

Thinking of engineering education: Program Curriculum and Teaching – Learning Processes

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Abstract – Education for engineers cannot be the transposition of academic courses as taught in institutes giving a general education. Students in engineering, throughout their scientific and humanistic studies, would be encouraged to find and develop their own way of thinking, to be creative themselves and at the same time, to understand the process of creativity. In doing this, they influence the external and internal processes and instruction that govern students behavior. During instruction, higher education faculty customarily faces matters of concern related to students' performance and conduct. Thus this article outlines program curriculum and teaching – learning processes, mechanism, curricular gaps, etc

Keywords: Program Curriculum, Teaching – Learning Processes, Engineering Education

1. INTRODUCTION

Engineering institutes can appear as a true laboratory for social and human sciences from the double point of view of research and teaching. Program curriculum and teaching – learning process can be a way to open a new field of research: the researches in social and human sciences in the Engineering institutes and draw a new cartography of knowledge, drawn by another kind of rationality, the creative rationality.

On the contrary, the education of engineers needs to be shaped in a specific pedagogical way which should characterize engineering universities. Besides, it needs to educate the students to be creative which also implies to develop pedagogical innovations, a pedagogical creativity. This aim implies to develop interdisciplinary approaches of knowledge. Program curriculum and teaching – learning processes are critical to an instructor's success in a course that seeks to help educators become reflective practitioners and academicians. Many instructors in undergraduate and graduate courses do more than teach about specific topics. While much thought is given to the contents, meaning, and philosophy of a specific course, considerably less effort may be expended to evaluate instruction and student learning during and after a course ends. This severely limits the scope of changes that can be made while the class is in progress and when planning for the next iteration of the course. It also does not help students to use methods to assess their own learning.

A particular mechanism and instruction give instructors just-in-time data to help them to understand student's immediate needs. It can also provide data for instructors /students to reflect about their beliefs, assumptions, and actions and to make their own

changes. Students do two-to three page reflections in their workplaces. A content analysis of these reflections provides individuals and teams with information that they can use to assess their own work and the work of members of their team. Students also examine their beliefs and feelings about action research and those of their peers. Redacted information is given to the team after each member of the group completes an emailed assessment (Individual Team Assessment) of his or her roles and work on the team, the quality of the collaboration, and characteristics of their work with the research site.

2. IDENTIFICATION OF EXTENT OF COMPLIANCE OF THE PROGRAM CURRICULUM

a. Curricular Aspects: The preparatory phase entire faculty members were involved in the preparation of revised outline of all courses offered to students. Numerous Seminars, Workshops and brainstorming sessions were conducted. Visits to the various autonomous institutions were organized to expose the faculty to the nitty gritty of the process and mechanism underlying the framing of syllabi. The College formulated Advisory Boards with expert members from various quarters such as industry, academia, alumni and current students in case of each and every subject. A well-defined mechanism was developed to draft new syllabi of various courses. The outline for the entire three years of graduation was drafted and circulated amongst the members. Before drafting the outline for the current University Syllabi, a model UGC

syllabi and syllabi of various National and International premier institutes were collected, compiled and compared.

- b. Curriculum Approval Process:** The purpose of the curriculum approval process is to provide a forum for discussing curriculum issues and to serve as an advisory committee to HOD regarding the coordination, improvement, updating, expansion and inactivation of the College's instructional programs and courses. The process is designed to allow effective representation and input from instructional and student services personnel while minimizing the total processing time from origination to implementation. The types of course proposals which must be reviewed by the Curriculum Committee prior to approval and action:

- Course proposal (new, modify, update upon review, inactivate, or reactivate),
- General Education Requirements Program (new or modify), and
- New Program or New Option to Existing Program (new, modify, or reactivate)

The process can also be used to initiate advice on these instructionally related issues:

- New Internal Articulation Agreements,
- Grading System,
- Student Assessment,
- Student Placement,
- Program Admission Requirements,
- Graduation Requirements,
- Counseling and Advising, and
- Internal Articulation Agreements.

Prior to going to the Curriculum Committee, proposals are vetted by HOD to ensure degree programs demonstrate appropriate length and content, including appropriate progression of courses. Development of and adjustments to the curriculum in the form of program and course offerings are driven by external factors such as changes in programmatic accreditation standards or state frameworks, local employment trends, and emergence of new occupations. Internal factors, including annual College Program Review plans and Institutional Effectiveness Assessment

plans, stimulate change and ensure compliance with the current purpose and mission of the institution. This information is shared with the local Workforce board, advisory committees, and other stakeholders to develop or change the curriculum.

- c. Mechanism used to suggest in the design and development of the curriculum:** The Philosophy of the curriculum was in tune with institutional mission statement. It was also ensured that the syllabi had contemporary contents and were in tune with the current developments in a given domain area. One of guiding principles was that the delivery of the curriculum should be in consonance with the emerging pedagogy in education. The quintessential mechanism adopted in design and development of the curriculum may be represented by the five-point agenda (as approved by the Academic Council and to be complied by all the Board of Studies):

- Defining the learning outcome: The Board of Studies were asked to articulate the clear purpose and curricular goal embodied in the curriculum, which will provide solid foundation of intended learning outcome of the graduates.
- Identify the key areas of subject content: After comparing various syllabi of the premier National and International institutions, existing University of Mumbai syllabi and model UGC curriculums, Board of Studies identified key concepts, models and principles of the subject content. The concepts were aligned to provide understanding of the topics being taught which will meet the learning outcome. Care was taken while selecting the key concepts such that the acquired knowledge should become a resource for purpose of meaningful application.
- Rational sequence: The selected key concepts were arranged in the units to form a cogent curriculum based on stated intended outcome. The key instructional method and learning task in the form of units were identified. The syllabi were arranged in the form of logical units. The units in the syllabi designed were compliant to Choice-based Credit System.
- The design of continuous monitoring and assessment and evaluation of actual outcome: The preplanned valid and reliable assessment indicators were designed to evaluate effectiveness of curriculum in fostering student's development. Suggested

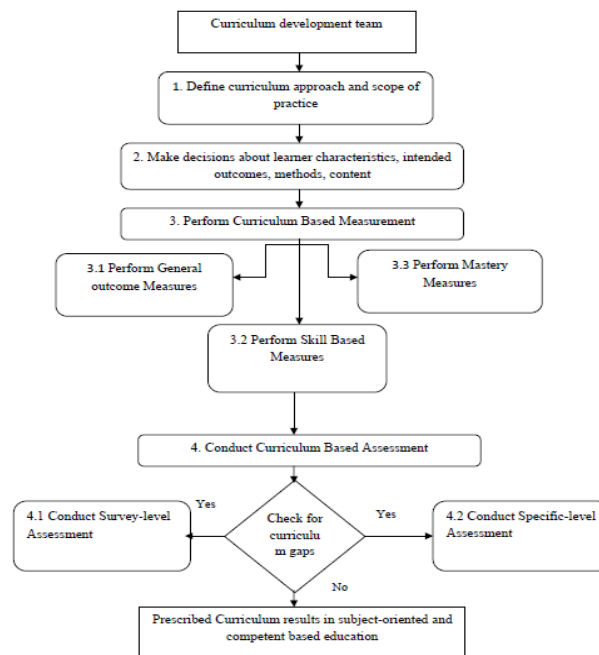
Assessment indicators were as follows: Projects, Case studies, presentations, stimulation, was asked to prepare.

- Reading and reference material: At the end of each syllabus, list of reading material was asked to be provided. The list of prescreened websites and MOOCS was also provided to help learners assimilate a desired key concept of the subject. A pack of lecture notes was asked to be prepared.
- d. **The Institute involves industry, research bodies and civil society in the curriculum design and development process:** In the composition of Board of Studies in all the subjects include the Experts from Industry, subject experts from various academic institutes including research institutes. A Board of Studies also has members each of alumni and existing faculty, students and the exiting faculty members. The industry experts bring their perspective of current needs of the industry while framing the syllabi. The researchers insist on including topics from relevant cutting-edge knowledge areas. The alumni and the current students contribute on the basis of their experience of the curriculum learnt by them. The College has immensely benefited by the involvement and contribution of various stakeholders.
- e. **Extent of compliance the Institute uses the guidelines of the regulatory bodies for developing or restructuring the curricula:** Development and restructuring of curricula always is carried out in accordance with the guidelines as set out by the University of Mumbai. The College follows Semester system with Choice Based Credit System (CBCS) based on the common structure provided by the Mumbai University. The departments design and develop curriculum through their Board of Studies and present it in the Academic Council for approval. During the curriculum design, the models of various renowned universities are referred. University guidelines regarding the duration of a programme, number of working days, teaching hours, total credits, etc. are taken into consideration while designing the curricula. Similarly, Mumbai University guidelines in respect of question paper pattern, division of units, etc. are given weightage while designing the curriculum for each programme.
- f. **Feedback from students regarding the curriculum:** The Board of studies involves two students' representatives from current year and also alumni who give their opinion about the curriculum. Their suggestions are

discussed in the meeting of the Board of studies and are accepted while revising the curriculum. Member of student's council during their interaction with the Principal and faculty members provide feedback on components and depths of the syllabus.

4. PROCESS FOR IDENTIFYING CURRICULAR GAPS:

The following flowchart shows a comprehensive approach for identifying curricular gaps;



5. PROCESSES FOLLOWED TO IMPROVE AND INNOVATION QUALITY OF TEACHING & LEARNING

a. Pedagogical initiatives:

- Effective teachers use an array of teaching strategies because there is no single, universal approach that suits all situations.
- Different strategies used in different combinations with different groupings of students will improve learning outcomes.
- Some strategies are better suited to teaching certain skills and fields of knowledge than are others.
- Some strategies are better suited to certain student backgrounds, learning styles and abilities.
- Effective pedagogy, incorporating an array of teaching strategies that support intellectual engagement, connectedness to the wider

world, supportive classroom environments, and recognition of difference, should be implemented across all key learning and subject areas.

- Effective pedagogical practice promotes the wellbeing of students, teachers and the institute community - it improves students' and teachers' confidence and contributes to their sense of purpose for being at institute; it builds community confidence in the quality of learning and teaching in the institute.

b. Process:

1. Active learning to the students: The most important value is that active learning increases students' retention and comprehension of the course material. Tasks to be accomplished become explicit. Active learning utilizes the students' data and knowledge base. Students have an opportunity to provide personal insights and interpretation (develop their own answers). The process allows students to experiment with ideas, to develop concepts, and to integrate concepts into systems.

2. Active learning to the teacher: Active learning concentrates on the teaching function. It helps the teacher select objectives at the correct level of difficulty to meet the students' needs. The teacher encourages the students to be responsible for their own learning. Active learning brings the students into the organization, thinking, and problem solving process of the discipline. Active learning also gives the teacher time to perform the helping teacher functions of coach, listener, and advocate.

c. Guidelines for active learning in the college classroom:

1. Professor is student oriented

- Course begins where the students are, not where the professor is
- Though students are expected to bring needed skills and background knowledge and to be self-motivated, the professor also accepts responsibilities for motivation, clarity, and diagnostic/supportive teaching
- Students are treated with the same dignity and respect expected by the professor

- Individual differences are expected, welcomed, and supported

2. Students participate in goal setting

- Some goals are provided by professor
- Students create or select additional goals
- Goals are individualized (different students may have different goals)

d. Guideline for incorporating critical thinking skills into expected course outcomes:

Many faculty members choose to incorporate words that reflect critical or higher order thinking into their learning outcome statements. Bloom proposed the following taxonomy of thinking skills. All levels of Bloom's taxonomy of thinking skills can be incorporated into expected learning outcome statements.

1. Remember – recalling relevant terminology, specific facts, or different procedures related to information and/or course topics. At this level, a student can remember something, but may not really understand it.
2. Understand – the ability to grasp the meaning of information (facts, definitions, concepts, etc.) that has been presented.
3. Apply – being able to use previously learned information in different situations or in problem solving.
4. Analyze – the ability to break information down into its component parts. Analysis also refers to the process of examining information in order to make conclusions regarding cause and effect, interpreting motives, making inferences, or finding evidence to support statements/arguments.
5. Evaluate – being able to judge the value of information and/or sources of information based on personal values or opinions.
6. Create – the ability to creatively or uniquely apply prior knowledge and/or skills to produce new and original thoughts, ideas, processes, etc. At this level, students are involved in creating their own thoughts and ideas.

e. Guideline for developing course-level expected course outcomes:

- Limit the course-level expected learning outcomes to 4 – 06 statements for the entire course (more detailed outcomes can be developed for individual units, assignments, chapters, etc.).
 - Focus on overarching or general knowledge and/or skills (rather than small or trivial details).
 - Focus on knowledge and skills that are central to the course topic and/or discipline.
 - Create statements that are student-centered rather than faculty.
 - Focus on the learning that results from the course rather than describing activities or lessons in the course.
 - Incorporate or reflect the institutional and departmental missions.
- f. Approach to teaching and learning:**
- Help teachers to tell students more precisely what is expected of them.
 - Help students to learn more effectively: students know where they stand and the curriculum is made more open to them.
 - Help teachers to design their materials more effectively by acting as a template for them.
 - Make it clear what students can hope to gain from following a particular course or lecture.
 - Help teachers select the appropriate teaching strategy matched to the intended learning outcome, e.g. lecture, seminar, group work, tutorial, discussion, peer group presentation or laboratory class.
 - Help teachers to tell their colleagues more precisely what a particular activity is designed to achieve.
 - Assist in setting examinations based on the materials delivered.
 - Ensure that appropriate teaching and assessment strategies are employed
- g. Bright student encouragement:**
- Students with outstanding talent who perform or show potential for performing at remarkably high levels of accomplishment when compared with others of their age require services or activities that may not be provided to the majority of their class.
- Essentially, research tells us that students who are talented are characterized by three interlocking clusters of ability, these clusters being above average ability, creativity and task commitment.
 - We identify these students by using test score nominations (standardized, formative and summative), teacher referrals, and parental request for testing.
 - Our procedure for providing for our academically talented students is to evaluate to assess the students' needs, provide a challenging and supportive learning environment, observe students responses to curriculum, consult with peers, parents/caregivers, teachers, and community, nominate and screen if appropriate, analyze information, plan appropriate to students' needs and monitor the continuous cycle.
- h. Weak student assistance policy:**
- Provide a lot of success oriented activities.
 - Start by asking question what they know and build their knowledge confidence by teaching some familiar material
 - Teach the material/topics subconsciously without them realizing they are being taught.
 - Guide these learners to contribute on the board, and it makes him/her feel good.
 - Try to relate the topic to the real life situation
 - Move around the class and speak to them for a while (Ask what he did in the school? Ask about the TV shows s/he watches? Communicate with learners)
 - Add variety of academic routine; include educational games, puzzles, and other techniques as much as possible.
 - Bring a lot of love and care.
 - Bring humor in the class to create interest (Make learning fun and comfortable. Teacher's positive attitude is very important)
 - Give extra time to ask question for weak students.

- Remedial teaching should be provided for these learners to avoid confusion and chaos in the classroom.
- Individual attention should be given, possibly

i. Quality of internal semester question papers, assignments and evaluation:

1. Initiative:

The benefits of the quality questions papers for engineering and technology can be divided into two parts; namely academic (student) and administrative (institutional). From the students prospective the type of questions paper becomes very important as the outcome of that is considered as the indicator of students learning. The Code of Ethics of Engineers, clearly clarify that engineers uphold and advance the integrity, honor and dignity of the engineering profession by:

- Using their knowledge and skill for the enhancement of human welfare;
- Being honest and impartial, and serving with fidelity the public, their employers and clients;
- Striving to increase the competence and prestige of the engineering profession; and
- Supporting the professional and technical societies of their disciplines

2. Implementation and Analysis:

- The question of which assignments and term test are best to collect depends on the purpose and focus of the individual evaluation or research project.
- For our final research question, however, we wanted to know which assignments might provide the best estimates of the quality of students' learning environments.
- To investigate this, we examined the relation between classroom observations and the different types of assignments collected from teachers (using the average of the three raters' scores). This reveals that the typical reading comprehension assignments and typical writing assignments were statistically significantly associated with the quality of observed instructional practice with regard to elements of constructivist practices.
- The typical reading comprehension assignment also was associated with the

variables measuring the quality of lesson implementation.

- The content-area writing assignment and the challenging major project assignment, in contrast, were not associated with the quality of observed instruction.
- We concluded from this analysis that every day or typical reading comprehension and writing assignments likely provide the best view on the quality of classroom practice for language arts at least.
- This seems logical as well because we had requested to see a typical lesson when we observed in classrooms.
- The rating methodology consider for grading the question are the presence or absence of the quality parameters.
- The levels of presences are graded from 0 to 3 which are qualitative measure rated as low, medium or high (LMH) category. Here, such five parameters are considered which are: innovations, creativity, theoretical, numerical, objectivities and subjective.

3. The process of an Evaluation:

It is divided into three key sections:

- Planning the evaluation:** This important initial stage involves collecting data, in a baseline study, to assess the situation before going on to develop the programme. Based on the information collected, it is then necessary to define the aims of an evaluation, and to consider the different types of evaluation methods that could be used for your evaluation.
- Choosing the evaluation methods:** Once the type of evaluation has been determined, there are different methods that can be applied to carry out an evaluation. This section describes the different study types possible, explaining the advantages and disadvantages of each type of method. It outlines the types of performance indicators that can be used to measure the success of a programme. This section also briefly describes how to conduct an economic evaluation, and provides guidance on calculating sample size.
- Dissemination and feedback:** This section describes how to feed the result of an evaluation back into the planning and

implementation stages, as well as ways that the results of an evaluation can be shared with different committees.

4. The process of innovations by the faculty in teaching and learning:

Education is a light that shows the mankind the right direction to surge. The purpose of education is not just making a student literate but adds rationale thinking, knowledge ability and self-sufficiency. When there is a willingness to change, there is hope for progress in any field. Creativity can be developed and innovation benefits both students and teachers.

a. Multimedia learning process:

Multimedia, is the combination of various digital media types such as text, images, audio and video, into an integrated multi-sensory interactive application or presentation to convey information to an audience. Traditional educational approaches have resulted in a mismatch between what is taught to the students and what the industry needs. As such, many institutions are moving towards problem based learning as a solution to producing graduates who are creative; think critically and analytically, to solve problems. We focus on using multimedia technology as an innovative teaching and learning strategy in a problem-based learning environment by giving the students a multimedia project to train them in this skill set.

Table 1: Tools and methods for innovative teaching and learning

S. No.	Tools	Methods	Metaphors
1	Ms-PowerPoint, Astound Graphics and Flash Slide Show Software	Easy to prepare and it can be prepared with many of the popular multimedia elements like graphs, sound and video.	Slide Based
2	Macromedia, Flash	Presentation is created using icons to represent different media elements and placed in a flow line.	Icon Based
3	Windows Movie Maker, Winamp, Macromedia Director	Presentation is created using moviemaking concepts of casts, sounds, pictures and scores	Movie Based
4	Adobe Acrobat Reader	Easy to prepare and with word documents if u have Acrobat	Book Based

		Reader 10 with many popular multimedia elements like graphs sound and charts	
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b. Other innovative tools

- **Mind Map:** The key notion behind mind mapping is that we learn and remember more effectively by using the full range of visual and sensory tools at our disposal. Pictures, music, color, even touch and smell play a part in our learning armory will help to recollect information for long time. The key is to build up mind maps that make the most of these things building on our own creativity, thinking and cross linking between ideas that exist in our own minds.

- **Teaching with Sense of Humor:** It is easy to create a humor in the classroom by reading books of jokes and to listen to professional comics. The students should be encouraged to take notes, especially to learn about the professionals' use of such techniques as exaggeration, pauses, and timing. Observe reality and exaggerate it - much humor lies in observations about real life and truthful situations.

- **Mnemonics Words Approach:** Here the teacher is not supposed to talk on a particular concept for a quite long time. But to make it clear to the students he can just go on saying mnemonics or its associated meaning in words. Here he goes on saying only words instead of sentence, and once they come to a basic understanding of the meaning of a particular concept then the teacher will explain in sentences.

- **Role playing and scenario analysis based teaching:** Science and engineering courses have practical but in support of those practical if students are given a scenario and other options to solve a particular issue, then the students are exposed to decision making in a given environment.

5. Attainment of program outcomes and program specific outcomes

6. ASSESSMENT TOOLS AND PROCESSES USED FOR MEASURING THE ATTAINMENT OF EACH OF THE PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

The all surveys will give broad idea about attainment of POs and PSOs by alumni while latter three will help the department to find out how students and faculty are moving towards developing those aspects in students and implement corrective measures so that attainment of POs and PSOs within 4 years of their

graduation happens. The inputs from different stakeholders are obtained in survey forms where they to give their judgment in the scale of 1 to 3 for the attainment of each of the POs and PSOs.

Table 2: The Assessment Tools and Processes

Assessment Tools	Method	Process
Alumni Survey	Indirect	Alumni Survey conducted among alumni at the end of each academic year
Employer Survey	Indirect	Employer Survey conducted among employers both as formal and informal mode of communication
Student Exit Survey	Indirect	Student Exit Survey conducted among the graduates
Project Evaluation	Direct	Project Evaluation conducted among the students towards the end of their final year
Course Evaluation	Direct	Course evaluation is collected from the faculty at the end of each semester. Modes of evaluation are End Semester Exam, Class Tests, Series Tests, Model Exams, Assignments, Attendance and Seminars.

Table 3: The frequency with which these assessment processes are carried out

Assessment Tools	Frequency	Stakeholders	Coordinating Committee
Alumni Survey	Yearly	Alumni	Department Advisory Board(DAB)
Employer survey	Yearly	Employer	
Student Exit Survey	Yearly	Graduates	
Project Evaluation	Yearly	Student	
Course Evaluation	Twice an Year	Student	

Table 4: Assessment processes are carried out with PI and expected level

Project Evaluation	Rubrics	60%
	Engineering knowledge	75%
	Problem analysis	
	Design/Development of Solutions and Investigations of complex problems	
	Ethics and Professional responsibilities	
	Individual and Team work	
	Ethics and Professional responsibilities	
	Lifelong learning	
Employer Survey	Members of Professional Societies/organizations	

1. Evaluation of each PO & PSO:

All the data files of Project Evaluation, Exit Surveys and Employer Survey are placed in Department office. Alumni Survey data is collected through Google Docs which was sent through email. Tools can be divided into two categories

- Direct Assessment and
- Indirect Assessment

The tools such as tests, assignments, examinations etc. are utilized to design the questions that relate to specific course outcomes in each course. Presentations are aimed towards wider scope of the subject including its impact on society and environment as a whole. The question/answer at the presentation make the scope even wider and relate with the course and programme outcomes and give the student a feel that things are almost never complete, thus the need for continuous independent life-long learning is emphasized. The above elements put together result in a grade in each course. The grade O,A,B,C,D,E, are pass grades, which indicate the level of attainment of the programme outcome related to that course. (Which can be vary university

to university) Thus the grades in courses along with a mapping of course outcomes and programme specific outcomes will result in a measure of the direct attainment of each programme outcome in the form of a percentage.

Another element included in the assessment of attainment of programme outcomes is the opinion of exiting graduates about the attainment of each programme outcome. This survey is taken near the end of the semester of the final year. Besides, a survey on the attainment of each programme outcome is also taken from the recent alumni, employers and performance in tests such as GATE, GRE, Government competitive exams which gives us an idea about the strength, weakness of each PO/PSOs, thus providing a basis for revision of POs/PSOs. They all contribute equally towards indirect attainment of POs/PSOs

2. Overall attainment of POs/PSOs:

Both direct and indirect assessment tools are used for evaluation of attainment of POs/PSOs. For the overall attainment, 65-70% & 30% Weightage are given to direct and indirect assessment respectively for this report.

3. Impact assessment:

This will determine whether the programme has brought about a change. The impact, or programme effect, refers to a change in the target population that has been brought about by the programme that is, a change that would not have occurred if the programme had not happened. For example, if the programme involved airing television advertisements on drinking and driving, the impact assessment might examine whether people who had seen the advertisements believe that there is a good chance that they will be stopped and breathalysed by the police if they drink and drive. Unlike a process evaluation, this would tend to take place at the end of a programme, as the focus would be on the outcome.

CONCLUSION:

In discussions of program curriculum, teaching – learning processes and the continuous use of data by instructors and their students provide a model for improving practice in a wide range of professions. Instruction of practice can become a habit that informs practice. The priorities and understanding of institute faculty members directly shape the educational experiences and success of the rapidly growing group of college students. Thus they can be developed and monitored by faculty and hold the promise of aiding teachers and students to use a metacognitive approach to their own learning. This helps both students and their instructors to understand their own actions and responses as they occur. Through a

continuous assessment process, practice can be data-driven.

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