtypes of Factual Knowledge are knowledge of terminology and knowledge of specific details and elements.

Knowledge of terminology includes specific verbal and nonverbal labels and symbols (e.g., words, numerals, signs, pictures). Each subject matter contains a large number of labels and symbols, both verbal and nonverbal, that have referents. They are the basic language of the discipline – shorthand used by experts to express what they know. The novice learner must be cognizant of these labels and symbols and learn the generally accepted referents that are attached to them. Some examples of knowledge of terminology are

- Knowledge of the alphabet and numbers
- Knowledge of engineering or technical terms
- Knowledge of physical and chemical constants
- Knowledge of mathematical and graphic representations
- Knowledge of specific details and elements refers to knowledge of events, locations, people, dates, sources of information, and the like.

It may include exact and specific information, such as the exact date of an event or the exact magnitude of a phenomenon, which could be descriptive or prescriptive. It may also include approximate information, such as a period in which an event occurred or the general order of magnitude of the phenomenon. Specific facts are those that can be isolated as separate, discrete elements in contrast to those that can be known only in a broader context.

Knowledge of specific facts and knowledge of the sources of the facts of a given subject belong to this category. However, the tremendous number of specific facts forces educators (curriculum specialists, textbook authors, and teachers) to make choices about what is basic and secondary importance or importance primarily to experts. Some examples of knowledge of specific details and elements are:

- Knowledge of products, companies, and major stakeholders related to computing
- Knowledge of important events people in the evolution of computing
- Knowledge of important features of different types of computers
- Knowledge of currently used semiconductor devices and technologies used for fabricating them
- Knowledge of performance characteristics of commercially available optical microscopes

4.2.2 Conceptual Knowledge: A concept denotes all the entities, phenomena, and/or relations in a given category or class by using definitions. Concepts are abstract in that they omit the differences of the things in their extension, treating the members of the extension as identical. Classical concepts are universal in that they apply equally to everything in their extension. Concepts are also the essential elements of propositions, much the same way a word is the essential semantic element of a sentence. Unlike perceptions, which are images of individual objects, concepts cannot be visualized. Because they are not themselves individual perceptions, concepts are discursive and result from reason. Concepts are bearers of meaning, as opposed to agents of meaning. A single concept can be expressed in any number of languages. The concept of DOG can be expressed as a dog in English, Hund in German, as Nayi in Kannada, and Kuttha in Hindi. The fact that concepts are, in some sense, independent of language makes translation possible - words in various languages have identical meanings because they express the same concept.

Conceptual knowledge includes knowledge of categories and classifications, and the relationships between and among them – more complex, organized knowledge forms. Conceptual knowledge includes schemas, mental models, or implicit or explicit theories in different cognitive psychological models. These schemas, models, and theories represent the knowledge an individual has about how a subject matter is organized and structured, how the different parts or bits of information are interconnected and interrelated in a more systematic manner, and how these parts function together. For example, the mental model of how a computer works may include ideas about how information can be represented in binary form, Boolean algebra, logical expressions, registers, instructions, control unit, ALU, primary memory, secondary memory, storage media, display of information, keyboards,

printers, etc. This type of conceptual knowledge might be one aspect of what is termed "disciplinary knowledge."

Conceptual knowledge includes three subtypes: knowledge of classifications and categories, knowledge of principles and generalization, and knowledge of theories, models, and structures. Classification and categories form the basis for principles and generalizations. These, in turn, form the basis for theories, models, and structures. These three subtypes should capture a great deal of the knowledge that is generated within different disciplines.

Knowledge of Classification and Categories includes specific categories, classes, divisions, and arrangements that are used in different subject matters. This type of knowledge is somewhat more general and often more abstract than terminology and specific facts. Each subject matter has a set of categories that are used to discover new elements and deal with them once they are discovered. Classification and categories differ from terminology and facts in that they form the connecting links between and among specific elements. When one is concerned with realizing a logic expression, the major categories include 'binary variables' 'logic functions,' 'truth-tables,' 'hardware logic units,' 'assertion levels,' etc.

Sometimes it is challenging to distinguish knowledge of classifications and categories from factual knowledge. Primary classifications and categories can be placed into larger, more comprehensive classifications and categories. For example, binary, hex, octal, and decimal systems can be placed into number systems.

Knowledge of classifications and categories is an essential aspect of developing expertise in an academic discipline. Proper classification of information and experience into appropriate categories is a classic sign of learning and development. Some examples of knowledge of classification and categories are

- Knowledge of number systems
- Knowledge different elementary particles

Principles and Generalizations are composed of classifications and categories. Principles and generalizations tend to dominate an academic discipline and are used to study phenomena or solve problems in the discipline. These include abstractions that summarize observations of phenomena and have the highest value in describing, predicting, explaining, or determining the most appropriate and relevant action or direction to be taken. Principles

and generalizations bring together many specific facts and events, describe the processes and interrelationships among these specific details (thus forming classifications and categories, and describe processes and interrelationships and among the classifications and categories). Principles and generalizations enable us to organize the whole in an economical and coherent manner.

Examples of knowledge of principles and generalizations are

- Knowledge of fundamental laws of physics
- Knowledge of Boolean algebra
- Knowledge of the principles that govern arithmetic operations

Knowledge of Theories, Models, and Structures include different paradigms and epistemologies that disciplines have for structuring inquiry. Students should know these different ways of conceptualizing and organizing subject matter and areas of research within the subject matter.

For example, the relevant operating characteristics of electrical and electronic devices are adequately described through currents and voltages as time functions at appropriately selected points or point pairs. An expert in a discipline knows not only the different disciplinary theories, models, and structures but also their relative strengths and weaknesses and can think "within" as one of them as well as "outside" any of them. Examples of knowledge of theories, models, and structures are

- Knowledge of social network theory
- Knowledge of field theory
- Knowledge of behavioral, cognitive, and social constructivist theories of learning
- Knowledge of systems view of organizations

4.2.3 Procedural Knowledge

Procedural knowledge is the "knowledge of how" to do something. The "something" might range from completing routine exercises to solving novel problems. Procedural knowledge often takes the form of a series or sequence of steps to be followed. It includes knowledge

of skills, algorithms, techniques, and methods, collectively known as procedures. Procedural knowledge also includes knowledge of the criteria used to determine when to use the procedures.

Procedural knowledge is specific or germane to a subject matter or an academic discipline. In mathematics, for example, there are algorithms to find the local minimum value of a function to determine the determinant of a square matrix, etc. In digital systems, there are methods to prepare a truth-table from a logic expression, to minimize a given logic expression, to do state assignment, etc. The subcategories of procedural knowledge are:

- Knowledge of subject-specific skills and algorithms
- Knowledge of subject-specific techniques and methods
- Knowledge of criteria for determining when to use appropriate procedures

Knowledge of subject-specific skills and algorithms can be expressed as a series or a sequence of steps. Sometimes the steps are followed in a fixed order; at other times, decisions must be made which step to perform next. The result is generally considered fixed in this type of knowledge.

Examples of this category of knowledge include

- Knowledge of algorithms used with mathematics exercises
- Knowledge of algorithms for minimizing logic expressions
- Knowledge of pattern-search algorithms in Artificial Intelligence

Knowledge of subject-specific techniques and methods includes knowledge that is mostly the result of consensus, agreement, or disciplinary norms rather than knowledge that is more directly an outcome of observation, experimentation, or discovery. This subtype of knowledge generally reflects how experts in the field or discipline think and solve problems. Examples of this category of knowledge include

- Knowledge of methods of management research
- Knowledge of system dynamics methods to model complex socio-technical systems

Knowledge of criteria for determining when to use appropriate procedures involves knowing the ways they have been used in the past. Systematization is used by subject matter experts as they solve problems in their field. Experts know when and where to apply their knowledge. They have criteria that help them make decisions about when and where to use different types of subject-specific procedural-knowledge. Their knowledge is "conditionalized" because they know the conditions under which a given procedure is to be applied. Initially, these criteria are likely to appear complex and abstract to students; they acquire meaning related to concrete situations and problems. Examples of this category of knowledge include

- Knowledge of the criteria for determining whether to use time-domain methods or frequency domain methods in analyzing a given electrical circuit.
- Knowledge of the criteria for determining which statistical procedure to use with the data collected in an experiment
- Knowledge of the criteria for determining the performance of Industry and Service sectors in India

4.2.4 Metacognitive Knowledge: Metacognitive knowledge is knowledge about cognition in general and awareness of and knowledge about one's cognition. Regardless of their theoretical perspective, researchers generally agree that with development, students will become more aware of their thinking and more knowledgeable about cognition in general, and as they act on this awareness, hey will learn better (Bransford, Brown, and Cocking, 1999). The labels for this general developmental trend vary from theory to theory but include metacognitive knowledge, metacognitive awareness, self-awareness, self-reflection, and self-regulation. An essential distinction in the field is between knowledge of cognition and the monitoring, control, and regulation of cognition. Flavell (1979) suggested that metacognition included knowledge of strategy, task, and person variables. These are categorized here as

- Strategic knowledge
- Knowledge about cognitive tasks
- Self-knowledge

Strategic knowledge is knowledge of the general strategies for learning, thinking, and problem-solving. The strategies in this subtype can be used across many different tasks and subject matters. This subtype includes knowledge of the variety of strategies that students might use to memorize material, extract meaning from text, or comprehend what they hear in classrooms or read in books and other course materials. These learning strategies can be grouped into three general categories: rehearsal, elaboration, and organizational (Weinstein and Mayer, 1986).

- Rehearsal strategies involve repeating words or terms to be recalled over and over to oneself; they are generally not the most effective strategies for deeper levels of learning and comprehension.

- Elaboration strategies include using various mnemonics for memory tasks and techniques such as summarizing, paraphrasing and selecting the main idea from texts. Elaboration strategies foster deeper processing of the material to be learned and result in better comprehension and learning than rehearsal strategies.

- Organizational strategies include various forms of outlining, drawing "cognitive maps", mind mapping or concept mapping, and note-taking; students transform the material from one form to another. Organizational strategies usually result in better comprehension and learning than do rehearsal strategies.

In addition to these general learning strategies, students can know metacognitive strategies useful in planning, monitoring, and regulating their cognition. Students can eventually use these strategies to plan their cognition (e.g., set sub-goals), monitor their cognition (e.g., ask themselves questions as they read a piece of text, check their answer to a math problem) and regulate their cognition (e.g., re-read something they don't understand, go back and "repair" their calculating mistake in a math problem).

This subtype of knowledge also includes general strategies for problem-solving and thinking. These strategies represent the various general heuristics students can use to solve problems, particularly ill-defined problems that have no definitive solution method. Examples of heuristics are means-ends analysis and working backward from the desired goal state. In addition to problem-solving strategies, there are general strategies for deductive and inductive thinking (including evaluating the validity of different logical statements, avoiding circularity in arguments, making appropriate inferences from different

sources of data, and heuristic – making decisions from convenient instead of representative symbols).

The third subtype includes knowledge about cognitive tasks, including contextual and conditional knowledge. Different cognitive tasks can be more or less difficult, and may make differential demands on the cognitive system, and may require different cognitive strategies. For example, a recall task is more difficult than a recognition task. As students develop knowledge of different learning and thinking strategies, this knowledge reflects both general strategies and how to use them. Students also need to develop conditional knowledge for these general cognitive strategies; in other words, they need to develop some knowledge about when and why of using these strategies appropriately. All these different strategies may not be appropriate for all situations. The learner must develop some knowledge of different conditions and tasks for which the different strategies are most appropriate. Conditional knowledge refers to knowledge of the situations in which students may use Metacognitive knowledge. If one thinks of strategies as cognitive "tools" that help students construct understanding, then different cognitive tasks require different tools. An important aspect of learning about strategies is the conditional knowledge of when and why to use them appropriately. Another important aspect of conditional knowledge is the local situational and general, conventional, and cultural norms for using different strategies. For example, the strategies used in a classroom learning situation may not be the most appropriate ones to use in a work setting.

Self-knowledge includes knowledge of one's strengths and weaknesses of cognition and learning. One hallmark of experts is that they know when they do not know something, and they then have some general strategies for finding the needed and appropriate information. Self-awareness of the breadth and depth of one's knowledge base is an important aspect of self-knowledge.

Students need to be aware of the different types of general strategies they are likely to rely on in different situations. An awareness that one tends to over-rely on one strategy when there may be other more adaptive strategies for the task could lead to a change in strategy use.

In addition to knowledge of one's general cognition, individuals have beliefs about their motivation. Motivation is a complicated and confusing area. A consensus has emerged,

however, around general social cognitive models of motivation that propose three sets of motivational beliefs.

- Self-efficacy beliefs that are students' judgments of their capability to accomplish a specific task
- Beliefs about goals or reasons students have for pursuing a specific task (e.g., learning vs.

  getting a good grade)
- Students' perception of their interest (liking) for a task as well their judgments of how important and useful the task is to them

Just as students need to develop self-knowledge and awareness about their knowledge and cognition, they also need to develop self-knowledge and awareness about their motivation. Again, awareness of these different motivational beliefs may enable the learners to monitor and regulate their behavior in learning situations in a more adaptive manner.

Self-knowledge is an essential aspect of Metacognitive knowledge, but the accuracy of self-knowledge seems to be most crucial for learning. The role of the teacher is to help students make an accurate assessment of their self-knowledge and not attempt to inflate students' academic self-esteem.

4.3 In Summary

Four types of knowledge are factual, conceptual, procedural, and metacognitive. Factual and conceptual knowledge are similar in that they involve the knowledge of 'what,' although conceptual knowledge is deeper, more organized, integrated, and systemic knowledge than just knowledge of terminology and isolated facts. Procedural knowledge is the knowledge of 'how' to do something. Metacognitive knowledge, in simplest terms, is knowledge about cognition. However, there can be domain-specific categories of knowledge. It is believed that there are categories of knowledge specific to Engineering, Social Sciences, Management, Computing, and Humanities.

5. Affective Domain

Many researchers firmly believe that non-cognitive factors and skills are more important than cognitive aspects in educative processes. Grit, tenacity, curiosity, attitudes, self-concept, self-efficacy, anxiety coping strategies, motivation, perseverance, confidence are among those frequently referred to as non-cognitive factors. Many of these factors fall into the affective domain.

Every one of us develops a unique personality or self-concept in the process of interacting with and growing in the physical and social environment. We reject pain and embrace pleasure. This happens when we become autonomous, make our own decisions and choices in structuring the experiences, we become what we are capable of becoming, we actualize our possibilities and potentialities, we achieve unity of personality and blend or integrate our experiences into a coherent, unified, and consistent system of feelings, ideas, and attitudes.

An individual growing in a dynamic, pluralistic, urban-industrial society encounters a fast-changing set of circumstances. Young persons are confronted by various experiences that were not part of the pre-adult experience of elders. Adults may become confused as they attempt to reconcile their past inconsistencies and contradictions. Such confusion is easily communicated to the younger generation. Such a climate is not conducive to healthy psychological development. Affective education has a significant role in resolving this problem.

The Affective Domain is most commonly associated with feelings and emotions. It is usually displayed in positive or negative reactions to given events, objects, behaviors, policies, or situations. Affective behaviors are accompanied by varying degrees of feelings and reflect distinct "approach" or "avoidance" predispositions. A person's experience in interacting with the environment shapes the nature and scope of affective responses. (Pierce and Gray, 1981)

An "affect" is any type or degree of positive or negative feeling toward environmental circumstances, expressed through an observable display of emotive, reactive, or evaluative behavior.

Attitudes are largely unexamined inclinations or dispositions for or against particular objects, ideas, or actions. They serve as general feeling indicators that usually influence behavior.

Values are tested dispositional insights for or against particular objects, ideas, or actions. When someone values something, he/she assigns worth to it concerning goals and purposes. Values (enjoying, conserving, respecting, supporting, etc.) serve as specific guides for consistent behavior.

Activities in all three domains involve Sensory Inputs, Mental Processing, and Output. Pierce-Gray taxonomy recognizes this three-step process and classifies the affective domain in terms of increments in cognition.

1. Perceive

- Emotive Imprinting
- Response Setting

Sample Outcome: Listen to others' points of view on ethical issues in genetics and biotechnology.

Action verbs: ask, choose, describe, follow, give, hold, identify, locate, name, point to, select, sit, erect, reply and use

2. React

- Emoting
- Recognizing
- Controlling

Sample Outcomes:

- Discusses the nature of his/her past and present reactions to the ethical issues in genetics and biotechnology
- Discusses with classmates whether he/she should continue to react in the same way to the ethical issues in genetics and biotechnology
- Assists teammates in resolving ethical issues in genetics and biotechnology.

Action Verbs: answer, assist, aid, comply, conform, discuss, greet, help, label, perform, practice, present, read, recite, report, select, tell, and write.

3. Conform

- Artificial Attitude
- Consistent Attitude
- Rationalized Attitude

Sample Outcomes:

- Justify the position he/she has taken regarding the use of genetic experimentation from an ethical point of view.
- Display commitment to using ethical standards when resolving ethical problems in genetics and biotechnology.

Action verbs: Complete, demonstrate, differentiate, explain, follow, form, initiate, invite, join, justify, propose, read, report, select, share, study, and work.

4. Validate

- Examining Values
- Accepting Values

Sample Outcome:

- Write a two-page paper explaining why he/she intends to maintain, revise, or discard his/her present stance on the current genetic experimentation from an ethical point of view.
- Adhere to ethical standards in discussing specified issues in genetics and biotechnology.

Action verbs: Explain, follow, justify, propose, read, report, select, share, study, and work

5. Affective Judge

- Establishing Value Criteria
- Value Judging

Sample Outcome: Given multiple stands taken on ethical issues on genetics and biotechnology by different groups, develop criteria based on which one can judge the ethical issues.

Action verbs: Adhere, alter, arrange, combine, develop, complete, defend, explain, formulate, generalize, identify, integrate, and modify.

6. Affective Create

- Integrating Values
- Inspirational Insight

Sample Outcome: Prepare a report that attempts to present his/her ethical standard on genetics and biotechnology supported by the assumptions made and data collected.

Action verbs: Act, create, influence, modify, perform, propose, revise, serve, solve, support.

Teachers can set up affective goals to be attained in their courses. These goals can be classified as

- Behavioral Goals are attitudes and values related to the rights, feelings, and property of others, including fellow students, teachers, and the institution.
- Procedural Goals are attitudes and values concerned with demonstrating respect for critical thinking, objectivity, evidence, and logical analysis.
- Substantive Goals are attitudes and values related to economic, social, political, ethical, and aesthetic questions and importance to a pluralistic society.

In addressing the activities in the affective domain, the teacher has to choose a position. Should he/she try to avoid controversy? Try to be the impartial (and neutral) observer? Try to instill acceptable values in students? It is suggested that the teacher is to take the role of "defensible partisanship" in a culturally pluralistic and democratically oriented society. Teacher's attitudes should be that values are not taught, but they are critically examined.

6. Psychomotor Domain

Learning in the psychomotor domain involves motor, muscular activities. Psychomotor learning also occurs in combination with cognitive and affective domain learning. It is demonstrated by physical skills that are acquired through practice. The development of these skills requires practice and is measured in terms of speed, precision, distance, procedures, or techniques in execution. Riding a bicycle, driving a car, playing a musical instrument, typing, acting, and running are dominantly psychomotor activities. Psychomotor activities become important and even dominant in courses of programs in Theatre, Music, Painting, Sports, Medicine, Nursing, Dentistry, Emergency Medical Services, etc.

There are several taxonomies of the psychomotor domain due to Ragsdale, Simpson, Kibler, Barker and Miles, Hauenstein, and Harrow.

Activities in all three domains involve Sensory Inputs, Mental Processing, and Output. Pierce-Gray taxonomy recognizes this three-step process and classifies the psychomotor domain in terms of increments in cognition.

1. Psychomotor Perceive

- Sensory Transmission
- Physio Functional Maintenance

One needs the ability to use sensory cues to guide motor activity. There is the readiness to act. It includes mental, physical, and emotional sets. These three sets are dispositions that predetermine a person's response to different situations

Outcome Sample: Estimate where a ball will land after it is thrown and then move to the correct location to catch it.

Action verbs: Choose, describe, detect, differentiate, distinguish, identify, isolate, relate, and select.

2. Activate

- Physical Outputs

- Mimicry
- Deliberate Modelling

Activation is a 3-stage process: Physical Outputs, Mimicry, and Deliberate Modelling. The early stages in learning a complex skill that includes imitation and trial and error. Adequacy of performance is achieved by practicing.

Outcome Samples:

- Perform proper breathing techniques.
- Reproduce basic stances, including aramandi, sama, muzhumandi, and the related exercises.

Action verbs: Copy, trace, follow, react, reproduce, respond

3. Execute

- Task Execution
- Operational Execution
- Skilled Execution

Execute is also a 3-stage process: Task Execution, Operational Execution, and Skilled Execution. Learned responses have become habitual, and the movements can be performed with some confidence and proficiency

Outcome samples:

- Operate a computer quickly and accurately.
- Perform tha-thai-tham adavus.

Action verbs: Perform skilfully, react fast, reproduce fast, and respond fast

4. Maneuvere

- Inspecting Skills

- Selecting Skills

The maneuvere is a 2-stage process: Inspecting Skills and Selecting Skills. Skills are well developed, and the individual can modify movement patterns to fit unique requirements.

Outcome Samples:

- Perform a task with a machine that it was not originally intended to do.
- Link different movements together.
- Prioritize equipment to carry fewer loads in my backpack.

Action verbs: Adapt, alter, change, rearrange, reorganize, revise, vary, perform, link, and prioritize.

5. Psychomotor Judge

- Establishing Performance Criteria
- Performance Judging

Psychomotor Judge is a 2-stage process: Establishing Performance Criteria and Performance Judging. Skill judging involves considerably more cognitive activity than the lower levels. Actual psychomotor activities maybe even absent for the individual making a judgment.

Outcome Samples:

- Judge the singing performance of participants.
- Judge the quality of a dance performance.

Action verbs: Judge, critique, differentiate, mark and select

6. Psychomotor Create

- Combining Skills
- Performance Insight

Psychomotor Create is a 2-stage process: Combining Skills and Performance Insight. Skills are combined to create a new whole.

Outcome Samples:

- Develop a new and comprehensive training program.
- Create a new gymnastic routine.
- Perform a Kuchipudi dance for a given Sanskrit poem.
- Sing a given song in a specified Raga.

Action verbs: Create, develop, perform, arrange, build, combine, compose, construct, design, initiate, make, and originate.

Cognitive, affective, and psychomotor activities are not independent of one another. Higher levels of affective and psychomotor activities involve more and more cognitive activities. Instruction needs to pay attention to these dependencies, especially integrating affective and psychomotor elements into cognitive activities in general courses.

For completion, we can also include Spiritual Domain as the fourth domain. The exploration of that domain is beyond the scope of this note. The four domains and their taxonomies are presented as a concept map in figure 1.

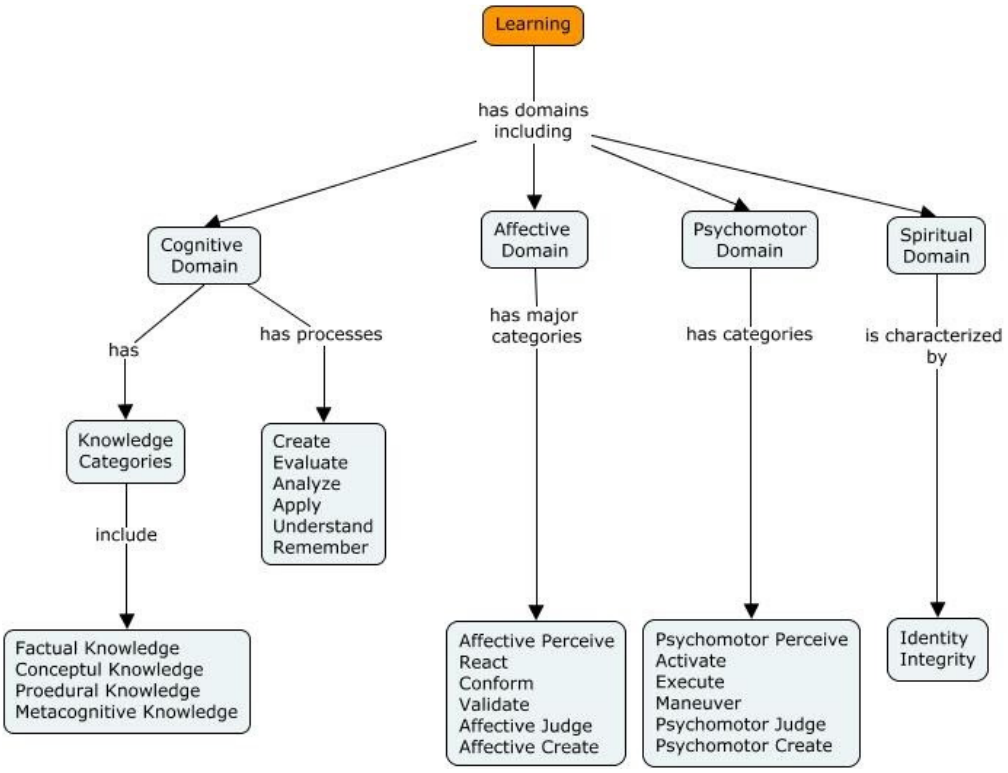

Fig. 1: Taxonomy of the four domains of learning

7. Taxonomy Table

Cognitive Domain has two dimensions: Cognitive Processes (Levels) and Knowledge Categories. There are six cognitive processes and four general categories of knowledge. A table with the six rows of cognitive processes and four categories of knowledge can serve as an excellent tool to deal with several issues of teaching and learning. Such a table known as the Revised Bloom taxonomy table is shown in figure 2.

Cognitive Processes	**Knowledge Categories**			
	Factual	**Conceptual**	**Procedural**	**Metacognitive**
Remember				
Understand				
Apply				
Analyze				
Evaluate				
Create				

Fig. 2: Revised Bloom Taxonomy Table of the cognitive domain

A cell of the Taxonomy Table can be numbered by its cognitive process (1 to 6) and its knowledge category (1 to 4). The cell (4,3) represents Analyse-Procedural outcome, instructional activity, and/or assessment. As there is a hierarchy among cognitive processes, the cell (4,*) represents a more complex (higher level) cognitive activity than the cell (3,*), but not a necessarily more difficult activity. The cell (4,*) implies all activities in (3,*), (2,*) and (1.*) cells.

The three elements of a Course are

- Course Outcomes (CO)
- Assessment Items (AI) of the course include assignments, tests, presentations, reports, examinations, etc.
- Instructional Activities (IA) to facilitate the learners attaining the course outcomes

Good learning can take place when there is alignment between the three elements of a course. This would require

- Assessment should be in alignment with the course outcomes.
- Instruction should be in alignment with the assessment.

An element of a course can be tagged by its cognitive level (action verb) and knowledge categories (can be more than one). An element can be in one or more cells of the taxonomy table based on tagging. Alignment among the elements of a course means all the aligned elements being in the same cell of the taxonomy table, as shown in figure 3.

Cognitive Processes	Knowledge Categories			
	Factual	Conceptual	Procedural	Metacognitive
Remember				
Understand				
Apply			CO3, IA3, AI3	
Analyze				
Evaluate				
Create				

Fig. 3: Alignment of the three elements in the AB taxonomy table

The taxonomy table can also be used to check for alignment among the three elements of a course. Consider the taxonomy table shown in figure 4.

Cognitive Processes	Knowledge Categories			
	Factual	Conceptual	Procedural	Metacognitive
Remember	AI5	IA5, AI5	IA4	
Understand		IA5, AI5	IA4	
Apply		IA5, AI5	**CO4, AI4**	
Analyze		CO5		
Evaluate				
Create				

Fig. 4: Partial or no alignment

- CO4 is in Apply-Procedure Cell, Instructional Activity is also in the cell (3,3), but AI4 items are either in the cell (3,1) or (3,2).
- The absence of Assessment Items in the cell (3,3) is unacceptable.
- CO5 is in the Analyze-Conceptual cell, but AI5 and IA5 are not in the cell (4,2). This is unacceptable.
- AI5 is also in the cell (1,1) is not directly related to the "Analyze" cognitive process nor to the "Conceptual" category of knowledge. It is also not acceptable.

Proper alignment requires

- Course Outcome and its related Instructional Activities should be in complete alignment (locatable in the same cells)
- While some (small percentage) assessment items can be in cells representing cognitive levels lower than that of CO, a significant percentage of Assessment Items should be in the same cell as that of CO.

Taxonomy table can facilitate achieving a specified alignment among the three elements of a course, help in designing of well-structured Test Item Banks, and can serve as a useful tool for organizing tutoring.

A table of the Pierce-Gray taxonomy for the affective domain is shown in figure 5. There is a hierarchy in affective goals. Procedural affective goals are at a higher level than those of behavioural affective goals, and substantive affective goals are at a higher level than those of procedural affective goals. Attaining affective goals at higher levels can be that much more difficult.

Affective Level	Behavioural Goal	Procedural Goal	Substantial Goal
Perceive			
React			
Conform			
Validate			
Affective Judge			
Affective Create			

Fig. 5: Pierce-Gray taxonomy table of the affective domain

8. Program Outcomes

Program Outcomes represent the knowledge, skills, and attitudes that all students are required to attain at the time of graduation from any general undergraduate program. Program Outcomes (POs) outcomes are non-specific to a program. No accreditation agency formally presents a set of POs for all institutions, unlike accreditation agencies associated with professional programs. General programs can significantly differ from one another. However, the NAAC requires that every University or Deemed to be a University identify its own set of POs that need to be attained by all its general programs. If a university offers a professional program, it is convenient if it used the POs identified by the corresponding accreditation agency. Every degree awarding institute around the world

identifies its own POs. A comparison of POs of several institutions shows that they are similar in spirit while they are not identical. The institutions may also differ in the number of POs. A set of POs identified in the nature of POs proposed and identified by institutions and organizations (for example, AACU) across the world are proposed in the following.

1. **Critical Thinking**: Make informed decisions after analyzing the assumptions that frame our thinking and actions.

2. **Problem Solving**: Solve problems of relevance to society to meet the specified needs using the knowledge, skills, and attitudes acquired from humanities/sciences/ mathematics/social sciences.

3. **Effective Communication**: Speak, read, write, listen clearly in person and through electronic media in English and one Indian language.

4. **Individual and Team work**: Function effectively as an individual and as a member or leader in diverse teams of settings.

5. **Ethics**: Understand multiple value systems, including your own, the moral dimensions of your decisions, and accept responsibility for them.

6. **Environment and Sustainability**: Understand the impact of technology and business practices in societal and environmental contexts and sustainable development.

7. **Self-directed and life-long learning**: Engage in independent learning in the broadest context socio-technological changes.

8. **Computational Thinking**: Understand data-based reasoning through the translation of data into abstract concepts using computing technology-based tools.

9. **Effective Citizenship**: Participate in civic life through volunteering with empathetic social concern, understanding of equity-centered national development, and informed awareness of relevant issues.

10. **Global Perspective**: Understand the economic, social, and ecological connections that link the world's nations and people.

11. **Aesthetic Engagement**: Infer meaning and values from aesthetic engagement with artistic works that integrate intuitive dimensions with broader social, cultural, and theoretical dimensions.

A University may consider all the ten POs or a subset of them or even add more POs. The chosen POs may also get reworded. In the following part of the document, we assume that these ten POs are identified for all general programs offered by a University.

Designing and conducting undergraduate programs to attain a set of POs is a new experience for Indian Universities. These POs cannot always be addressed through courses specifically designed for a PO or a set of POs. These POs need to be addressed through the core courses of the program under consideration. We need to understand the nature of elements of the POs selected and identify activities that address these elements. It should be remembered that activities planned to address POs should be amenable to the measurement of their attainment by students.

PO1.Critical Thinking: Make informed decisions after analyzing the assumptions that frame our thinking and actions.

While everyone considers critical thinking is essential, hardly any program has activities that directly address and promote critical thinking. Critical thinking is the kind of thinking—about any subject, content, or domain—that improves itself through disciplined analysis and assessment. Analysis requires knowledge of the elements of thought; assessment requires knowledge of standards for thought.

Critical Thinking entails

- identifying the assumptions that frame our thinking and determine our actions
- checking out the degree to which these assumptions are accurate and valid
- looking at our ideas and decisions (intellectual, organizational, and personal) from several different perspectives
- taking informed actions based on all these

Activities that promote critical thinking

- Structured discussions on Newspaper articles, essays and books, speeches, policies, and movies
- Explore the relationships between different subjects.
- Taking W-GCTA (Watson- Glaser Critical Thinking Appraisal) test

PO2. Problem Solving: Solve problems of relevance to society to meet the specified needs using the knowledge, skills, and attitudes acquired from humanities/sciences/ mathematics/social sciences.

Every course facilitates learners to acquire some knowledge, skills, and attitudes. There exist problems of relevance to society to meet the specified needs that will focus on the program's discipline. It is necessary to understand the identified problem and clarify and formulate (model) the problem. Solve problems that are well-defined (like the end-of-chapter) problems and ill-defined problems.

Activities that promote problem-solving

- Exercises to convert ill-defined problems to well-defined problems
- Case studies to understand problems that have their focus in the discipline of concern
- Solving end-of-the chapter problems

PO3. Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and at least one Indian language.

All professionals need to communicate effectively with their communities in person and on electronic media. She is also required to communicate with lay-educated persons, including customers of one’s organization and society at large, in English and the local Indian language. All professionals work in groups. It requires all members to document and present their day-to-day work in commonly agreed formats. As all formal professional activities in India are conducted in English, many colleges have one course each in English and Professional Communication

PO3 can be addressed through activities such as

- Several writing exercises should be embedded in some courses with evaluation rubrics having elements related to correctness and writing skills.
- Report writing should be given adequate weightage in evaluating project reports.
- Write technical documents (reports) that get evaluated as per declared rubrics.
- Make short presentations to peers in English and laypersons in English and in an Indian language that gets evaluated as per declared rubrics.
- Give feedback on a presented activity.
- Document the feedback given on a presented activity

PO4. Individual and Team work: Function effectively as an individual and as a member or leader in diverse teams of settings.

All activities in an organization are group activities. A group has to work as an effective team to meet the goals of a project. Organizations consider the ability to work in a team is an essential characteristic of all employees. After becoming a team member and identifying his/her role, an individual should work effectively to achieve the team's objectives despite personal differences from other team members.

Some activities that can address PO4

- Coaching students on becoming members of teams
- Develop rubrics to measure how good a team member is and make the evaluation count.
- Provide students with experiences as members or leaders in technical, semi-technical, and non-technical teams.
- Group assignments that involve group decision-making and division of work through negotiation.
- Group projects.
- Co-curricular activities

- Activities through e-groups

PO5. Ethics: Understand multiple value systems, including your own, the moral dimensions of your decisions, and accept responsibility for them.

The application of ethical principles requires moral autonomy. Moral autonomy means conduct and principles of action are owned, decisions and actions are based on critical reflection and not a passive adoption of some "code," and moral beliefs and attitudes are integrated into the core of one's personality and lead to committed action. Professional ethics are rules and standards governing the conduct of individuals in their roles as professionals. Every professional society will define a code of ethics for its practitioners. Students should understand the nature of ethical problems they face in professional practices. Students should understand the ethical norms of professional practice and their implications on professional decision-making.

PO5 can be addressed through

- A dedicated course on professional ethics and/or case studies focusing on ethical issues and their resolutions.
- Identifying the deviations of a proposed solution from the accepted professional practices
- Identifying the impact of a proposed solution on different groups of persons
- Recognizing the ethical dilemma in the case study presented.
- Propose actions that minimize damage and synthesize solutions rather than judge the players in ethically complex situations presented as case studies.

PO6. Environment and sustainability: Understand the impact of technology and business practices in societal and environmental contexts and sustainable development.

A student should understand the need for sustainable development. A student should understand the impact of technology and business practices in societal and environmental contexts. A student should demonstrate knowledge of what can lead to sustainable development.

The PO6 can be addressed through

- Courses on technology and society and sustainability
- Case studies can be incorporated into some courses that will bring the attention of the students to sustainability issues.

The assessment could be in terms of the student's perception of the impact of technology and business practices solutions on sustainability.

- Having some COs in some courses
- Understand what sustainable growth is.
- Understand the impact of a given technology on the environment and sustainability.

PO7. Self-directed and life-long learning: Engage in independent learning in the broadest context socio-technological changes.

Life-Long Learning (LLL) is a concept of learning that enables us to deal with continuous change in the life and practice of a professional. Lifelong learning skill is the ability to "continue one's self-education beyond the end of formal schooling." The technological and business changes in the last hundred years should convince us all to recognize that learning is a continuous and life-long pursuit. It is not possible to progress in one's career only with the knowledge and skillset acquired at graduation. If students are to be motivated and equipped to continue teaching themselves, their formal education must go beyond the presentation of predetermined content.

Some activities that promote life-long learning are

- Helping students to understand their learning processes,
- Requiring students to take responsibility for their learning,
- Creating an atmosphere that promotes confidence in students' ability to succeed,
- Helping students see schooling and education as personally relevant to their interests and goals,

- Incorporating activities that promote self-learning in several core courses. Rubrics need to be developed to measure the attainment of this outcome, and
- Making students do projects that promote self-learning, but appropriate rubrics are necessary for measurement.

PO8. Computational Thinking: Understand data-based reasoning through the translation of data into abstract concepts using computing technology-based tools.

A large class of problems in all areas can be solved through programming. Data is extensively available on the internet in every facet of life. Many open source and proprietary computing tools are available to process the data. Every profession has decision-making elements that require computational thinking.

Activities that promote computational thinking

- Courses like Statistics, Problem Solving through Programming, Simulation of Dynamic Systems of all kinds, Numerical Analysis, Database Management, Finite Element Methods, etc.
- Case studies that involve the use of databases.

PO9. Effective Citizenship: Participate in civic life through volunteering with empathetic social concern, understanding of equity-centered national development, and informed awareness of relevant issues.

We all wish that graduates of all programs be responsible citizens. Becoming responsible citizens requires an informed awareness of issues and participating in civic life. Effective citizenship means having an empathic social concern and a belief in equity-centered development.

Activities that can promote effective citizenship

- Courses specifically designed to understand Indian society
- Service-learning courses
- Participating in service activities in a structured manner

- Case studies on issues that have a social impact

PO10. Global Perspective: Understand the economic, social, and ecological connections that link the world's nations and people.

Globalization is here to stay with all its positive negative impacts. Graduates of different programs are likely to work in multicultural groups. Graduates are likely to work in groups with members from different countries and interacting only online.

PO10 can be addressed through

- A course on the history of globalization
- Case studies on global issues that have both positive and negative impacts
- Writing reports on economic and social issues from a global perspective

PO11. Aesthetic Engagement: Infer meaning and values from aesthetic engagement with artistic works that integrate intuitive dimensions with broader social, cultural, and theoretical dimensions.

The visual design of a product influences one's choices and buying decisions. People prefer to use emotionally appealing products and services rather than poorly designed ones. But one may not realize the extent to which design can impact a person's emotions, which in turn affects how people think and learn. Cognition and emotions are strongly intertwined. Aesthetics help users avoid the negative emotions associated with poor designs, such as frustration and dissatisfaction, therefore enhancing the learning experience.

Aesthetic engagement involves active participation in the appreciative process, sometimes by overt physical action but always by creative perceptual involvement. Aesthetic engagement emphasizes the holistic, contextual character of aesthetic appreciation. Aesthetic engagement can be integrated into some of the courses like Product Design, Ecology and Environment, and Graphic User Interface Design. Even the design of a course can incorporate some features of aesthetic engagement to incorporate positive emotional experiences.

As identifying Program Outcomes is a new experience to Program designers as well as course designers. While all the eleven POs presented are relevant, we propose the six POs

for consideration by an Institution. These six POs are a subset of the eleven POs presented. Example course designs presented in this note and the related notes are based on these six POs.

1. **Critical Thinking:** Make informed decisions after analyzing the assumptions that frame our thinking and actions.

2. **Problem Solving:** Solve problems of relevance to society to meet the specified needs using the knowledge, skills, and attitudes acquired from humanities/sciences/ mathematics/ social sciences.

3. **Effective Communication**: Speak, read, write, listen clearly in person and through electronic media in English and at least in one Indian language.

4. **Effective Citizenship**: Participate in civic life through volunteering with empathetic social concern, understanding of equity-centered national development, and informed awareness of relevant issues.

5. **Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development.

6. **Self-directed and Life-long Learnin**g: Engage in independent learning in the broadest context socio-technological changes.

9. Program Specific Outcomes

Program Specific Outcomes (PSOs) are outcomes that are specific to a program. PSOs characterize the specificity of the core (core courses) of a program. PSOs of a general program can only be two to four in number. All programs should be designed and conducted to attain the POs identified by the University and PSOs identified by the concerned Boards of Studies. The PSO statement should start with one or more action verbs. The action verbs should be followed by clearly identified technical objects, and if required, by the conditions under which the actions are to be performed.

Some examples of action verbs

- Formulate, specify, conceive, design, plan, architect, build, implement, test, operate

- Select
- Analyze, determine, estimate, calculate

Some sample PSOs prepared by groups of faculty members from different branches are given below. It is not necessary to take them as standard. It is the Boards of Studies that need to rewrite the PSOs whenever the curriculum is reviewed and changed.

BSc Zoology

1. Understand the nature and basic concepts of cell biology, Biochemistry, Taxonomy, and ecology.
2. Analyze the relationships among animals, plants, and microbes
3. Perform procedures as per laboratory standards in the areas of Biochemistry, Bioinformatics, Taxonomy, Economic Zoology, and Ecology
4. Understand the applications of biological sciences in Apiculture, Aquaculture, Agriculture, and Medicine.

BSc in Chemistry

1. Understand basic principles of Organic, Physical, and Inorganic Chemistry.
2. Identify and estimate the components of organic and inorganic chemicals and determine the physical properties of compounds.
3. Synthesize specified chemicals and characterize them and interpret spectral data to elucidate the structure of the synthesized chemical compound.
4. Solve problems in thermodynamics, electrochemistry, analytical chemistry, spectroscopy, and photochemistry.

BSc in Microbiology

1. Understand concepts of microbial physiology, microbial genetics, microbial metabolism, virology, and mycology

2. Understand basic concepts of biochemistry, biotechnology, instrumentation, biostatistics, bioinformatics, research methodology, nutrition, and immunology

3. Perform procedures as per laboratory studies in microbiology, biochemistry, and biotechnology

4. Understand the applicability of microbial studies in medical, agriculture, food and other industries, and environment

BSc in Biotechnology

1. Understand the origin, history, and significance of biotechnology and its multidisciplinary nature combining microbiology, biochemistry & cell and molecular biology.

2. Illustrate the cellular and molecular biological processes that provide the platform for basic research in Biosciences.

3. Understand the procedural strategies in Biotechnology, applications of biotechnology in medicinal, agricultural, environmental, and industrial fields, and the ethical issues related to Biotechnology.

4. Perform procedures in Biochemistry, Cell Biology, Microbiology, and recombinant DNA technology as per laboratory standards.

BSc in Mathematics

1. Understand the basic concepts and tools of Mathematical logic, set theory, number theory, geometry, calculus, analysis, abstract structures and algebra and methods of poofs

2. Model real-world problems into Mathematics problems and find solutions and understand the application of Mathematics in other sciences and engineering

BSc in Statistics

1. Understand the methods of collection, presentation, analysis, and interpretation of data

2. Understand and apply the methods in the estimation of parameters and testing of hypotheses

3. Understand and solve problems in probability, statistical distributions, correlation, and regression analysis

4. Understand and apply the methods and techniques used in sampling techniques and the design of experiments.

BSc in Physics

1. Understand and apply the basic principles of classical mechanics, quantum mechanics, statistical mechanics, nuclear physics, and thermodynamics

2. Understand and interpret the principles of optics, laser, spectroscopy, relativity, and solid-state Physics.

3. Understand the concepts of electricity and magnetism.

4. Understand the principles of semiconductor and computational Physics.

10. Course Outcomes

Graduates of all UG and PG General Programs in India are required to attain the Program Outcomes (POs) identified by the University/College and Program Specific Outcomes (PSOs) identified by the University or the Department offering the Program. POs and PSOs are to be attained through courses, projects, and co-curricular and extra-curricular activities in which the performance of the students is evaluated.

Courses are broadly classified into core courses, electives, ability enhancement courses, and skill enhancement courses. POs and PSOs are to be attained through core courses, ability enhancement courses, and activities in which all students participate. Courses constitute the dominant part of any program. Under the present CBCS (Choice Based Credit System), the courses can be of 3:0:0, 3:0:1, 3:1:0. 4:0:0, 4:0:2, 5:1:0, 0:0:2, 0:0:1, 1:0:2 or1:0:1credits. It should be remembered that One Credit is defined as

- One hour of classroom interaction per week over a semester
- One hour of tutorial per week over a semester
- Two hours of laboratory/fieldwork per week over a semester

The course content will have to be realistically adjusted to the number of credits allotted to the course.

Course Outcomes (COs) are what the student should be able to do at the end of a course. It is an effective ability, including attributes, skills, and knowledge, to carry out some activity that is identified successfully. The most important aspect of a CO is that it should be measurable.

Learning Outcomes (Instructional Objectives) as per R.E. Mager (1962), should include three elements

- Performance: An outcome statement should always say what the learner should be able to do.
- Condition: The outcomes always describe the important conditions, if any, under which the performance is to occur.
- Criterion: Whenever possible, an outcome describes the criterion of acceptable performance by describing how well the learner must perform to be considered acceptable.

Learning Outcomes (Instructional Objectives), as per Revised Bloom (2001), will have a common stem: "Student should be able to."

- The stem will be followed by a verb phrase and an object of the phrase.
- The verb phrase states the mental process belonging to any of the cognitive levels. Remember, Understand, Apply, Analyse, Evaluate, and Create.
- The object of the phrase states the type of knowledge.

We combine the elements proposed by Mager with the Phrase and Object of Anderson and Bloom. "Performance" of Mager will now consist of a Phrase and occasionally two Phrases and one or more Objects. We retain the optionality of "Condition" and "Criterion." The proposed structure of the Course Outcome statement in cognitive, affective, and psychomotor domains, in addition to the common stem, consists of "Action," "Knowledge," "Condition," and "Criterion."

The structure of CO statement now, in addition to the common stem, is

- Action: Represents a cognitive/ affective/ psychomotor activity the learner should perform. An action is indicated by an action verb, occasionally two, representing the concerned cognitive process (s).
- Knowledge: Represents the specific knowledge from any one or more of the four knowledge categories.
- Condition: Represents the process the learner is expected to follow or the condition under which to act (This is an optional element of CO).
- Criterion: Represents the parameters that characterize the acceptability levels of acting (This is an optional element of CO).

Sometimes it becomes equally important for a student to perform two cognitive processes on given knowledge elements. Only in such cases, two action verbs are used in a CO statement. It is not an artifact to combine two COs into one. Consider the example of a CO

- Prepare and explain financial statements using fund flow and cash flow.

Preparation and explanation are equally important, and both processes are related to the same knowledge element, "financial statement."

Some examples of CO statements are

Sample 1: Determine the slope from the given topographical map using the Wentworth method.

Action: Determine (Apply)

Knowledge: slope (Conceptual, Procedural)

Condition: given a topographical map, the Wentworth method

Criteria: None

Sample 2: Model a spring-mass system as a differential equation

Action: Model (Understand)

Knowledge: spring-mass system (Conceptual)

Condition: as a differential equation

Criteria: None

Sample 3: Understand the paradigm shifts in historical research.

Action: Understand (Understand)

Knowledge: paradigm shifts in historical research (Conceptual)

Condition: None

Criteria: None

Sample 4: Understand the concepts of Dhwani and Vakrokti

Action: Understand (Understand)

Knowledge: Dhwani, Vakrokti (Conceptual)

Condition: None

Criteria: None

Sample 5: Estimate the test reliability using Cronbach's Alpha method, accurate up to two decimal places, from the given test results.

Action: Estimate (Apply)

Knowledge: Test Reliability (Conceptual and Procedural)

Condition: Cronbach's Alpha method, Given test results

Criteria: accurate up to two decimal places

How many COs should we write for a course? Too small a number does not capture the course adequately and may not serve instruction design that very well. Too many COs make all the processes related to assessment design and computation of the attainment of COs messy and demanding. A 3:0:0, 3:1:0, and 3:0:1 course should have about six-course

outcomes. The number of COs of courses carrying a different number of credits can be suitably adjusted.

Attainment of course outcomes is measured using summative assessment instruments. It should be possible to determine the attainment of a CO through the typically followed assessment mechanisms without needing additional instruments.

It is the practice of many Universities to present the syllabus, of course, as a set of Units to facilitate equal attention to all sections of the syllabus. There need not be a one-to-one correspondence between Units of a course and the COs. A Unit can be addressed by more than one CO. A CO, if necessary, can address topics from more than one Unit. The unitization of the syllabus (list of topics) was brought in as an administrative convenience and not recommended from Outcome Based Education. OBE demands that COs are written first, and the list of topics is identified next. Even if the scope of all COs is not the same, a simple method can -resolve the issues of computation of CO attainment.

CO statements need to be tagged with several parameters to plan for proper instruction, assessment and to compute the attainment of COs, POs, and PSOs. As stated earlier, a CO statement starts with an action verb from one of the cognitive levels and occasionally by two action verbs from two cognitive levels. The action verb enables us to tag a CO with the Cognitive Level. One can use the acronyms R-Remember, U-Understand, Ap- Apply, An-Analyse, E-Evaluate, and C-Create. As there are no sharp demarcation lines between some cognitive levels, there is a possibility of one Action Verb representing two different cognitive levels. Use judgment in such cases. As mentioned earlier, a CO statement will include one or more categories of knowledge. The CO statement itself may not explicitly indicate all the concerned knowledge categories. Some knowledge categories may be implicitly addressed. The instructor needs to decide these categories based on the proposed design of instruction and assessment.

Each CO is also tagged with the number of classroom sessions likely to be taken to address that CO and the number of laboratory/field trip allocated hours.

If the PSOs are written well, there should not be any ambiguity regarding the PSO addressed by the course under consideration. All the COs of a course are likely to address the same PSO(s).

Many of the courses as they are offered at present, particularly in non-autonomous institutions, do not directly address many POs. However, some specific courses like Sustainability, Environment, and Communication address specific POs. Projects and reports can potentially address many POs. But the POs addressed must get reflected in the rubrics used. Tagging a CO with a PO requires that the assessment includes items related to the identified PO. A CO of a course can potentially address more than one PO. However, it may not be possible to conduct instruction and assessment to address all the identified POs within the available time and resources. Assessment items related to some POs cannot be efficiently designed, and even if designed, cannot be used in centrally conducted and evaluated examinations. A Department can arrange for some activities outside the curriculum to address some POs. However, the scope and distribution of these activities need to be carefully planned by the Department.

Therefore, a Course Outcome (CO) is to be tagged with POs, PSOs, Cognitive Level, Knowledge Categories, number of Classroom Sessions, and/or number of Laboratory/Field Trip hours. It will facilitate the computation of CO attainment and PO/PSO attainment as well.

Samples of courses whose COs are tagged are given in the following. These samples were created by faculty participating in faculty development workshops. Some editing was done on some of the statements. These are the first iterations. Teachers concerned with these courses can improve the COs and add or delete POs.

Course: Developmentaliology **Credits 3:0:0**

Program: BSc Biology

	Course Outcome	**POs/ PSOs**	**CL**	**KC**	**Class Hrs**
CO1	Understand the structural and functional features of the human reproductive system.	PO2, PSO3	U	C	5
CO2	Understand the type of eggs based on the amount, distribution, and position of yolk	PO2, PO5, PSO3	U	C	6
CO3	Compare the early developmental process of the egg up to the gastrula stage	PO2, PO3, PSO3	U	C	6
CO4	Illustrate the development of 18 hr, 24 hr, 33 hr, and 48 hr chick embryo and development of extraembryonic membranes	PO3, PSO3	U	C	4
CO5	Understand aspects of human development, including pregnancy, parturition, birth control, infertility, developmental defects, and miscarriage	PO3, PO5, PSO3	U	C	8
CO6	Describe the prenatal diagnostic techniques.	PO2, PO3, PSO3	U	F	3
CO7	Explain the scope of IVF, embryo transfer, and stem cell research and the ethical values involved in their	PO3, PSO3	U	C	5

	practice.				
CO8	Enumerate the different types of the placenta and its functions in mammals.	PO2, PSO3	U	C	3
CO9	Understand the mechanism of embryonic cell differentiation and gene action leading to differential potency of cells	PO2, PO5, PSO3	U	C	5
	Total Hours of instruction				45

Practical- 1 **Credits:**

0:0:3

Program: BA Dance

CO	**CO Statement**	**PO/ PSO**	**CL**	**KC**	**Lab Hrs**
CO1	Perform Dhyaanasloka, Hastabhedas, Siro-drushti-greevabhedas, basic stances including aramandi, sama, muzhumandi, and the related exercises	PO2, PSO1	Ap	F, C	16
CO2	Perform thattadavus	PO2, PSO1	Ap	F, C	8
CO3	Perform naattadavus	PO2, PSO1	Ap	F, C	12
CO4	Perform tha-thai-thai-tha adavus	PO2, PSO1	Ap	F, C	20
CO5	Perform kudithumett adavus	PO2, PSO1	Ap	F, C	15

CO6	Perform tha-thai-tham adavus	PO2, PSO1	Ap	F, C	15
CO7	Recite adavus in tala	PO2, PSO1	Ap	F, C	5
CO8	Notate the adavus	PO2, PSO1	Ap	F, C	5
	Total number of hours				96

Course: Indian Economy **Credits: 4:0:0**

Program: BA Economics

CO	**CO Statement**	**PO/ PSO**	**CL**	**KC**	**Class Hrs**
CO1	Understand the characteristics of the Indian Economy	PO1, PSO2	U	F, C	11
CO2	Analyze the changing pattern of Indian Agriculture	PO1, PSO2	An	C	13
CO3	Evaluate the performance of Industry and service sectors in India	PO1, PSO2	E	C	15
CO4	Describe the role of international trade in India's economic development	PO1, PSO1, PSO2	U	F	12
CO5	List the causes and consequences of population growth	PO2, PSO2	R	F, C	11
CO6	Explain the variables literacy, employment, and unemployment in the Indian context	PO1, PSO2	U	C	18
	Total Number of Hours				80

Course: Organic Chemistry 1 **Credits: 3:0:0**

Program: BSc Chemistry

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Name organic compounds using IUPAC Nomenclature.	PO1, PSO1	Ap	F, C	6
CO2	Understand electron displacement effects in the organic reaction mechanism.	PO1, PSO1	U	C	6
CO3	Identify the reaction intermediate and write the mechanism of nucleophilic substitution and elimination reactions.	PO1, PSO1	U	C	14
CO4	Explain the preparation and properties of alkane, alkene, alkyne, diene, polynuclear hydrocarbons, and cycloalkanes.	PO1, PSO1	U	F	15
CO5	Explain the preparation and properties of alkyl halides, dihalides, and trihalides.	PO1, PSO1	U	F	5
CO6	Explain the preparation and properties of alcohols and phenols.	PO1, PSO1	U	F	5
CO7	Distinguish between primary, secondary, and tertiary alcohols.	PO1, PSO1	U	C	1
CO8	Understand the mechanism of pinacol pinacolone, Fries, and Claisen rearrangements	PO1, PSO1	U	C	2
	Total Number of Hours				54

Course: Fundamental Writing Skills **Credits: 4:0:0**

Program: BA English

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Draft informal, formal letters, CV, resume	PO1, PO2, PSO1, PSO2	Ap	P	8
CO2	Write texts for given concepts and specified needs	PO1, PO2, PSO1, PSO2	Ap	P	6
CO3	Create ads and brochures for given products and programs	PO1, PO2, PSO2	C	P	6
CO4	Prepare reports based on a given news	PO1, PO2, PSO2	C	P	6
CO5	Describe the characteristics of things, animals, people, and events and processes	PO1, PO2, PSO2	C	P	10
CO6	Evaluate, summarize and paraphrase	PO1, PO2, PSO2	U	P	6
CO7	Prepare notice, agenda, minutes	PO1, PO2, PSO2	C	P	8
CO8	Edit and proofread texts	PO1, PO2, PSO2	Ap	P	8
	Total Number of Hours				58

Course: Bhakthi Movement in Hindi literature **Credits: 4:0:0**

Program: BA Hindi

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Understand the historical survey of medieval Hindi language and literature	PO1, PSO2	U	F, C	12
CO2	Analyze trends and structure of medieval Hindi literature	PO1, PSO2	An	F, C	10
CO3	Understand the novel and interesting features of medieval Hindi literature	PO2, PSO2	U	C	8
CO4	Develop a critical attitude about literary studies	PO1, PSO2	An	F, C	12
CO5	Identify the human values and sense of social service in Bhakti Hindi literature	PO3, PSO2	An	C	10
CO6	Explore the features of the Bhakti movement in Hindi literature.	PO5, PSO2	An	F, C	12
	Total Number of Hours				64

Course: History of Modern India **Credits: 4:0:0**

Program: BA History

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Describe the role of leaders, nature of events, and stages of freedom struggle	PO1, PSO1	R	F	5
CO2	Understand the impact of colonialism on the Indian economy and society	PO1, PSO1	U	C	8
CO3	Explain the concept of nationalism and its phases of growth	PO1, PSO1	U	C	7
CO4	Understand the legacy of the national movement in the making of modern India	PO1, PSO1	U	F, C	6
CO5	Explain the political and social issues in postcolonial India in the context of colonial experiences	PO1, PSO1	U	C	7
CO6	Identify the centers of freedom struggle, the borders during the partition of Bengal and partition of India in the relevant maps and locate states and union territories in India,	PO1, PSO1	R	F, P	4
CO7	Construct arguments in defense of or against a historical proposition based on the analysis and evaluation of historical writings	PO1, PSO1	An	C, P	8
	Total Number of Hours				45

Course: Marketing Management **Credits: 5:0:0**

Program: BBA

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	understand traditional and modern marketing concept, selling and marketing, service marketing, marketing environment, marketing mix	PO1, PO2, PSO1	U	C	5
CO2	Understand consumer behavior concept and market segmentation concept	PO1, PSO1	U	C	**8**
CO3	Determine the length and breadth of the marketing mix of a given situation	PO6, PSO1	A	P	10
CO4	understand the concept of branding, publicity, public relations, personal selling, and Product life cycle	PO1, PO2, PSO1	U	C	15
CO5	formulation of pricing strategy of a product	PO6, PSO1	A	P	10
CO6	understand the distribution and physical distribution, advertising and sales promotion	PO1, PSO1	U	C	12
CO7	Prepare advertisement copy of a given product, design a marketing mix for consumer goods, and market segmentation of a given product	PO6, PSO1	A	P	10
CO8	understand Nature and functions of sales promotion, relative merits of advertising medias	PO1, PO2, PSO1	U	C	10
	Total Number of Hours				80

Course: Graph Theory **Credits: 4:0:0**

Program: BA Mathematics

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Understand a Graph, Euler's theorem on Graph, Sub Graph, types of Graphs including simple, bipartite, Complete, regular and also their properties	PO1, PSO1	U	C, P	10
CO2	Understand a Walk, Trail, Path, Circuit, Connected Graph, di-Connected, n-connected	PO1, PSO1	U	C, P	10
CO3	Understand Tree, Spanning tree, Cayley's Formula	PO1, PSO1	U	C, P	10
CO4	Understand Eulerian graphs, Hamiltonian Graphs and around the World Problem	PO1, PSO1	U	C, P	10
CO5	Formulate flow network problems using graphs	PO9, PSO1	Ap	C, P	4
CO6	Solve flow network problems using graphs	PO9, PSO1	Ap	C, P	4
CO7	Model Real World Problems using the concepts of Graphs	PO9, PSO1	Ap	C, P	8
CO8	Solve Real-World Problems using the concepts of Graphs	PO9, PSO1	Ap	C, P	8
	Total Number of Hours				64

Course: Symbolic Logic and Informatics **Credits: 4:0:0**

Program: BA Philosophy

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Understand the fundamental symbols used in symbolic logic	PO2, PSO4	U	C	10
CO2	Understand the truth tables for conjunction, disjunction, negation, implication, and equivalence	PO2, PSO4	U	C	11
CO3	Classify statements and argument forms using truth tables	PO2, PSO4	U	C	9
CO4	Understand the nine rules of inference	PO2, PSO4	U	C	12
CO5	Construct formal proof of validity for simple arguments using the nine rules	PO2, PSO4	Ap	P	12
CO6	Understand the fundamentals of informatics and the philosophical approach to informatics	PO2, PSO4	U	F	10
	Total Number of Hours				64

Course: Classical Mechanics and Relativity **Credits: 3:0:0**

Program: BSc Physics

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Understand the concepts and consequences of the special theory of relativity	PO1, PSO1	U	C	14
CO2	Understand the concepts of linear and angular momentum	PO1, PSO1	U	C	2
CO3	Determine the dynamic variables of colliding particles using energy and momentum conservation laws.	PO1, PSO1	Ap	C, P	6
CO4	Determine the trajectory of a body in central force problem using Newton's laws	PO1, PSO1	Ap	C, P	4
CO5	Understand Kepler's laws of planetary motion	PO1, PSO1	U	C	2
CO6	Determine the center of mass for a given mass configuration	PO1, PSO1	Ap	C, P	4
CO7	Determine field and potential due to a given charge/mass distribution	PO1, PSO1	Ap	C, P	8
CO8	Formulate Lagrangian equation of motion for a system with given constraints	PO1, PSO1	U	C	8
	Total Number of Hours				48

Course: Weaker Sections of Indian society **Credits: 4:0:1**

Program: BA Social Work

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs	Lab Hrs
CO1	Identify the weaker sections of Indian society	PO1, PO4, PSO1	U	C	6	3
CO2	Examine historical processes that contributed to the low status of weaker sections	PO1, PO4, PSO1	U/A	F/C	6	2
CO3	Identify constitutional provisions for weaker sections	PO2, PSO1	U	F	6	2
CO4	List the Govt. welfare programs for the weaker sections	PO2, PSO1	R	F	6	2
CO5	Check the appropriateness of 10% financial reservation to the poor among the higher castes	PO2, PSO1	E	C, M	8	4
CO6	Identify the developmental status of Scheduled castes and Scheduled tribes	PO2, PO7, PSO1	An	F, C	6	3
CO7	Understand the caste system and its impacts	PO1, PO7, PSO1	U	F, C	5	2
CO8	Describe progressive social movements in the upliftment of weaker sections	PO1, PO7, PSO1	U	F	5	2

	Total Number of Hours	48	20

Course: Tour Operations Management **Credits: 4:0:0**

Program: BTTM (Bachelor of Tourism & Travel Management)

CO	CO Statement	PO/ PSO	CL	KC	Class Hrs
CO1	Understand the definition, history, types, and regulations of tour operators	PO1, PSO1	U	F, C	9
CO2	Understand the types and components of tour packages	PO1, PSO1, PSO2	U	C	9
CO3	Understand the preparation of tour itineraries	PO1, PSO1, PSO2	U	C	8
CO4	Prepare domestic and international tour itineraries	PO1, PSO2	C	F, C, P	10
CO5	Understand the tour operation process, managing crises	PO1, PSO2	U	C, P	10
CO6	Describe the major tour operating companies in India and tour operation trends	PO1, PSO2, PSO3	U	F, C	8
CO7	Understand the concepts and practices of tour guiding and tour escorting	PO1, PSO2	U	F, C	10
	Total Number of Hours				64

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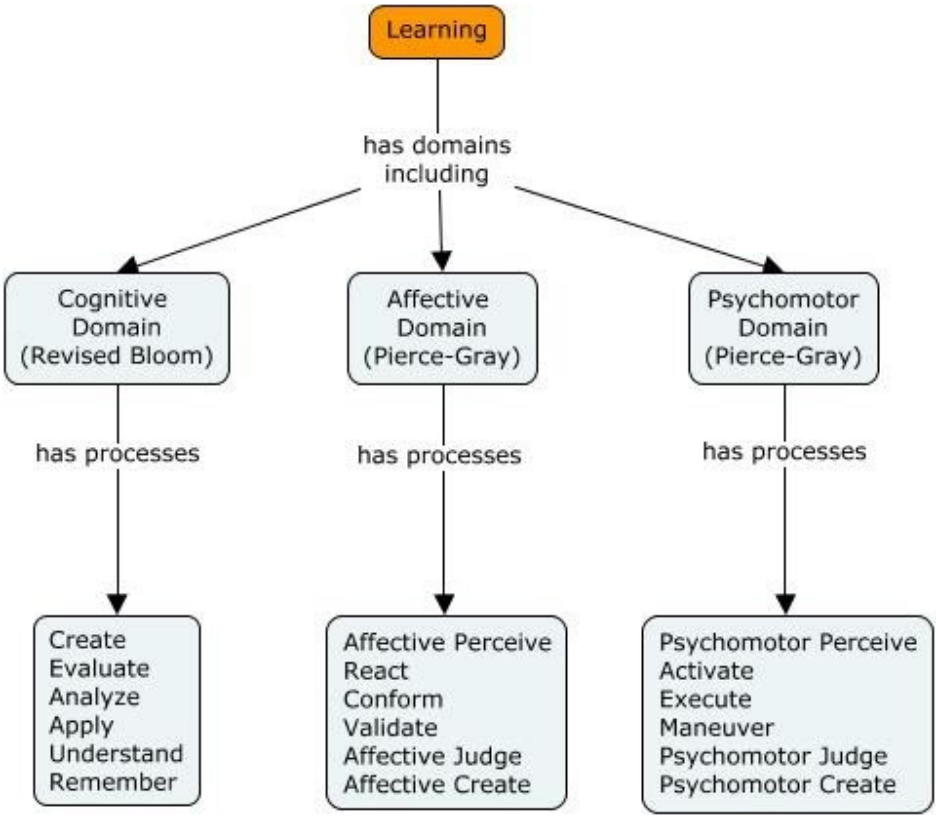
Annexure 4

Action Verbs associated with Bloom's Cognitive Processes and Pierce-Gray Affective and Psychomotor Processes

Learning is classified into three domains: Cognitive, Affective, and Psychomotor. Each one of these domains is characterized by six processes, as indicated in the figure.



Action verbs characterize the cognitive, affective, and psychomotor processes. There are several action verbs for each process. Some action verbs may be common to more than one process. The user needs to recognize the process from the action verb based on the context of the statement. Different researchers also suggested more action verbs. No attempt was made to list the action verbs exhaustively. These action verbs can greatly facilitate writing outcomes and designing assessments.

Action Verbs of Cognitive Processes of Revised Bloom's Taxonomy

Remember

- Recognize/Identify.
- Recall/Retrieve: List, mention, state, draw, label, define, name, describe, prove a theorem tell, show, label, collect, examine, tabulate, quote, who, when, where, etc.

Understand

- Interpret: Translate, paraphrase, represent, describe, express, extend, and clarify
- Exemplify: Illustrate and instantiate
- Classify: Categorize and subsume
- Summarize: Generalize and abstract
- Infer: Extrapolate, interpolate, predict, and conclude
- Compare: Contrast, match, map, distinguish and differentiate
- Explain: Illustrate, construct a model, confirm, state, write down, associate, and discuss

Apply

- Execute: Determine, calculate, compute, estimate solve, use, draw, and carry out (a procedure in a known situation)
- Implementing: Determine, calculate, compute, estimate, solve, use, draw, and carry out (a

  procedure in an unfamiliar situation)

Analyze

- Differentiate: discriminate, select, focus and distinguish (between accurate and inaccurate, cause and effect, consistent and inconsistent, dominant, and subordinate, essential and inessential, facts and conclusions, facts and hypotheses, facts and inferences, facts and opinions, facts, and value statements, plausible and implausible, possible, and impossible, relevant and irrelevant, summaries and conclusions, supportive and contradictory, valid and invalid, verifiable and unverifiable, and warranted and unwarranted)

- Organize: Identify (adequacy, assumptions, attributes, biases, causes, central issues, completeness, concepts, consequences, contradictions, criteria, defects, distortions, effects, elements, errors, exceptions, fallacies, inconsistencies, inferences, limitations, main ideas, nature of evidence, organization, plausibility, problems, procedures, reasoning, relationships, relevance, stereotypes, trends, validity, variables), structure, integrate, find coherence, outline, and parse.
- Attribute: Deconstruct and ascertain (Assumptions, attitudes, biases, conditions, characteristics, motives, organization, points of view, purposes, qualities, relationships)

Evaluate

- Check/test (Accuracy, adequacy, appropriateness, clarity, cohesiveness, completeness, consistency, correctness, credibility, organization, reasonableness, reasoning, relationships, reliability, significance, usefulness, validity, values, worth), detect, monitor, and coordinate.
- Critique/judge (Criteria, standards, and procedures)

Create

- Generate alternatives or hypotheses.
- Plan/design
- Produce/construct.

Action Verbs of Affective Processes of Pierce-Gray

Perceive

Ask, choose, describe, follow, give, hold, identify, locate, name, point to, select, sit, erect, reply, and use.

React

Answer, assist, aid, comply, conform, discuss, greet, help, label, perform, practice, present, read, recite, report, select, tell, and write.

Conform

Complete, demonstrate, differentiate, explain, follow, form, initiate, invite, join, justify, propose, read, report, select, share, study, and work.

Validate

Explain, follow, justify, propose, read, report, select, share, study, and work.

Affective Judge

Adhere, alter, arrange, combine, develop, complete, defend, explain, formulate, generalize, identify, integrate, and modify.

Affective Create

Act, create, influence, modify, perform, propose, revise, serve, solve, and support.

Action Verbs of Psychomotor Processes of Pierce-Gray

Psychomotor Perceive

Choose, describe, detect, differentiate, distinguish, identify, isolate, relate, and select.

Activate

Copy, trace, follow, react, reproduce, and respond.

Execute

Perform skilfully, react fast, reproduce fast, and respond fast.

Maneuver

Adapt, alter, change, rearrange, reorganize, revise, vary, perform, link, and prioritize.

Psychomotor Judge

Judge, critique, differentiate, mark, and select.

Psychomotor Create

Create, develop, perform, arrange, build, combine, compose, construct, design, initiate, make, and originate.

Annexure 5

Program Outcomes – A Survey

N.J. Rao

March 2021

Program Outcomes represent the knowledge, skills, and attitudes that all students must attain at the time of graduation from any general undergraduate program. Program Outcomes (POs) outcomes are non-specific to a program. No accreditation agency formally presents a set of POs for all institutions, unlike accreditation agencies associated with professional programs. General programs can significantly differ from one another. However, the NAAC requires that every University or Deemed to be a University identify its own set of POs that need to be attained by all its general programs. If a university offers a professional program, it is convenient to use the POs identified by the corresponding accreditation agency. Every degree awarding institute around the world identifies its own POs. Comparing POs of several institutions shows that they are similar in spirit while they are not identical. The institutions may also differ in the number of POs. A set of POs identified in the spirit of PO proposed and identified by institutions and organizations (for example, AACU) across the world are proposed in the following.

Students graduating from a General Program should be able to

1. **Critical Thinking**: Make informed decisionsafter analyzing the assumptions that frame our thinking and actions.

2. **Problem Solving**: Solve problems of relevance to society to meet the specified needs using the knowledge, skills, and attitudes acquired from humanities/sciences/ mathematics/social sciences.

3. **Effective Communication**: Speak, read, write, listen clearly in person and through electronic media in English and one Indian language.

4. **Individual and Team work**: Function effectively as an individual and as a member or leader in diverse teams of settings.

5. **Ethics**: Understand multiple value systems, including your own, the moral dimensions of your decisions, and accept responsibility for them.

6. **Environment and Sustainability**: Understand the impact of technology and business practices in societal and environmental contexts and sustainable development.

7. **Self-directed and life-long learning**: Engage in independent learning in the broadest context socio-technological changes.

8. **Computational Thinking**: Understand data-based reasoning through the translation of data into abstract concepts using computing technology-based tools.

9. **Effective Citizenship**: Participate in civic life through volunteering with empathetic social concern, understanding of equity-centered national development, and informed awareness of relevant issues.

10. **Global Perspective**: Understand the economic, social, and ecological connections that link the world's nations and people.

11. **Aesthetic Engagement**: Infer meaning and values from aesthetic engagement with artistic works that integrate intuitive dimensions with broader social, cultural, and theoretical dimensions.

A University may consider all the eleven POs, or a subset of them, or even add more POs. The chosen POs may also get reworded. One suggested subset of these eleven POs to get initiated into outcome based education is

Students graduating from a General Program should be able to

1. **Critical Thinking:** Make informed decisions after analyzing the assumptions that frame our thinking and actions.

2. **Problem Solving:** Solve problems of relevance to society to meet the specified needs using the knowledge, skills, and attitudes acquired from humanities/sciences/ mathematics/ social sciences.

3. **Effective Communication**: Speak, read, write, listen clearly in person and through electronic media in English and at least in one Indian language.

4. **Effective Citizenship**: Participate in civic life through volunteering with empathetic social concern, understanding of equity-centered national development, and informed awareness of relevant issues.

5. **Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development.

6. **Self-directed and Life-long Learnin**g: Engage in independent learning in the broadest context socio-technological changes.

Designing and conducting undergraduate programs to attain a set of POs is a new experience for Indian Universities. These POs need to be addressed through the core courses of the program under consideration. We need to understand the nature of elements of the POs selected and identify activities that address these elements. It should be remembered that activities planned to address POs should be amenable to measuring students' attainment.

Annexure 6

GENERAL COURSE DESIGN

N. J. Rao

March 2021

1. Preamble

Higher education programs in Humanities, Social Sciences, and Sciences are (operationally) referred to as General Programs, and courses offered in those programs are referred to as General Courses. These programs at the undergraduate level are of three/four-year duration in India. They are offered through two types of Institutions, called Tier 1 and Tier 2. Tier 1 Institutions are academically autonomous and are responsible for all academic processes, including curriculum design, assessment, and evaluation. Tier 2 institutions, which constitute more than 90% of India's higher educational institutions, are affiliated to some Universities. The affiliating Universities control the design of curricula, Semester End Examinations (SEE), and evaluation of student performances in SEE, and declaration of results. Tier 2 institutions are responsible only for the conduct of the course and Continuous Internal Evaluation (CIE). While NAAC (National Accrediting and Assessment Agency) accredits institutions offering higher education programs in India, there is no accrediting agency to accredit general higher education programs at the program level. The respective accrediting agencies accredit all professional programs like engineering, nursing, medicine, and dental.

Most graduates of these general programs enter into a profession. In contrast, a small but significant percentage of these graduates proceed to postgraduate programs and subsequently research programs. But all the graduates need to work and interact with society effectively and responsibly. The present-day society is characterized by complex demography, large populations, access to large databases, extensive use of information and communication technologies in all aspects of life, large scale pollution and consequent health and climate changes, growing interdependencies among all countries and continually shifting world, and national political and economic scenarios. All graduates must have some common attributes irrespective of the specific program from which they are graduating. These are known as Program Outcomes (POs), which are statements of what the graduates should be able to do. In addition to these common Program Outcomes, each program needs

to append a small number of (2 - 4) Program Specific Outcomes. While there are no universally accepted PO statements, there has been a fair amount of commonality among the many academic societies. We use nine Program Outcomes that are considered relevant in the current context of India. The course design process presented here is for the design of courses in both Tier 1 and Tier 2 institutions offering General Programs.

2. Good Teaching

Good teachers want good learning to occur as a result of their teaching. Besides recalling information, good learning means problem-solving, critical thinking, and creative thinking. Good learning is also referred to as meaningful learning, significant learning, or higher orders (Apply, Analysis, Evaluate, and Create categories of Bloom's taxonomy) of learning. There are four components of teaching (L.D. Fink 2003), as depicted in figure 1.

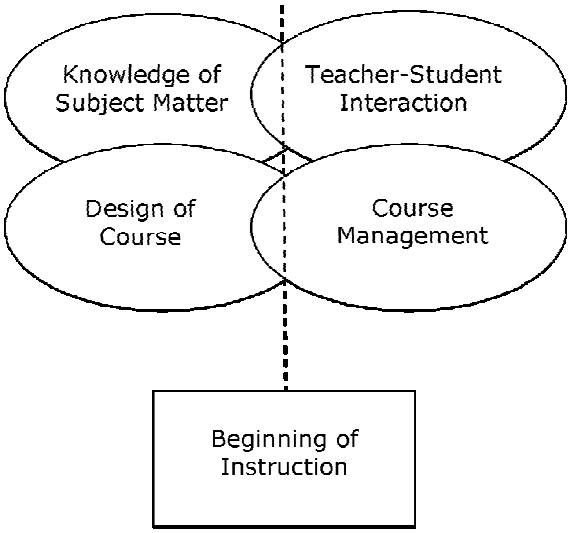


FIG. 1: Four components of teaching

All teachers need to have adequate knowledge of the subject matter, design instruction of their course (Course Design), interact with students, and manage course events. The first two, in general, take place before the course begins; the other two after it begins. This view implies that a teacher can improve his/her teaching, leading to students' good learning by improving any or all of the four competencies. However, the impact of improvement in these teacher competencies on student learning may not be equal. For example, knowledge of subject matter is not a major bottleneck for good teaching, as teachers are hired to have

the requisite knowledge. Still, a teacher can improve her knowledge of the subject from the many resources available.

"Teacher-student interactions" is an umbrella term that refers to all the different ways teachers interact with their students through lecturing, leading class discussions, tutoring, meeting with individual students, communicating through e-mail, and so on. This aspect of teaching is a skill that runs the entire spectrum from poor to excellent. Some faculty members have a personality and a set of social skills that make it easy for them to interact naturally with students to enhance learning. Others need to learn how to be more dynamic, establish better credibility, and otherwise relate/connect better with their students. For a significant percentage of college teachers, learning how to improve their interactions with students would be a considerable advance.

"Course management" refers to conducting instructional events of the course in an organized manner. Instructional events refer to conducting the sessions as per the declared timetable, having assignments ready when needed, grading and returning test papers promptly, etc. In most cases, course management is not a significant problem.

"Course Design" or "Design of Instruction" is a skill for which few college-level teachers have any training. But most teachers follow the traditional ways of teaching in their particular discipline, which consist of presenting the material in the class strictly as per the selected chapters and sections of identified textbooks. Of these four essential aspects of teaching, faculty knowledge about course design is the most significant bottleneck to better teaching and learning in higher education.

Course design consists of choosing the Course Outcomes the students are expected to acquire at the end of the course, the assessment aligned with the stated outcomes, and planning instructional activities that facilitate students to attain these outcomes. A course is an element of a program consisting of several courses belonging to different categories like Common Core, Disciplinary Core, and Electives. These courses are offered in a specified sequence over six semesters or three years and sometimes in eight semesters. A Higher Education program is required to meet a set of Program Outcomes.

One framework for the systematic design of a course is known as ADDIE. The ADDIE model is elaborated in the following as applied to the design of a higher education course,

3. Instructional System Design Model

The purpose of instruction is to help people learn and develop. The kinds of learning and development may include cognitive, affective, psychomotor, and spiritual. Learning can undoubtedly occur without instruction. We are continuously encountering and interpreting our environment and the events in it. Learning is a natural process that leads to changes in what we know, what we can do, and how we behave. However, one function of an educational system is to facilitate intentional learning to accomplish many goals that would take much longer without instruction. Educational institutions teach knowledge and skills that the community feels desirable, even if they are not of immediate personal interest to them and if they would not be encountered naturally in non-school environments. The government and commercial industries provide both skills and training and continuing refresher training to help employees acquire the skills and learning needed to succeed in a changing workplace (Gagne et al., 2005).

We define instruction as anything done purposefully to facilitate learning. Is teaching different from instruction? Teaching is only one part of instruction. The word 'teach' means that a person is lecturing or demonstrating something to the learner. However, the teacher's or trainer's role includes many tasks, such as selecting materials, gauging student readiness to learn, managing class time, monitoring instructional activities, and finally serving as a content resource and a learning facilitator. "Instruction" emphasizes a whole range of activities the teacher uses to engage the students. Instruction is more likely to be effective if planned to engage students in those events and activities that facilitate learning. Using instruction design principles, the teacher can select or plan and develop activities that best help students learn.

Application of instructional design principles would benefit several persons connected with education, including those in the business of producing instructional materials, such as textbook writers, curriculum material developers, web-based course designers, and knowledge management system designers.

Instructional Systems Design (ISD) Models are the systematic guidelines instructional designers follow to create a workshop, a course, a curriculum, an instructional program, a training session, or the instructional materials and products for educational programs. ISD is a process to ensure learning does not occur haphazardly but occurs using a process with specific, measurable outcomes. The instructional designer's responsibility is to create learning experiences, which ensure that the learners will achieve instruction goals. ADDIE is a generic model for instructional system design. All other ISD models are particularizations

or elaborations of this model for specific purposes. For example, the well-known Dick and Carey model (2005) can be seen as one elaboration of the ADDIE model for training programs, though the authors did not refer to ADDIE. One particularization of the ADDIE model to courses in formal general programs is presented in the following.

ADDIE Model: The "ADDIE Model" is a colloquial term used since the 1980s, also known as a military model of instruction, to describe a systematic approach to instructional development. It is not a specific, fully elaborated model but rather an umbrella term that refers to a family of models that share a standard underlying structure. ADDIE is an acronym referring to the major processes that comprise the generic ISD: **Analyze, Design, Develop, Implement**, and **Evaluate**. These processes are sequential and iterative, as depicted in figure 2.

The basic engine of ISD models (Molenda, 2003) is the systems approach: viewing human organizations and activities as systems in which inputs, outputs, processes (throughputs), and feedback and control elements are the salient features. The iterative aspect of the model is represented by arrows in both directions between phases, as depicted in figure 2. Activities in all phases are accompanied by formative evaluations, as drawn on the model's left side. For example, after the Analysis phase activities, the accuracy of the audience's descriptions, their learning needs, and the outcomes to meet the learning needs are evaluated by a peer group. In the Design phase, the assessment pattern, sample assessment items in alignment with the outcomes, and item bank are created. Based on the peer evaluation of Design Phase outputs, instructional material is developed, and learning materials are selected or developed for all instructional units in the Develop Phase.

Fig. 2: ADDIE model of ISD

After the evaluation of Develop Phase outputs, the course is implemented in the Implement Phase, and the efficacy of the prototype is evaluated. Improvements to the learning materials are worked out. Did the entire intervention achieve its goal, or what remains to be done after Implementation? This summative evaluation is what is symbolized by the final Evaluate Phase. At each of these phases, the evaluative activity results could lead the developers to revisit earlier steps.

The single most crucial feature of the ADDIE model is the identification, at the beginning of instruction design, of instructional objectives, which we refer to here as outcomes. The activities in a phase will significantly depend on the nature of and the context of the course. The context is defined by the nature of the audience and their background, the environment in which the instruction occurs, and the technologies used.

4. The Specificity of Instructional Objectives

The general domain of objectives is best represented as a continuum ranging from quite general to very specific. Krothwal and Payne (1971) identify three specificity levels, along the continuum of the general domain of objectives, as global, educational and instructional (guidance) objectives. In the case of formal general programs of three/four-years in India, we identify three levels of objectives:

- Program Outcomes and Program Specific Outcomes
- Course Outcomes
- Competencies

Program Outcomes and Program Specific Outcomes: Program Outcomes are statements that describe what the graduates of the program are expected to know and be able to do. These relate to the knowledge, skills, and behavior the students acquire through the program.

A course is an element of a program consisting of several courses belonging to different categories like Common Core, Disciplinary Core, and Electives. These courses are offered in a specified sequence over six semesters or three years and sometimes in eight semesters.

A Higher Education program is required to meet a set of Program Outcomes and Program Specific Outcomes. Program Outcomes are the traits of graduates of any general degree programs (Arts, Humanities, Social Sciences, and Sciences), including transferable skills. These are program non-specific and are not identified by any national agency. These are to be identified by the University and autonomous Institutions. A survey of Universities around the world indicates that the POs identified by them are very similar. A set of ten POs, written very similar to those given by AAHE (American Association of Higher Education) and AAC&U (Association of American Colleges and Universities), are presented in the following

for the Higher Educational Institutions in India to consider following Program Outcomes are proposed.

1. **Critical Thinking**: Make informed decisionsafter analyzing the assumptions that frame our thinking and actions.

2. **Problem Solving**: Solve problems of relevance to society to meet the specified needs using the knowledge, skills, and attitudes acquired from humanities/sciences/ mathematics/social sciences.

3. **Effective Communication**: Speak, read, write, listen clearly in person and through electronic media in English and one Indian language.

4. **Individual and Team work**: Function effectively as an individual and as a member or leader in diverse teams of settings.

5. **Ethics**: Understand multiple value systems, including your own, the moral dimensions of your decisions, and accept responsibility for them.

6. **Environment and Sustainability**: Understand the impact of technology and business practices in societal and environmental contexts and sustainable development.

7. **Self-directed and life-long learning**: Engage in independent learning in the broadest context socio-technological changes.

8. **Computational Thinking**: Understand data-based reasoning through the translation of data into abstract concepts using computing technology-based tools.

9. **Effective Citizenship**: Participate in civic life through volunteering with empathetic social concern, understanding of equity-centered national development, and informed awareness of relevant issues.

10. **Global Perspective**: Understand the economic, social, and ecological connections that link the world's nations and people.

11. **Aesthetic Engagement**: Infer meaning and values from aesthetic engagement with artistic works that integrate intuitive dimensions with broader social, cultural, and theoretical dimensions.

An Institution can use all the twelve or a subset of them as they are given or in suitably modified form.

A program should add a small number (2 -4) of Program Specific Outcomes to this list. Any course in a general higher education program should be designed and conducted to meet a selected subset of Program Outcomes and Program Specific Outcomes.

Course Outcomes: Course Outcomes are statements on what the students will be expected to do at the end of the course. The number of course outcomes needs to be small in number, around six. These statements start with action verbs like understand, compute, determine, model, analyze, select, formulate, architect, specify, design, build, implement, operate and test.

Competencies: The course outcomes are elaborated, if necessary, into a set of competencies, say 15±5. Competencies are effective abilities, including attributes, skills, and knowledge, to successfully carry out some activity that is totally identified. The competencies require a small number (1 to 5) of instruction hours and represent well-defined goals. Each competency may be treated as one Instructional Unit.

5. Course Design in ADDIE Framework

Analyze Phase

As general higher education programs are formal, elaborate mechanisms exist for selecting students to these programs, and the curriculum identifies the course structure and prerequisites of each course. The Analysis of audience and entry behaviors need not be undertaken for each course. The time and budget constraints also do not change from one course to the other very much. All courses are of one-semester duration and have a well-defined credit load. Therefore, the analysis phase's primary task is the identification of instructional goals (Course Outcomes). A general program has (should have) well-defined *Program Outcomes* (POs) and a small number of *Program Specific Outcomes* (PSOs). A course, described by its Course Outcomes, can only meet a subset of these POs and PSOs. The stages of the analyze phase for an engineering course are

1. Writing the course context and overview

2. Program Specific Outcomes as decided by the Department under which the course is offered

3. Writing 4 to 8 Course Outcomes that can be measured for attainment, and marking them with relevant POs, PSOs, Cognitive Level, Knowledge Categories, and the sessions (classroom, tutorial, and laboratory) required.

4. Locating the Course Outcomes in the taxonomy table

5. Writing a minimum of four representative test items for each course outcome at its cognitive level and sample solutions to these test items that would reflect the instructor's way of integrating course outcomes and selected POs and PSOs

6. Preparing Course-PO/PSO matrix (row) of the course

7. Elaborating Course Outcomes into 15±5 Competencies of the course to facilitate instructional planning

8. Having the output of the analyze phase peer-reviewed and make the changes needed

Design Phase

The **design** phase represents activities that enable the course designer to generate a plan according to which the instruction would be conducted, the assessment plan is determined, and an Item Bank is created. These provide the basis for developing instructional material and learning material. The activities of the design phase for a general course may be listed as

1. Generating an instructional plan/schedule

2. Set targets for CO attainment

3. Determining the assessment plan

4. Creating the Item Bank as per the assessment plan

5. Having the outputs of the design phase, peer-reviewed, and modifying them if necessary

Develop Phase

The **develop** phase represents activities that convert the blueprints created in the design phase to instructional materials and learning materials. Each competency represents one Instructional Unit. The activities of the develop phase of an engineering course consist of

1. selecting the delivery technologies proposed to be used,
2. preparing script for each Instructional Unit,
3. preparing instructional materials for all Instructional Units,
4. selecting and preparing learning materials for all Instructional Units of the course, and
5. having the outputs of develop phase peer-reviewed and modifying them if necessary.

Implement Phase

Instructors conduct the course as per the instructional plan prepared in the Design Phase using instructional material and learning material prepared in Develop Phase. However, each instance of course conduct is likely to be slightly different based on the context and offering time. Implement phase presents specifics of an instance of the offering. The specific elements of the implement phase are

1. Syllabus
2. Resources Planning
3. Instruction Schedule
4. Instructor's perception of students about their abilities and motivation
5. Observations on Instruction
6. Additional sessions, if any, conducted by the instructor beyond the scheduled hours and reasons thereof
7. Student feedback during the session
8. Create sample structures of Assessment Instruments

9. Create actual Assessment Instruments

10. Observations on Assessment Instruments and Student Performance

11. Feedback to students after every assessment

12. Tracking students

Evaluate Phase

Instructors conduct the course as per the instructional plan created in the Design Phase using instruction material and learning material prepared in the develop phase. However, each instance of conducting a course is likely to be slightly different based on the context and offering time. Implement phase presents specifics of the instance of the offering. It involves preparing and communicating the Syllabus of the course, planning resources for conducting the course, scheduling instruction, creating specific assessment instruments, giving feedback to students after every assessment, and tracking students' performance.

Every instance of course conduct should be evaluated to plan for improvements to the next instance of the course offering. The evaluation can be self-evaluation by the instructor as well as my peers. The activities of the evaluate phase include

1. Collecting student feedback at the end of the course

2. Computing CO attainment and from there PO and PSO attainment

3. Making summary observations

4. Collecting peer feedback

5. Planning for reducing the CO attainment gap or increasing CO attainment target

6. Summary

The design of a general course is done in five stages as per the ADDIE model. The Analyze, Design, Development, Implement, and Evaluate phase activities require an in-depth understanding of the present-day context and an awareness of various technologies

available. The instructor needs to appreciate the availability of many instructional methods and learning resources. He can now facilitate students to learn as per his/her view of good learning.

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Annexure 7

Attainment of Outcomes in General Programs

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1. Introduction

Learning leads to acquiring new knowledge, behaviors, skills, values, preferences, or understanding and sometimes involves synthesizing different information types. Outcomes of Learning or 'learning outcomes' represent what the students should be able to do at the end of a learning experience. Learning experiences in formal higher education can be identified as learning units. A unit of learning maybe a few hours of self/classroom learning activity, a one-semester course, or a formal program of two to four years. An outcome of education is what the student should be able to do at the end of a program/course/instructional unit. An outcome is an effective ability, including attitudes, skills, and knowledge. Outcome-Based Education (OBE) is an approach to education in which decisions about the curriculum, instruction, and assessment are driven by the exit learning outcomes that the students should display at the end of a program or a course. It facilitates establishing the conditions and opportunities within the system that enable all students to achieve those intended outcomes. A system based on outcomes gives priority to ends, purposes, learning, accomplishments, and results.

We identify outcomes at two levels in general undergraduate programs, as per the National Assessment and Accreditation Council (NAAC).

Program Outcomes (POs): POs are statements that describe what the students graduating from general undergraduate programs should be able to do at the end of any program. The Institution or the University identifies these. Non-autonomous Institutions conduct their teaching-learning activities using POs identified by the affiliating University. **Program Specific Outcomes** (PSOs): PSOs are statements that describe what the graduates of a specific program should be able to do at the end of the program. The PSOs should be 2 to 4 in number and prepared by the Department offering the program or decided by the University's Board of Studies.

Course Outcomes (COs): COs are statements that describe what students should be able to do at the end of a course.

As per Outcome Based Education, students learn well when

- they are clear about what they should be able to do at the end of a course/program,
- the assessment is in alignment with what they are expected to do, and
- the instructional activities are designed and conducted to facilitate them to acquire and demonstrate what they are supposed to do.

The relationships between the two levels of Outcomes are shown in figure 1. It should be noted that well-defined processes need to be defined and followed for writing and modifying the outcomes.

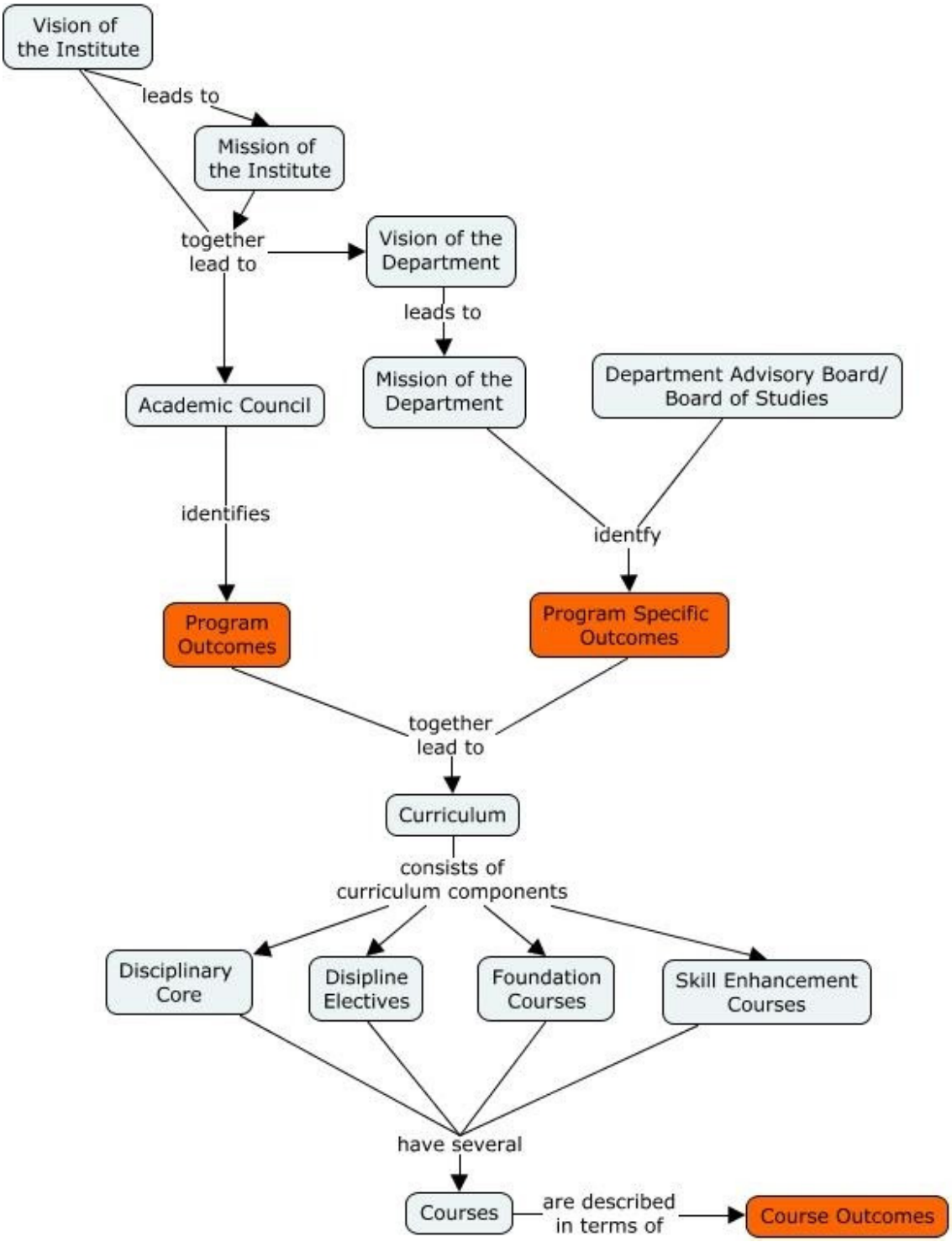


Fig. 1: Outcomes in OBE framework

The NAAC classifies Institutions into Universities, Autonomous, and Non-autonomous Institutions. Nearly 90% of Institutions offering general programs in India are Non-autonomous Institutions.

The affiliating University is responsible for curriculum design, conducting semester-end examinations, evaluating students' performances in the semester-end examinations, and declaration of results based on the performances of students in continuous internal evaluation and semester-end examinations. This Note presents the activities related to POs/PSOs and COs for all the Autonomous Institutions courses.

While this Note presents all the important process steps in reasonable detail with examples, we emphasize that these steps should not be implemented in a routine and blind fashion. The discretion of the teacher is necessary at several places, as will be explained in later sections. For example, the computations may indicate that 7.5 marks are allocated to a particular CO, say CO5, in Test 1 of Continuous Internal Evaluation. As this is not practical, the teacher must use her discretion and allocate 6 or 7 or 8 marks to CO5! It would, in turn, necessitate adjusting marks for one or more other COs.

Thus, this Note must be seen as providing a framework for making decisions that will lead to better implementation of accreditation quality processes.

2. Correlation between COs and POs-PSOs

Program Outcomes and Program Specific Outcomes are dominantly attained in any program through the program's core courses/activities. That requires that the COs of all courses should be, in some measure, correlated to the POs and PSOs. However, any course can only be correlated to a subset of POs and PSOs. All the program's core activities should together lead to satisfactory attainment of all the POs and PSOs.

POs are varied in their nature and cannot be attained to the same level by the program's core activities. The correlations between COs and POs-PSOs can be presented as a "course articulation matrix." Such a course articulation matrix can present a program in terms of relations among COs, POs, and PSOs. It will also serve to redesign the course, if necessary, leading to a better course articulation matrix.

Boards of Studies (BOS) of the Universities design the curriculum and the courses' content. Many times, it is the BOS that writes the Course Outcomes of all courses. If the

Departments of an Autonomous Institution wishes to rewrite the COs for the content already given by BOS, it may do so.

A 3: 0: 0 and 3: 1: 0 courses should have about seven (7±2) Course Outcomes to represent the course in detail. The number of COs of courses carrying a different number of credits can be suitably adjusted. A 3: 0: 1 course, which has the laboratory activity integrated, will also have about seven Course Outcomes, with the CO statements reflecting the laboratory activities also. Such courses are relatively rare in non-autonomous institutes in India! A 0:0:1 or 0:0:2 course has completely laboratory related activities. These activities involve simulation, writing and testing programs, designing and testing circuits, setting up a system with available machines and components, and performing a procedure to collect data and process the same, collect data from the field and process the same, conduct surveys with instruments, and more. Two or more practical activities/experiments can be grouped using some theme that can serve as a Course Outcome. A practical course can have about seven COs. The CO statements have four possible components:

- **Action:** Action verb representing the cognitive process
- **Knowledge: O**ne or more elements (from the four categories of knowledge)
- **Conditions(s)** under which the cognitive activity needs to be performed
- **Criteria** that the cognitive activity needs to meet

Conditions and **Criteria** are optional elements of a CO statement.

Program Specific Outcomes are also normally given by the BOS. However, the Department may wish to reword or rewrite the PSOs. PSOs must be written following a well-defined and implemented process at the level of the Department.

Program Outcomes (POs) are to be identified by Autonomous Institutions and Universities. Any accreditation or regulatory agencies do not mandate these. POs that any Institution may consider are presented in the following. These POs are prepared based on a survey of such POs from several Institutions and Associations. However, an Institution may consider selecting a subset or superset of these POs and even reword the selected ones to align with its Vision.

Suggested Program Outcomes

1. **Critical Thinking**: Make informed decisionsafter analyzing the assumptions that frame our thinking and actions.

2. **Problem Solving**: Solve problems of relevance to society to meet the specified needs using the knowledge, skills, and attitudes acquired from humanities/sciences/ mathematics/social sciences.

3. **Effective Communication**: Speak, read, write, listen clearly in person and through electronic media in English and one Indian language.

4. **Individual and Teamwork**: Function effectively as an individual and as a member or leader in diverse teams of settings.

5. **Ethics**: Understand multiple value systems, including your own, the moral dimensions of your decisions, and accept responsibility for them.

6. **Environment and Sustainability**: Understand the impact of technology and business practices in societal and environmental contexts and sustainable development.

7. **Self-directed and life-long learning**: Engage in independent learning in the broadest context socio-technological changes.

8. **Computational Thinking**: Understand data-based reasoning through the translation of data into abstract concepts using computing technology-based tools.

9. **Effective Citizenship**: Participate in civic life through volunteering with empathetic social concern, understanding of equity-centered national development, and informed awareness of relevant issues.

10. **Global Perspective**: Understand the economic, social, and ecological connections that link the world's nations and people.

11. **Aesthetic Engagement**: Infer meaning and values from aesthetic engagement with artistic works that integrate intuitive dimensions with broader social, cultural, and theoretical dimensions.

As an example, consider taking the following six POs by an Institution. All example computations are presented with these POs.

1. **Critical Thinking:** Make informed decisions after analyzing the assumptions that frame our thinking and actions.

2. **Problem Solving:** Solve problems of relevance to society to meet the specified needs using the knowledge, skills, and attitudes acquired from humanities/sciences/ mathematics/ social sciences.

3. **Effective Communication**: Speak, read, write, listen clearly in person and through electronic media in English and at least in one Indian language.

4. **Effective Citizenship**: Participate in civic life through volunteering with empathetic social concern, understanding of equity-centered national development, and informed awareness of relevant issues.

5. **Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development.

6. **Self-directed and Life-long Learnin**g: Engage in independent learning in the broadest context socio-technological changes.

The Department identifies Program Specific Outcomes. They are two to four in number. One sample set of PSOs of a BSc program in Zoology is.

1. Understand the nature and basic concepts of cell Biology, Biochemistry, Taxonomy, and Ecology.

2. Analyze the relationships among animals, plants, and microbes

3. Perform procedures as per laboratory standards in the areas of Biochemistry, Bioinformatics, Taxonomy, Economic Zoology, and Ecology

4. Understand the applications of biological sciences in Apiculture, Aquaculture, Agriculture, and Medicine.

The identification of correlations between COs and POs/PSOs can be undertaken after writing COs as per the given structure.

Consider the core course on Developmental Biology that can be offered in the BSc program in Zoology. This course has 3 (3: 0: 0) credits. If the college has 15 teaching weeks in a

semester, the number of classroom sessions is 45. COs, if given by the affiliating University, may be accepted as they are, or the concerned potential instructors or the Department may rewrite them for the content given by the affiliating University. A sample set of course outcomes of this course is:

Course: Developmental Biology **Credits 3:0:0**

Program: BSc Biology

1. Understand the structural and functional features of the human reproductive system.
2. Understand the type of eggs based on the amount, distribution, and position of yolk.
3. Compare the early developmental process of the egg up to the gastrula stage.
4. Illustrate the development of 18 hr, 24 hr, 33 hr, and 48 hr chick embryo and development of extraembryonic membranes.
5. Understand aspects of human development, including pregnancy, parturition, birth control, infertility, developmental defects, and miscarriage.
6. Describe the prenatal diagnostic techniques.
7. Explain the scope of IVF, embryo transfer, and stem cell research and the ethical values involved in their practice.
8. Enumerate the different types of the placenta and its functions in mammals.
9. Understand the mechanism of embryonic cell differentiation and gene action leading to differential potency of cells.

Course Articulation Matrix: It presents the strengths to which the COs of a course address POs and PSOs. Every CO will not address the same subset of POs and PSOs. Therefore, we tag the COs with POs and PSOs that are addressed. We need to follow some method to identify the POs and PSOs addressed by a CO. Each PO statement refers to some key activities/elements. For example, consider the PO3 statement:

PO3. Effective Communication: Speak, read, write, listen clearly in person and through electronic media in English and at least in one Indian language.

Consider the course outcome CO7 of the course 'Developmental Biology':

CO7. Explain the scope of IVF, embryo transfer, and stem cell research and the ethical values involved in their practice.

Students are required to explain the scope of IVF, embryo transfer, and stem cell research, relate that activity to the existing ethical values, comments from one's ethical perspective on some specific research programs, and understand why a particular program was initiated. Hence, PO3 is addressed by CO7 as effective communication is required. CO7 also addresses PSO3.

In identifying the POs and PSOs addressed by a CO, we may find the need to modify the CO itself. Hence, the process of writing COs and establishing a correlation between COs and POs/PSOs is iterative.

In determining the strength to which a CO addresses a PO/PSO, it is convenient to tag each CO with the number of Class Hours we propose to use for instruction. The number of instruction hours also indicates the depth to which the instructor intends to deal with that CO

Table 1 presents the COs of the course "Developmental Biology," indicating the POs and PSOs addressed and the number of instruction hours.

C301: Developmental Biology **Credits: 3: 0: 0**

CO	Course Outcome	POs/ PSOs	CL	KC	Class (Hrs)
	Understand the structural and functional features of human reproductive system.	PO1, PSO4	U	C	5
	Understand the type of eggs based on the amount, distribution, and position of yolk	PO1, PO5, PSO4	U	C	5

	Compare the early developmental process of the egg up to the gastrula stage	PO1, PO3, PSO4	U	C	5
	Illustrate the development of 18 hr, 24 hr, 33 hr, and 48 hr chick embryo and development of extraembryonic membranes	PO3, PSO4	U	C	4
	Understand aspects of human development, including pregnancy, parturition, birth control, infertility, developmental defects, and miscarriage	PO3, PO5, PSO4	U	C	6
	Describe the prenatal diagnostic techniques.	PO1, PO3 PSO4	U	C	5
	Explain the scope of IVF, embryo transfer, and stem cell research and the ethical values involved in their practice.	PO3, PSO4	U	C	5
	Enumerate the different types of the placenta and its functions in mammals.	PO1, PSO4	U	C	5
	Understand the mechanism of embryonic cell differentiation and gene action leading to differential potency of cells	PO1, PO5, PSO4	U	C	5
Total number of hours					**45**

Table 1: Tagged COs of the course C301.

Strength of Mapping of COs to POs and PSOs: If all the key elements of the addressed POs are considered concerning the CO statement, it will be challenging to determine the strength to which it is addressed. Several elaborate methods can be worked to assess the strength of mapping to PO/PSO, but implementing them across a few hundred courses can become a burden. We overcome this difficulty by quantizing the strength. The strength of mapping is defined at three levels: Level 1(Low), Level 2 (Medium), and Level 3 (Strong).

We suggest an approximate quantitative method to determine the strength to which a PO/PSO is addressed. A simple way is to relate the strength with the number of hours devoted to the COs, which address that PO.

Classroom sessions/tutorials/lab hours that address a PO/PSO	PO/PSO is addressed at level
>40 %	3
25% to 40%	2
5% to 25%	1
< 5%	0 (PO/OSO is not addressed)

The percentages indicated can be altered if all the faculty of an Institution wish to.

Computation of the mapping strength of POs for the course C301: Developmental Biology is in Table 2.

PO/ PSO	COs	Total number of Hours	Percentage Hours	Mapping Strength
PO1	CO1, CO2, CO3, CO6, CO8, CO9	5+5+5+5+5+5 = 30	66.7	3
PO3	CO3, CO4, CO5, CO6, CO7	5+4+6+5+5 = 25	55.6	3
PO5	CO2, CO5, CO9	5+6+5 = 16	35.6	2
PSO4	CO1, CO2, CO3, CO4, CO5, CO6, CO7, CO8, CO9	5+5+5+4+6+5+5+5+5=45	100	3

Table 2: CO-PO/PSO mapping strength of the course C301

The course articulation matrix is presented as in Table 3.

Course C301	PO	PSO

	1	2	3	4	5	6	1	2	3	4
CO1	3									3
CO2	3				2					3
CO3	3		3							3
CO4			3							3
CO5			3		2					3
CO6	3		3							3
CO7			2							3
CO8	3									3
CO9	3				3					3
Average	3		3		2					3

Table 3: Course articulation matrix of C301

Another method is for the faculty to determine the strength directly from the CO statements subjectively. When many faculty members participate in this exercise, it will be challenging to ensure some level of consistency. The course articulation matrix in such a case is presented in Table 4.

Course C301	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	2									3
CO2	3				3					3
CO3	3									3

CO4			2							3
CO5			1		2					3
CO6	3									3
CO7			3							3
CO8	3									3
CO9	2				2					3
Average	2.66		2.4		2.33					3

Table 4: Course articulation matrix of C301 determined by the subjective method

The Course-PO/PSO correlation can be presented in Table5 as determined from Table 3.

Course C301	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
Mapping Strength	3		3		2					3

Table 5: Course-PO/PSO correlation row

If there is no correlation between the course and a specific PO/PSO, the row's corresponding element is left blank. Such rows representing Course-PO/PSO correlation are generated for all the core courses following the procedure presented.

The projects (both mini and major) can potentially address most of the POs and PSOs. The POs/PSOs addressed will depend on activities identified and the rubrics used for evaluating the performance in those activities. Even internships, if any, can also be characterized by such rows of correlation. All these rows of correlation, representing the mapping strengths, are put together as a matrix, referred to as Program Articulation Matrix. Such a matrix will have 30 to 40 rows. Assuming a maximum number of four PSOs, an indicative program articulation matrix is shown in Table 6.

Core Activity	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
C101	3									
C102	3									
C103	2		2	2						
……										
C301	3		3		2					3
……										
C801	2	1							3	
Project	2	3	3	3	2		2	2	2	2
Internship	1	1			1		1	1	1	1

Table 6: Program articulation matrix

The program articulation matrix presents a picture of the program and how well the program's core activities address the POs and PSOs. All columns will not be populated equally. If some columns are not adequately filled, the program does not address those POs/PSOs significantly or even moderately. If PSOs are written with due care, it should not happen that any of them is addressed inadequately. Thus, the most likely scenario is that some POs are inadequately addressed (PO5 in Table 6) or not addressed at all (PO6 in Table 6) by the program. The Department should consider

- rewriting COs of some identified courses to address POs that were not adequately addressed if feasible,
- planning additional co-curricular / extra-curricular activities as core activities to address the POs that were not addressed adequately, and

- discussing with the University regarding the redesign of the curriculum to ensure that the core activities adequately address all the POs.

It should be noted that each row of the articulation matrix represents one core activity. It can be a 3 or 4 credit course, a one-credit laboratory course, a 2 or 3 credit mini-project, or a 4 to 9 credit project/internship. Irrespective of the number of credits associated with a core activity, we treat every row in the same way for subsequent computations of attainments.

3. Attainment of Course Outcomes

The attainment values of Course Outcomes can be used as a measure of the learning by the students. The teacher can respond appropriately after comparing the actual attainments with the set targets. If the targets are not met, it is possible to plan some activities that improve the quality of learning the next time the course is offered. If the targets are met, the teacher can consider revising the targets to achieve better quality. This closure of the quality loop, which is an essential requirement of accreditation, is presented in figure 2.

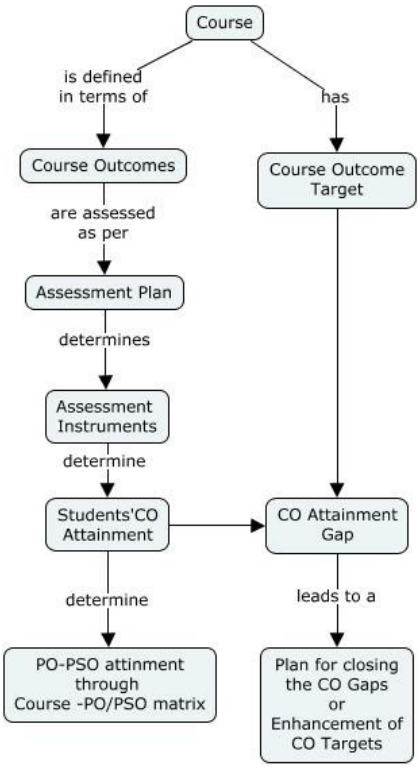


Fig. 2: The quality loop for continuous improvement of CO attainment

It should be noted that there is no unique way of measuring the attainment of Course Outcomes. It is always an issue where to draw the line concerning the details. It should be detailed enough to lead to specific actions to improve the quality of learning. It should be gross enough not to demand more types of assessments than what is typically used.

The first step in the quality process at the course level is to set targets for attainments. Some alternatives are presented in the following.

Method1: The same target is identified for all the COs of a course. For example, the target can be "the class average marks > 60 marks."

Method 2: Targets are the same for all COs and are set in terms of performance levels of different groups of students. While this method classifies students into different categories, it does not provide any specific clues to plans for improving the quality of learning.

Targets (% of students getting)			
(≤50)	**(>50 and ≤65)**	**(>65 and ≤80)**	**(>80)**
10	40	40	10

Method 3: Targets are set for each CO of a course and diverse groups of students separately.

It provides considerable details, which can lead to specific plans for improvement.

CO	Targets (% of students getting)			
	(≤50)	**(>50 and ≤65)**	**(>65 and ≤80)**	**(>80)**
CO1	10	40	40	10
CO2	20	30	40	10
CO3	20	30	40	10
CO4	30	30	30	10

CO5	20	20	50	10
CO6	10	40	50	10
CO7	20	30	40	10
CO8	20	30	40	10
CO9	30	30	30	10

Method 4: Targets are set for each CO of a course separately. It does not directly indicate the distribution of performance among the students. However, it has the advantage of finding out the difficulty of specific COs.

CO	Target (Class Average) %
CO1	65
CO2	60
CO3	70
CO4	65
CO5	70
CO6	65
CO7	60
CO8	70
CO9	70

Method 5: Three levels are chosen to quantize the targets.

Level 3: Class Average > 70%

Level 2: 50% < Class Average $\leq$70%

Level 1: Class Average $\leq$ 50%

The target is to attain Level 3

Several variations of the target setting can be further explored. The choice should be based on convenience in computing the actual attainment of COs and planning for improvements in instruction.

We propose to use **Method 4**, where targets are set for each CO of a course separately. It is easy to use. It provides information on the difficulty of attainment of targets CO-wise. Improvements also can be planned CO-wise.

Assessment Plan: The second step in the quality process is creating an Assessment Plan for the course. The common practice in India is to measure learning through summative assessment. Therefore, the assessment plan needs to be prepared as per the summative assessment structure followed by the Institute. The summative assessment instruments include Continuous Internal Evaluation (CIE, sometimes called CATs: Continuous Assessment Tests) and Semester End Examination (SEE, sometimes called FAT: Final Assessment Test). CIE: SEE weightage distribution for autonomous institutions varies from 20: 80 to 50: 50 in India. CIE consists mainly of written tests, assignments, reports, presentations, laboratory work, and viva-voce. The components of CIE vary considerably across Institutions. SEE consists mainly of written tests and laboratory tests. Most of Non-Autonomous Institutes can only plan CIE (CAT). SEE (FAT) is the responsibility of the affiliating University. The SEE for Laboratories also has an External Examiner appointed by the University in addition to an Internal Examiner appointed again by the University. This is the most common scenario for Non-Autonomous institutes.

Hence, we discuss the Assessment Plan for CIE only here. In the context of an Autonomous institute, the assessment plan refers to the marks given by the instructor and approved by the Department to each CO in assessment instruments of CIE. The BoS of a University typically divides the course content into equal (apparently) parts, requires that instruction of each part is done in the same number of classroom sessions, and expects that assessment (especially the SEE) gives equal weightage to each part of the content. While we generally agree with this approach, it isn't easy to provide the right kind of weightage to the associated COs. We suggest that the weightage assigned to COs be proportional to the number of associated classroom/laboratory sessions. For example, consider the sample course Developmental Biology systems discussed earlier. Further, assume that the CIE is to

be for 40 Marks as per the University regulations. The weightage of COs can be worked out as follows:

CO1: (5 / 45) * 40 = 4.44; CO2: (5 / 45) * 40 = 4.44; CO3: (5/45) * 40 = 4.44

CO4: (4 / 45) * 40 = 3.55; CO5: (6 / 45) * 40 = 5.33; CO6: (5/45) * 40 = 4.44

CO7: (5 / 45) * 40 = 4.44; CO8: (5 / 45) * 40 = 4.44; CO9: (5/45) * 40 = 4.44

The values may need to be rounded and adjusted to make the total as required by the University regulations. This adjustment of the weightages will be based on subjective perceptions of the instructor or group of instructors teaching that course. Thus, the final allocation of marks need not be unique! One possible result is shown in Table 7.

CO	Class Hrs	Summative Assessment CIE Marks (rounded)
CO1	5	4
CO2	5	4
CO3	5	4
CO4	4	4
CO5	6	6
CO6	5	5
CO7	5	4
CO8	5	4
CO9	5	4
Total	**45**	**40**

Table 7: Allocation of marks to COs of a course for CIE

The number of assessment instruments under CIE and the marks to be allocated to those instruments is as per the policy of the Institute subject to the regulations of the affiliating University. Some Universities may give some freedom in deciding the number and nature of assessment instruments of CIE to the Institutes/Departments/teachers, depending on the nature of their courses. Sometimes one method is followed for all the courses in a Department/Institute. Assume that CIE is to have two Tests, each for 15 marks and one Assignment of 10 marks, making up a total of 40 marks. Note that the Institute has to maintain records of marks scored by students in these assessment instruments and communicate the total CIE marks scored by students to the University. Thus the CIE plan needs to be prepared carefully to conform to the University regulations. Following the procedure described above, an assessment plan for CIE for our sample course, Developmental Biology is shown in Table 8.

CO	**CIE Marks as per the plan**	**Allocation of CIE marks**		
		A1	**Test 1**	**Test 2**
CO1	4	0	4	0
CO2	4	0	4	0
CO3	5	2	3	0
CO4	4	0	4	0
CO5	6	0	0	6
CO6	5	0	0	5
CO7	4	0	0	4
CO8	4	4	0	0
CO9	4	4	0	0
Total	**40**	**10**	**15**	**15**

Table 8: Assessment Plan for the course Developmental Biology 3: 0: 0

(Allocation marks to COs under all summative assessment instruments of CIE)

The following may be noted in creating Table 8.

- To make the allocation of marks as required by the regulations, some adjustments will be necessary. However, the assessment plan does provide a basic framework helpful for the teacher in making conscious decisions that are not arbitrary! Decisions made this way will be of good quality and the allocation of marks to the COs in the required assessment instruments of CIE tend to be more rational and easily justifiable.

- No attempt was made to divide marks into fractions accurately. Each teacher may work out these numbers differently, keeping the distribution of marks based on the time spent and the extent of the content.

- The choice of assessment instruments and weightage given to them can also differ from one course to the another based on the nature of the course and policy of the Department/ Institute while maintaining compliance with the University regulations.

- It was assumed that the COs addressed by Test 1 and Test 2 are entirely different, keeping weightage proportional to content/class sessions.

Questions in Test papers may have sub-questions and usually there are restrictions on the maximum number of sub-questions that one main question can have. Test papers may or may not have choices. When there is a choice, it must be an internal choice. In other words, the choice should always between questions or sub-questions that belong to the same CO, same cognitive level, and of the same difficulty level.

All questions (and sub-questions) need to be tagged by the CO and cognitive level. The evaluation scores are recorded for every CO

The final marks obtained by the student in a course are determined from his/her performance in CIE and SEE. As different Universities follow different ways of combining CIE and SEE scores, the final marks can be

- 0.2 x CIE Marks + 0.8 x SEE marks

- 0.3 x CIE Marks + 0.7 x SEE marks

- 0.4 x CIE Marks + 0.6 x SEE marks

or any other combination as specified by the affiliating University.

An essential requirement of assessment is the alignment of assessments with the Course Outcomes. Planning assessment for alignment requires tagging the COs with their Cognitive Levels and the Knowledge Categories, in addition to the POs and PSOs addressed, and the number of sessions associated.

It is necessary to tag all test items of all assessment instruments with cognitive levels to ensure specified alignment and to compute the attainment of course outcomes.

Attainment of COs can be measured **directly** and **indirectly.** Direct attainment of COs can be determined from the performances of students in all the relevant assessment instruments. Indirect attainment of COs (which is optional) can be determined from the course exit survey. The exit survey form should permit receiving feedback from students on all the COs. The computation of the indirect attainment of COs is based on the perceptions of students. Hence, the percentage weightage to indirect attainment can be kept at a low value, say 10%.

Direct attainment of COs is determined from the performances of students in Continuous Internal Evaluation (CIE) and Semester End Examination (SEE). The proportional weightage of CIE: SEE will be as per the academic regulations in force at the University/Institute. Direct attainment of a specific CO is determined from the performances of students to all the assessment items related to that particular CO. Hence, every assessment item needs to be tagged with the relevant CO. Also, we need data on the assessment item-wise performance of students. We chose to identify targets for attainments and actual attainments in terms of class averages.

CIE Attainments: The class averages are computed for all COs in CIE using the Assessment Plan presented in Table 8 and recorded, as indicated in Table 9. The class averages were rounded off.

CO	CIE Marks	CIE			Class Average %
		A1	Test 1	Test 2	

CO1	4	0	3.2/4	0	3.2/4=80
CO2	4	0	2.3/4	0	2.3/4=58
CO3	5	1.4/2	1.0/3	0	2.4/5=48
CO4	4	0	2.1/4	0	2.1/4=52
CO5	6	0	0	3.6/6/3	3.6/6=60
CO6	5	0	0	3.05/5	3.05/5=61
CO7	4	0	0	0	3.09/4=64
CO8	4	3.09/4	0	3.09/4	3.09/4=77
CO9	4	2.4/4	0	0	2.4/4=60
Total	**40**	**10**	**15**	**15**	

Table 9: CIE Class averages in the course Developmental Biology

SEE Attainment: With respect to SEE a Autonomous institute will have full access to the details of the marks scored by the students and thus can get CO-wise class averages to compute the total direct attainment of COs. However, the scenario would be different with respect to a Non-Autonomous institute. The University will find it difficult to communicate to the Institution the marks for each CO obtained by each student or CO class averages. They may do so if processes are set up with appropriate IT tools at the office of the Registrar (Evaluation)/Chief Controller of Examination at the University. The only option we have till then is to take the class averages of SEE also as the class averages of individual CO in SEE. Thus, if the average performance of students in SEE is 61%, we assume that the performance in each CO is also 61% as shown in Table 10.

CO	Class Average %
CO1	61

CO2	61
CO3	61
CO4	61
CO5	61
CO6	61
CO7	61
CO8	61
CO9	61

Table 10: SEE class averages in the course Developmental Biology.

Total direct CO attainments are computed by combining the CIE attainment and SEE attainment in proportion chosen by the Institute. If we take CIE: SEE weightages as 40: 60, the direct attainment of COs is computed as shown in Table 11.

CO	**CIE Class Average %**	**SEE Class Average %**	**Direct CO Attainment 0.4xCIE+0.6xSEE %**
CO1	80	61	68.6
CO2	58	61	59.8
CO3	48	61	55.8
CO4	52	61	57.4
CO5	60	61	60.6
CO6	61	61	61.0
CO7	64	61	62.2

CO8	77	61	67.4
CO9	60	61	60.6

Table 11: Total CO attainment that combines direct and indirect attainments.

Total CO attainment taking Direct Attainment as 90% and Indirect Attainment based on the end of the course surveys as 10%, is computed as indicated in Table 12.

CO	Direct Attainment	Indirect Attainment	Total Attainment 0.9xDA+0.1xIA
CO1	68.6	95	71.2
CO2	59.8	63	60.1
CO3	55.8	82	58.4
CO4	57.4	78	59.5
CO5	60.6	71	61.6
CO6	61.0	65	61.4
CO7	62.2	67	62.7
CO8	67.4	50	65.7
CO9	60.6	81	62.6

Table 12: Total CO attainment (combining direct and indirect attainments) of the course

Developmental Biology

Now we can compute the gaps in the CO attainment in comparison to the set targets as indicated in Table 13.

CO	Targets %	Total Attainment %	Attainment Gaps %
CO1	65	71.2	-6.2

CO2	60	60.1	-0.1
CO3	70	58.4	11.6
CO4	65	59.5	5.5
CO5	70	61.6	8.4
CO6	65	61.4	3.6
CO7	60	62.7	-2.7
CO8	70	65.7	4.3
CO9	70	62.6	7.4

Table 13: Attainment gaps in Course Outcomes

The National Assessment and Accreditation Council requires that the Department offering the program should demonstrate that it is putting efforts to improve the quality of learning by the students. When the attainment Gap > 0, the attainment is less than the target and hence the instructor must plan for additional/modifying instructional activities that lead to the reduction in the attainment gaps, and when the Gap < 0, the attainment is greater than or equal to the target and hence enhancement of the attainment targets may be considered. If the target is retained and not enhanced even when the attainment is greater than or equal to the target, it must be accompanied by an appropriate justification. In any case, it is not generally considered as an acceptable practice to lower the targets once they are set. Thus, initial settings of targets must be done with considerable care and after a realistic assessment of the local context.

The action plan showing the response to the computation of the attainment gaps (both positive and negative) is presented in Table 14.

CO	Targets %	Total Attainment	Attainment Gaps %	Action plan to reduce the gap	Enhancement of targets

		%			
CO1	65	71.2	-6.2		The target is enhanced to 75%
CO2	60	60.1	-0.1		The target is retained as 60% as the attainment is only marginally higher than the target.
CO3	70	58.4	11.6	Explain in detail the early developmental process with pictures, flow charts, and videos. Have more formative assessments.	
CO4	65	59.5	5.5	Introduce group activities with classroom level discussion on the development of chic extraembryonic membranes	
CO5	70	61.6	8.4	Spend more time illustrating aspects of human development using several two-minute papers and illustrations.	
CO6	65	61.4	3.6	Present additional videos of prenatal stages	
CO7	60	62.7	-2.7		The target is enhanced to 65%
CO8	70	65.7	4.3	Introduce classroom activities that make students engage with the subject matter after making the learning material available to students much prior to the classroom sessions.	

CO9	70	62.6	7.4	Organize extensive discussions on differential potency of cells.	

Table 14: An action plan for improvement in the quality of learning

Action plans need to be as specific as possible. They should avoid vague statements like "Motivate the students" or "Work harder." The action plan can also include changes in lesson plans. Additional resources (physical as well as learning resources), if required to implement the improvement plans, should also be identified. Preferably, have the action plans reviewed by peers.

4. Attainment of POs and PSOs

The attainment values of Program Outcomes and Program Specific Outcomes can be used as a measure of the learning by a batch of students over three/four years. The Department can respond appropriately after comparing the actual attainments with the targets set by the Department. If the targets are not met, it is possible to plan for some activities that improve the quality of learning of the next batch of students. If the targets are met, the Department can consider revising the targets in the quest for achieving better quality. This closure of the quality loop, an essential requirement of the accreditation, is presented in figure 3.

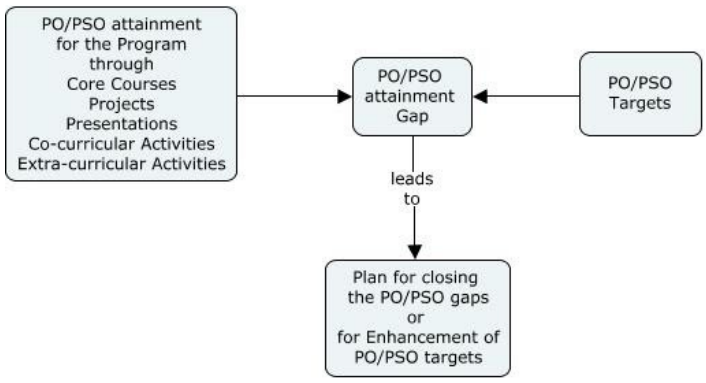


Fig. 3: Closing the quality loo around POs and PSOs

POs and PSOs are/can be addressed through:

- Core courses

- Projects
- Seminars / Presentations
- Internships
- Co-curricular and Extra-curricular Activities

All students of a batch are required to participate in an activity for its consideration for computing the attainment of POs/PSOs. For activities to be included for computing attainment, the related student performances should be measurable. Electives play an important role in providing depth and contribute to the attainment of POs/PSOs. However, they are not considered for computing the attainments of POs/PSOs as all students need not necessarily credit a course when it is an elective.

The first step in the quality process at the Program level is to set attainment targets for POs and PSOs. However, setting levels of attainment as targets will depend on the method chosen to measure the levels of attainment, as explained below:

Every CO addresses a subset of POs and PSOs, and the strengths to which they are addressed are computed based on some suitable method such as the number of class sessions. Let us consider a hypothetical course 'X' that is described in terms of its CO attainments and the addressed POs/PSOs, as shown in Table 15.

CO	Attainment Percentage	POs/PSOs addressed
CO1	71.2	PO1, PSO4
CO2	60.1	PO1, PO5, PSO4
CO3	58.4	PO1, PSO4
CO4	59.5	PO3, PSO4
CO5	61.6	PO3, PO5, PSO4

CO6	61.4	PO1, PO3, PSO4
CO7	62.7	PO3, PSO3
CO8	65.7	PO1, PSO4
CO9	62.6	PO1, PO5, PSO4

Table 15: CO attainment and the POs/PSOs addressed of course 'X'

The attainment of POs/PSOs through CO attainment of a course is computed as indicated in the following.

Attainment of PO/PSO = (Average of attainments of relevant COs) x Scale Factor

Scale Factor = (Actual Mapping Strength / Maximum Possible Mapping Strength)

= Actual Mapping Strength / 3

Attainment of POs/PSOs addressed by course X is presented in Table 16.

PO/PSO	COs	Mapping Strength	POs/PSO Attainment Percentage (Rounded)
PO1	CO1, CO2, CO3, CO6, CO8, CO9	3	(3/3) [71.2+60.1+58.3+61.4+65.7+62.6)/6] =63.2
PO3	CO4, CO5, CO7	2	(2/3) [(59.5+61.6+62.7)/3] = 40.8
PO5	CO2, CO5, CO9	3	(3/3) [(60.1+61.6+62.6)/3] = 61.4
PSO4	All nine COs	3	(3/3) [(71.2+60.1+58.4+59.5+61.6+ 61.4+62.7+65.7+62.6)/9] = 62.5

Table 16: PO/PSO attainment of course 'X.'

Attainment of POs and PSOs through course X can be represented as a row shown in Table 17.

Core Activity	PO	PSO

	1	2	3	4	5	6	1	2	3	4
Course 'X'	63.2		40.8		61.4					62.5

Table 17: PO/PSO attainment in course X

Attainment of POs and PSOs of the program are collated from the PO and PSO attainments of all core activities of the program, as in Table 18.

Core Activity	**PO**					**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
C101	55		22							
C102	62									
C103	43		48	37						
……..										
C301	47		69	69	69		58			
……..										
C801	51	31							56	
Project	46	68	70	64	45		55	55	55	55
Internship	23	15			25		16	16	16	16

Table 18: PO/PSO attainments in core activities of a program

Averages of these attainments need to be computed to obtain a single measure of attainment of each PO and PSO. There are two broad methods of computing these averages.

Method 1: Assuming no program can address all POs to the same strengths, the average is computed over all the core activities. If there are 30 core activities in the program, the attainment is computed by dividing the column sums of Table 19 by 30.

Method 2: Attainment is computed by dividing the column sums by the number of non-zero elements in the column. In this method, the absolute values are significantly inflated for several POs. However, this is acceptable as the purpose of computing PO/PSO attainments is to plan for continuous improvement.

Setting Targets: Targets for the attainment of POs need to be set depending on the method chosen for computing the average attainment of POs. As PSOs are addressed by most core activities, their targets can be set high irrespective of the method used. We will call attainments computed based on the performance of students in all core activities as Direct Attainment.

We recognize in Method 1 that all POs cannot be addressed adequately and set different targets over a much wider range. For example, setting 10% or lower for POs associated with some of the outcomes such as Ethics, Environment and Sustainability, Self-directed and Life-long learning and so on need not be considered inappropriate. A sample of targets and average attainments of POs and PSOs as per Method 1 is presented in Table 19.

Attainment	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
Target	70	50	60	60	60	10	70	70	70	70
Actual	62	34	56	48	57	8	66	59	63	65
Gap	8	16	4	12	3	2	4	11	7	5

Table 19: Direct PO/PSO attainments, targets, and attainment gaps as per Method 1

We set higher values for attainment targets when attainments are computed according to Method 2. For example, even if only one 2-credit course addresses the PO related to Ethics, and no other course addresses it, we can set a higher target. A sample of targets and average attainments of POs and PSOs as per Method 2 is presented in Table 20.

Attainment	PO						PSO			
	1	2	3	4	5	6	1	2	3	4

Target	70	50	60	60	60	60	70	70	70	70
Actual	62	44	56	51	57	53	66	59	63	65
Gap	8	6	4	9	3	7	4	11	7	5

Table 20: Direct PO/PSO attainments, targets, and attainment gaps as per Method 2

It may be noted that absolute targets are of less concern than continual improvement.

Direct and Indirect Attainment of POs and PSOs: Attainments of POs and PSOs be computed separately and then combined in some proportion to determine the total attainment of POs and PSOs. Direct attainment of POs and PSOs are presented as percentages. Attainments are calculated for all core activities, including core courses, seminars, and projects(s). Performances in co-curricular and extra-curricular activities, which are evaluated as per declared rubrics, are also treated as courses. Then, the average attainments of POs and PSOs are computed as per Method 1 or Method 2. Whatever method of computation of direct attainment of POs is used, it should be noted that if indirect attainment of COs (optional) was included, then direct attainment of PO also includes some amount of indirect computation. POs and PSOs' indirect attainments are computed based on surveys, including Graduate Exit Survey, Alumni Survey, and Employer Survey. We now combine Direct Attainment and Indirect Attainment using suitable weights, typical values being 0.8 and 0.2.

Total Attainment of POs and PSOs: 0.8 * Direct Attainment + 0.2 * Indirect Attainment

Example of PO3:

Direct attainment based on all relevant academic activities	25%
Indirect attainment based on all relevant surveys	35%
Combining them, the total attainment of PO3 for this batch of students is	(0.8 x 25) + (0.2 x 35) = 27%

We can repeat this type of calculation for all POs and PSOs.

Closing the Quality Loop at the Program Level: We close the quality loop as follows:

- If attainment < Target, then Plan improvement actions.

- If Attainment ≥ Target, then increase the target realistically. If the target is not enhanced but retained at the same level, give valid justification.

Wide choice exists for improvement plans (Semester, Course / Activity). It is possible to combine all the action plans from the courses and projects that address a particular PO/PSO and prepare an integrated plan. The Department needs to ensure that these plans are implemented for the subsequent batches of students.

Consider the example of PO10.

- Total attainment = 27
- Target = 35
- Attainment Gap = 8

Action plan improvement of PO attainment can be

- Add an extra communications lab in the fourth semester as a value-added core course.
- Introduce a seminar starting from the third semester.
- Add in the 5th Semester a 5-day workshop on communication skills.

It is worth noting that the benefit of such improvement plans may not be available to all the succeeding batches uniformly! We compute the attainments of POs and PSOs for the batch that has just graduated. The next batch would have entered the final year by this time. Thus any action plan to be implemented in lower semesters would not benefit this batch! Therefore, the current final year batch would not benefit from the first action plan listed above, i.e., "Add an extra communications lab in the fourth semester as a value-added core course." Improvement action plans must be worked out, keeping this limitation in view.

It should be noted that determining the strength to which a PO/PSO is addressed and computing the attainment are approximations at best! Even if a more precise computation of PO/PSO attainment is possible, the effort involved may not be worth it. What is essential is to follow one method across an Institute, strive for continual improvement in attainment, and demonstrate the improvements with evidence.

5.Summary

The central tenet of accreditation is to demonstrate a continual improvement in the quality of learning despite the continuously changing context (policies, funding, students, faculty, technology, and employment) taking place. NBA and NAAC require/advise that this continual improvement is achieved by closing the quality loops at the levels, of course, PO/PSO, vision/mission of the Department, and the Institute's vision/mission.

The quality loop at the course level is closed by setting targets for the attainment of COs, computing attainment of COs, and making and implementing appropriate action plans based on comparing actual attainments with the set targets. Similarly, the quality loop at PO/PSO level is closed by setting targets for the attainment of POs/PSOs, computing attainment of POs/PSOs, and making and implementing appropriate action plans based on comparing actual attainments with the set targets. There is neither a precise or unique way of computing attainments/setting targets for attainment. However, every Institute should arrive at a justifiable procedure after due deliberations with all the concerned. The closure of the quality loop at higher levels may be implemented in a similar manner. However, such quality improvement processes at higher levels often tend to be less formal because of the longer time frames involved.

While the attainment computations appear tedious, the use of some academic management system (AMS) will eliminate this tedium. Such an AMS can help create academic analytics also. Further, it can help prepare documentation as required by the NBA and NAAC.

Annexure 8

Curriculum Design of Undergraduate General Programs in India

N. J. Rao

March 2021

1. Preamble

General Programs are 3- or 4-year undergraduate programs and 2-year post-graduate programs in Sciences, Mathematics, Social Sciences, Humanities, and Arts. While most graduates of professional programs (engineering, medicine, nursing, dentistry, charted accountancy, etc.) seek professional careers, the graduates of general programs seek employment in a wide range of fields. General programs in India are to be conducted within the broad framework provided by University Grants Commission (UGC). The State level Higher Education Councils (SHEC) sometimes modify the UGC framework to meet the State's specific needs. At present, all higher education institutions are required to be accredited by National Assessment and Accreditation Council (NAAC). NAAC and UGC require that all higher education programs follow Outcome Based Education (OBE). Universities and Autonomous Institutions will design programs within the framework provided by UGC, OBE, and SHEC.

The curriculum is what we want our students to learn through the program and how you propose to facilitate this learning. The design of the curriculum for any program should answer the following questions (Tylor 1949)

- What educational purpose should the program seek to attain?
- What educational experiences can be provided that are likely to attain these purposes?
- How can these educational experiences be effectively organized?
- How can we determine whether these purposes are being attained?

This note presents the process of designing the curricula for 3-year undergraduate general programs in the framework of OBE and CBCS of UGC and accreditation by NAAC.

2. Educational Purposes: The educational purposes a general program in India seeks to attain are **Program Outcomes** as identified by the University/Autonomous Institution and **Program Specific Outcomes** chosen by the Department offering the program**.** Program Outcomes (POs) are what the students of any general undergraduate program are required to attain at the time of graduation. These relate to the knowledge, skills, and behavior the students acquire through the program. These POs are of two types: technical and generic. Many professional organizations like AAHE (American Association of Higher Education) and AACU (American Association of Colleges and Universities), and Universities worldwide have defined Program Outcomes, sometimes called Graduate Attributes. The POs suggested by all these organizations are similar. The Program Outcomes that incorporate all the desirable features of today's graduate are

1. **Critical Thinking**: Make informed decisionsafter analyzing the assumptions that frame our thinking and actions.

2. **Problem Solving**: Solve problems of relevance to society to meet the specified needs using the knowledge, skills, and attitudes acquired from humanities/sciences/ mathematics/social sciences.

3. **Effective Communication**: Speak, read, write, listen clearly in person and through electronic media in English and one Indian language.

4. **Individual and Team work**: Function effectively as an individual and as a member or leader in diverse teams of settings.

5. **Ethics**: Understand multiple value systems, including your own, the moral dimensions of your decisions, and accept responsibility for them.

6. **Environment and Sustainability**: Understand the impact of technology and business practices in societal and environmental contexts and sustainable development.

7. **Self-directed and life-long learning**: Engage in independent learning in the broadest context socio-technological changes.

8. **Computational Thinking**: Understand data-based reasoning through the translation of data into abstract concepts using computing technology-based tools.

9. **Effective Citizenship**: Participate in civic life through volunteering with empathetic social concern, understanding of equity-centered national development, and informed awareness of relevant issues.

10. **Global Perspective**: Understand the economic, social, and ecological connections that link the world's nations and people.

11. **Aesthetic Engagement**: Infer meaning and values from aesthetic engagement with artistic works that integrate intuitive dimensions with broader social, cultural, and theoretical dimensions.

An Institution may consider selecting a subset or superset of these POs and even reword the selected ones to align with its Vision. As all Indian higher education institutions are relatively new to outcome-based education, they include starting with the following six POs.

1. **Critical Thinking**: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

2. **Problem Solving**: Understand and solve problems of relevance to society to meet the specified needs using the knowledge, skills, and attitudes acquired from humanities/ sciences/mathematics/social sciences.

3. **Effective Communication**: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media, and technology.

4. **Effective Citizenship**: Demonstrate empathetic social concern and equity-centered national development and act with an informed awareness of issues and participate in civic life through volunteering.

5. **Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development.

6. **Self-directed and Life-long Learning**: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes

Program Specific Outcomes (PSOs) are statements of what the graduates of a specific general program are expected to be able to do in addition to Program Outcomes. These are two to four in number and must be arrived at by the committee specially constituted following a well-defined process.

Some sample PSOs

BA (Sociology)

1. Analyze the social structures and processes that create and interpret social relations
2. Understand the trends in tribal, rural, and urban cosmopolitan societies
3. Examine the positivist, classical, functional, conflict, interactionist, exchange, and post-modern frameworks in the context of current socio-political conditions.
4. Plan an empirical research program on a social problem/issue /situation after analyzing it using research tools and methods

BSc (Geology)

1. Understand the evolution of land and earth processes
2. Identify minerals and rocks and their mode of origin
3. Understand geologic history based on principles of stratigraphy, paleontology, and geochemistry.
4. Understand the impact of mining and geological disasters

3. Stages of Curriculum Design

The four questions presented earlier that need to be answered to design a general higher education program's curriculum are addressed through the stages, considering the NAAC framework

- Write the context of Indian Undergraduate General Programs
- Write the Department's Vision and Mission, offering the program aligned with the Institute's Vision and Mission.

- Write Program Outcomes and Program Specific Outcomes of the program.
- Sate the distribution of Credits.
- Identify the courses and their Course Outcomes to meet the stated Program Outcomes and Program Specific Outcomes.
- Define the assessment process.
- Write the course outcomes of all elective courses and outcomes of all common co-curricular and extra-curricular activities.

3.1 Context of the Indian Undergraduate General Programs

The Indian context in which general undergraduate programs need to designed and conducted may be stated as:

- Information, communication, and electronics technologies completely redefine how work is carried out and how business is organized and conducted.
- Large-scale demographic changes occur in every country, with population increases in Asian and African countries and practically zero percent growth in advanced countries.
- Global economic and political scenarios are continuously changing.
- Social and environmental scenarios change where hunger, poverty, public health, sustainability, climate change, water resources, and security constitute the significant problems facing humanity in general and particularly India at present.
- India is mainly characterized by large religious, linguistic, and cultural diversity.
- Equity, Scale, and Quality are the main issues of concern in Indian education.

3.2 Vision and Mission of the Department Offering the Program:

Vision Statement states where the faculty members 'see' their Department in the future and/or where they want it to go. **Mission** statements state what you propose to "do" to get there. These statements provide focus, flow, and a foundation for all plans and decisions. When people within an institution/Department align their efforts with an agreed-upon focus,

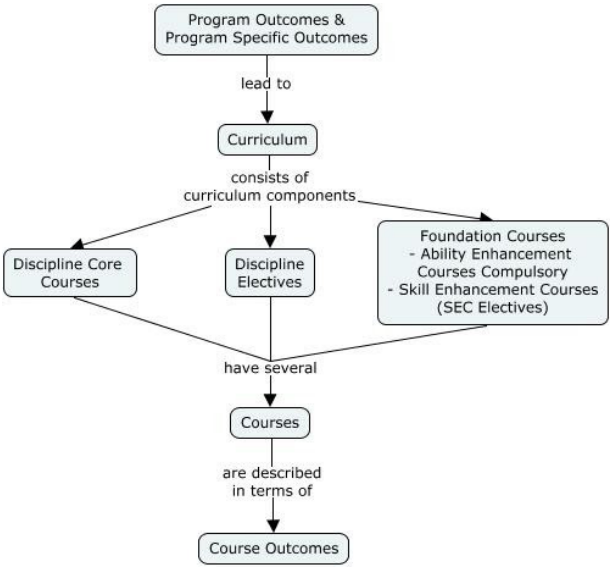
they save both time and frustration, and they make the institution/department achieve their academic objectives. These statements are to be created and periodically reviewed and modified by a committee with representatives of important stakeholders as members (Management, faculty, potential employers, and parents). The Vision statements and Mission statements should be as simple and brief as possible. It will make it easier to relate to them.

3.3 Distribution of Credits

Knowledge in all areas of Science, Social Science, and Humanities is exponentially growing. There is no way in which it is possible to include in the curriculum what is adequate by any branch or any stream in a branch. Besides, the shelf life of much of the knowledge is very limited in the current context. The knowledge of the graduating student can become outdated or even irrelevant in a short period. What can be attempted is facilitating students to learn well or learn meaningfully. Learning well is understood as acquiring knowledge and skills at higher cognitive levels, including Revised Bloom's taxonomy Apply, Analyze, Evaluate and Create. Such learning is ensured by making it heavily activity and practice-oriented rather than lecture-oriented. It is well established that for one hour of classroom interaction, the student must spend two or more hours working alone or in a group outside the classroom. It is also acknowledged that

- An undergraduate student can put in a maximum of 50-60 hours in a week, including classroom and outside classroom activities
- With the current UGC definition of credit (one hour of lecture, two hours of laboratory per week, or one hour of tutorial per week over a semester), the credit loads for an undergraduate degree program should be20-22 credits a semester.
- UGC considers all General UG programs should be offered with 120 to 140 credits for a 3-year degree and 14o-160 credits for an Honors program.
- The courses can be offered as per UGC as 5:1:0, 4:0:2, 4:0:1, 4:0:0, 3:1:0, 3:0:1, 2:0:2, 3:0:0, 2:0:0, 0:0:2, 1:0:1 and 0:0:1 (Lectures: Tutorials: Practical i.e., L:T:P).
- UGC proposes three categories of courses: Discipline Core Courses, Discipline Electives, and Foundation Courses. Foundation Courses are further sub-divided into Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC).

The process of designing the curriculum and the constituent courses is shown in the figure.



The University Grants Commission gives the credit distribution

S.No.	Courses	Credits
1	Core: 4 Courses of 6 credits each from the three disciplines chosen	72
2	Disciplines/Generic/Open Electives: 2 courses of 6 credits each from all or specified areas. Projects of 6 credits can also be offered	36
3	Foundation Core (Ability Enhancement) Courses: 2 courses of 2 credits each	4
4	Foundation Elective (Skill Enhancement) Courses: 4 Courses of 2 credits each	8
Total		120

This structure I very distant from the current practices in Kerala. The structure suggested by Prof. Vijayan's Committee of KSHEC provides a better framework. Curriculum design in the following framework is presented.

S. No.	Courses	Credits
1	Disciplinary core	40
2	Electives	40
3	Common Soft Core (Ability Enhancement and Skill Enhancement Courses) (Liberal Education)	40
Total		120

This structure provides several opportunities to students and enables them to attain the Program Outcomes better.

- The core courses (40 credits) are decided by the degree for which the students are admitted. They can be offered as 4:0:0, 3:0:0 3:1:0, 0:0:1 or 0:0:2 courses
- The student should be able to take elective courses from any discipline provided the prerequisites are met and the timetable permits. This permits the student to meet the CBCS in true spirit and get two degrees in the shortest time.
- If a student wishes to specialize in one discipline, she should be able to take all the electives (40 credits) in the core discipline leading to 80 credits in that discipline.
- While 120 credits are ideal for a three-year degree program, if an Institution feels 40 credits are inadequate for disciplinary core, the core credits can be increased by some credits, say six to nine credits.

3.4 Core Courses (40 credits)

The core courses in any discipline can be identified using the guidelines given by the UGC. The course contents indicated by the UGC can be suitably adjusted to fit into 40 credits.

3.5 Elective Courses (40 credits)

The student gets to select from a set of courses on offer from her parent Department or other Institute Departments. An elective course can be supportive of the discipline of study,

providing an expanded scope. It can also enable the student to have exposure to some other discipline or domain. It also can be a "Generic Elective" focusing on those courses which add generic proficiency to the students. It can also nurture student's proficiency/skill. It may also be 'Open Elective,' which means students from any program can credit such courses without any prerequisite requirement. The generic and open elective courses can be designed to prepare the student for life-long learning, which is a critical outcome in the present-day context, by drawing his/her attention to the vast world of knowledge within which his/her specialized field of study is situated. These courses can be from the Soft Core category, including language and communication, technology-society interaction, societal studies, culture studies, computing, etc.

Projects carrying six credits can also be considered as elective courses. Projects provide an excellent opportunity to address real-world problems. Projects can also be done by groups of students, which opens many more possibilities for both students and teachers.

3.6 Soft Core Courses (40 Credits)

The courses that can come under the category of Ability Enhancement or skill Enhancement may be organized into groups. Each group can include courses from which the student can choose some. Some groups and possible courses under these groups are listed in the following.

- Language and Communication
- Mathematics
- Computing
- Sciences
- Society and Technology
- Economics and Development
- History and Culture
- Skill Enhancement

Each category can have a weightage of six credits, while the 'skill enhancement' group can carry eight credits. Some possible candidates for the courses for each one of the categories are presented in the following. It should be remembered that all the suggested courses need to be designed to be of relevance to students of all programs, from Literature to Commerce.

1. Language and Communication (Two courses of three credits each)

- English Language
- English Literature
- Academic Writing and Presentation
- Communication Skills in Malayalam
- Malayalam Literature

2. Mathematics (Two courses of three credits each)

- Mathematical Modelling
- Elementary Statistics
- Linear Algebra
- Dynamic Systems

3. Computational Thinking (Two courses of three credits each)

- Problem Solving through Programming
- Data Processing
- Informatics
- Artificial Intelligence

4. Sciences (Two courses of three credits each)

- Physics View of the World

- Chemistry View of the World
- Biochemistry View of Life
- Plants
- Animals

5. Society and Technology (Two courses of three credits each)

- Energy and Society
- Water and Society
- Environment
- Food

6. Economics and Development (Two courses of three credits each)

- Economic Citizenship
- Indian Economics
- Development
- Organizations and Indian Constitution

7. History and Culture

- History of Kerala
- Peace and Value Education
- History of Indian Freedom Struggle
- In Search of Indianness

8. Skill Enhancement (Four Courses of two credits each)

- Art of Story Telling

- Basic Photography
- Latex
- Instrumentation (discipline-specific)
- Service-Learning Courses (hygiene, living space, water, waste management, etc.)
- Health and Hygiene
- Videography
- Programming with Python
- Programming with Java
- Programming with C
- Simulation of Systems with MATLAB
- Problem Solving with Mathematica
- Working R
- Problem Solving in Groups

4. Assessment

There is considerable evidence showing that **assessment drives student learning**. More than anything else, our assessment tools tell students what we consider to be important. They will learn what we guide them to learn through our assessments. Traditional testing methods have been limited to student learning, and equally important, of limited value for guiding student learning. These methods are often inconsistent with the increasing emphasis being placed on students' ability to think analytically, understand and communicate at both detailed and "big picture" levels, and acquire life-long skills that permit continuous adaptation to workplaces in constant flux. Moreover, because the assessment is in many respects the glue that links a course's components - its content, instructional methods, and skills development - changes in the course structure require coordinated changes in assessment.

The quality of learning in a course can be measured by the quality of assessment instruments used. Metrics to measure an assessment's quality can be defined in terms of distribution, difficulty level, and distribution of items (questions) among Revised Bloom's six cognitive levels. The nature of assessments and weightages given to sessionals and finals are mostly decided at the Institution level. However, instructors can have some freedom at the level of their courses in an autonomous institution.

Performance in each course of study is normally evaluated based on (i) continuous internal evaluation (CIE) throughout the semester and (ii) examination at the end of the semester (SEE). The assessment pattern suggested below is only a sample. The Institution / University decides the distribution of marks between Sessionals and Finals. Some possible ratios are: 50:50 or 40:60, 30:70, 20: 80. Some Institutions in India use 70 (CIE):30 (SEE).

Theory Courses (Courses with 4:0:0, 3:0:0, 2:0:0 or 3:1:0) will be assessed as per

The distribution is fixed in this sample as 50:50, whereas several other possibilities are listed earlier.

Finals (SEE): 50

Finals consist of a written examination.

Sessionals (CIE): 50

Sessionals must include two mid-semester tests, and assignments/term papers/group assignments/quizzes and/or presentations

Courses with Laboratory (Courses with 3:0:3) will be assessed as per

Finals: 50

Finals consist of a written examination and a laboratory examination assignment (35 marks for Theory and 15 marks for the Laboratory).

Sessionals: 50

Sessionals must give a weightage of 10 marks to the Laboratory and 20 marks to the theory that includes two mid-semester tests and/or assignments/term papers/group assignments/quizzes and presentations.

Similar distributions should be worked for courses with other credit distribution among Lectures, Tutorial, and Laboratories/Fieldwork. All non-written examination types of activities, including written reports, laboratory experiments, presentations, performances, and projects, will have respective rubrics designed for them.

Within this framework, an instructor may choose weightages for various activities. The assessment pattern, which includes selecting weightages for different cognitive levels for all tests and final examination decided by the faculty member, is approved at the Department level as per the pre-defined process and registered with the Controller of Examinations office. The assessment pattern should be communicated to the concerned students at the beginning of the semester.

References

1. Tylor R.W., Basic Principles of Curriculum and Instruction, The University of Chicago Press, 1949

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