Teaching-Learning Newsletter

Volume 01 | Issue 01 | May 2020

School of Chemical & Biotechnology

நற்றமிழ் கூறும் ஆசிரியம்

குலன்அருள் தெய்வம் கொள்கை மேன்மை
கலைபயில் தெளிவு கட்டுரை வன்மை
நிலம்மலை நிறைகோல் மலர்நிகர் மாட்சியும்
உலகியல் அறிவோடு உயர்குணம் இணைவும்
அமைபவன் நூல்உரை யாசிரின்னே

–– நன்னூல்

தெளிவுரை: நற்குடிப்பிறப்பும் அருள் உள்ளமும் இவற்றால் கிடைத்த மேன்மையும் பல நூல்களில் தேர்ந்த கல்வித்தேர்ச்சியும் மாணாக்கர்களுக்கு கற்பிக்கும் சொல்வன்மையும் அளவிட இயலாக் கல்வியறிவு, பொறுமை ,முயற்சிக்கு ஏற்ப பலன் தருதல் இவற்றில் நிலத்தைப் போன்றும் அசைக்க இயலாக் கல்வியறிவு ,கொடைத்தன்மை இவற்றில் மலையைப் போன்றும் ஐயம் நீக்குவதிலும் நடுநிலையுடன் செயல்படும் குணத்திலும் தராசு போலவும் நற்செயலுக்கு உரியவன் ஆகி,அனைவராலும் விரும்பக்கூடிய முகமலர்ச்சியில் மலரின் குணத்தை ஒத்தவராயும் உலகியல் அறிவும் உயர்ந்த குணங்கள் பிறவும் நிரம்ப உடையவன் நூலைக்கற்பிக்கும் ஆசிரியன் ஆவான். ***(Dr. Lalitha Bala, School of Education, SASTRA)***

Tamil Literature, Nannool, on Teaching: *The qualities of a good teacher include scholarliness that comes out of learning extensively from books, ability to articulate clearly to students, qualities of a land (reaping more with more efforts), mountain (strong foundational knowledge), physical balance (unbiased), flower (freshness) and the ability to learn from the world.* ***(Translation by Vigneshwar Ramakrishnan, SCBT, SASTRA)***

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Note from the Deans

Dr. K. S. Rajan, Dean, SCBT

The Knowledge Navigation era and more than exponential growth of smart devices/platforms require our breed (faculty members) to tune content creation-dissemination-assessment activities inline with the paradigm shift. We must also be mindful of heterogeneity in cognitive ability, technology awareness, interest levels and curiosity of the learners. A fixed formula of being equal to every learner might not work in a learner-centric environment. Thus, every faculty member needs to adopt suitable pedagogical tools through appropriate teaching experiments and adapt to this diversity. This newsletter is a small beginning towards documenting such experiences, both successful and otherwise, to help each other. I sincerely appreciate and congratulate the team of faculty members from SCBT, who had developed and nurtured the idea of this newsletter

Dr. K. Uma Maheswari, Dean, SASH

'*The art of teaching is the art of assisting discovery*' said Mark Van Doren, a Pulitzer prize winning poet and an inspirational thinker. Indeed, over the years, classroom teaching has witnessed a transformation from a regimental monologue of facts and information thrust upon the learners to an interactive forum that presents opportunities to the learners to discuss concepts and critically analyze the information to synthesize new knowledge. The role of the teacher has also evolved to become a facilitator who nurtures

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the creative spirit and inquisitive mind of the learners, providing them with appropriate technical inputs that steers them on a path of self-discovery and innovation. Adoption of modern pedagogical tools catering to the new generation of tech-savvy learners without compromising the joy of learning has also become a necessary art that needs to be mastered by the teaching fraternity in the current era. In this context, this teaching-learning newsletter is a laudable effort that will serve as a tool to share best practices among the teaching community. I congratulate the faculty team for this novel initiative and I am positive that this will present us all an opportunity to continuously augment our teaching skills.

Towards scholarship of teaching learning (SoTL)

What can we learn from our teaching experimentations?

What are some of the graduate qualities our students should have? What kind of strategy works best for teaching a concept? How do we bring out the latent talents of students? How do I make students interested in their course? These are some questions that we have all discussed over tea/coffee at KC, Chota and/or Canopy. Each of us has our own ways of addressing these questions and more importantly each time we address it differently! Can we learn from these experimentations that we do across the different sets of students we handle? The idea of scholarship of teaching learning (SoTL) says YES! Very simply put, SoTL is research on the teaching-learning process that we do, very similar to the 'other' kind of research that we are all normally engaged in. SoTL is about creating 'theories' of teaching & learning process and rest our teaching practices on these theories. For an idea of where we could aspire to move, do take a look at the recent post in the Stanford's *Tomorrow's Professor* mailing list titled "*How Theory, Research and Instruction come together in Active Learning*" where the author uses insights from cognitive research to tailor the instruction strategy (https://tomprof.stanford.edu/posting/1784). Another direction to look forward to move would be along the lines of the article "The Bundling Hypothesis" from a group at the Stanford University (https://aaalab.stanford.edu/papers/the_bundling_hypothesis.pdf) It is hoped that, through this newsletter – which is planned to be brought out at the end of every semester – we share our practices in teaching-learning process which will form the base on which we can develop our own theories of teaching-learning leading to the development of *scholarship of teaching-learning* (SoTL).

Some of us, who have been discussing these aspects, got together to give this idea a start, and here, we share our experiences and experimentations in our own classes, taking a step towards developing scholarship of teaching learning in our school. We hope there will be more to learn collectively in the forthcoming issues from all of you and we can move towards scholarship of teaching learning progressively.

--- Authors in this newsletter.

Enhancing classroom engagement through interventional peer learning

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Each of us has encountered students who are 'invisible' during a class—some students have neither activity nor reactivity while physically present in the classroom! Eventually, these students get into our blind spot; a convenience for the teacher as well as the student. The uncomfortable confrontation on a daily basis is avoided. Self-analysis of my attitude towards these kinds of students burdened me with guilt. Why guilt? I have been in the blind spot of my teachers during schooling, mostly because of my shyness. I always had a fear of humiliation and getting choked in the presence of a group (it happens even now!). As a school student, I wished I was able to answer or question during a class and being reciprocated with a teacher's appreciation. Now, as a teacher, I am unintentionally putting a few students in

my blind spot. Hence, I wanted to rectify my teaching attitude and reach out to shy students.

Teacher: “Dear students, please raise your right hand if you are a shy person.”

A few students raised their hands.

Student X to student Y: “Hey, you are a shy person, why didn’t you raise your hand?’

Student Y to student X: “shhhhhhh, but I am shy to raise my hand.”

The first problem is identifying the shy students. One cannot determine what is going on inside the mind of a person during the class. It takes a while to determine if a student is shy or not. Dealing with shy students is a problem less addressed for several reasons; large class size, insufficient time, inability to identify shy students and lack of reciprocation from the student.

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In general, the shy students feel uncomfortable while talking to unfamiliar people, to a group of people or people with authority. The hyper-conditioning at home, primary school or low self-esteem suppresses the students’ expressivity. Indeed, shyness could be multifactorial and beyond our capacity to deal with psychologically.

Nevertheless, we need to find a solution to encourage students whose academics are affected because of shyness. Overtly direct engagement of the shy student might be counterproductive; it is a risk of further damaging the psyche of the student. From a psychological perspective, it might not help if the instructors announced, in the classroom, the actual intent regarding the shy students. After all they are shy of being pointed out! Sometimes, tending to shy students personally arouses complicated issues. Hence, any strategy to address these students should be subtle in implementation and disguised as a general class event, just a fun activity.

I tried a method several years ago with the focus on encouraging shy students and also unmotivated students. The idea is to give them the leadership of a small team and that the whole team would reinforce

confidence and also motivation. Since then, I tend to implement this at least a few times during a semester.

There are a few hurdles to conduct such an exercise. We need a very fluid seating arrangement for students to group and discuss, as shown in figure (year 2013). I used JNC 201 and the adjacent rooms for this purpose. Slowly, I stopped using these rooms due to the intended use of the smart boards and heavy competition for the rooms. I tried to conduct this in the regular classrooms, but it was impractical (figure, year 2019). Sadly, I have abandoned this for the majority of the theory classes. Now, I limit this type of practice to the laboratory mostly because there is flexibility in seating arrangement (figure, year 2016 and 2017). I conduct these exercises during the long incubation steps in certain experiments. This approach integrates quiz activity, peer learning, group activity, leadership skills and team spirit. It is truly fulfilling as a group and also to bolden the shy students. I have been using this exercise with a success rate of 75%; to my content!

The steps, ways of conducting and the rationale of the exercises are detailed in tabular form below.

	Activity component	**Suggestions**
Step 1	MAKING THE TEAMS. Sorting of student key list based on CIA 1 (or previous SGPA) and divide the class into several groups, each comprising a mixture of students based on their academic capacities.	The academic grades may not necessarily represent the students' intelligence, but they represent the students' academic attitude. Hence, the low scoring students are generally the ones that are uninterested, shy or unmotivated. Having a balance in each of the teams is very important. Hence, the instructor should spend a lot of time, thought and discretion while making the groups.
Step 2	CHOOSING THE TEAM LEADER. The team leader is the student with the lowest score in the team. The teacher can choose to rotate the team lead position to several students if that helps (I opted for rotation-based leadership). The team leader does not have to know the answer but is the only one allowed to speak to other groups or teacher; either while answering or asking a query. The idea is that all the team members should work together and try to provide the answer to the team leader. Declare that there is no negative emotion from the teacher side and no judgement. Speak with a lot of empathy, lightness and playfulness.	Often, we are afraid to give responsibility to the least performing students. However, our goal is to raise confidence and motivation in underperforming students. In my view, this could be done by showering the responsibility of the team on the shy student. The team members should support and engage shy students. There is a negligible loss in this kind of exercise, and hence we could risk giving the leadership to the shy students. Genuine interest with an empathetic approach towards students is essential for this exercise.
Step 3	MODALITIES AND ANNOUNCEMENTS. Announce a weekly quiz. I often choose the afternoon theory classes because I guess that	Sufficient time should be given for preparation and internal organization of each team. It would also benefit the exercise if we were to

	students would not prefer to sit and listen anyway! The quiz, the theme, topic, the mode of conductance, etc. should be announced a week ahead.	remind the teams occasionally through the week leading to the date of the activity.
Step 4	CONDUCT THE QUIZ. Explain the rules of the quiz. No member of a team is allowed to speak to the instructor or other team members. The members are supposed to speak only to other members of the same team. Only the team leader is allowed to voice an answer or a query.	The teacher is the conductor of the quiz. S/He should ensure that the rules are obeyed. The types of questions asked in the first round should be of a lower cognitive level. It is to ease up any anxieties that any of the students may have. Most students would get into the sportive attitude while they answer. Gradually, the questions should involve discussion, calculation and analysis to encourage the intra-team interactions.
Step 5	PRIZE DISTRIBUTION. Distribute chocolates to the winners and runners' team. The chocolates should be handed only to the team leader who will further distribute to his/her team members. End the quiz with long applause by clapping (teacher as well as the learners).	It is essential to show appreciation for the participation of students. Just words are not enough! Some form of prizes or chocolates will help improve the engagement, tempo, fun and outcomes of the whole exercise.
Step 6	PRAISE. Genuinely praise each team leader for their efforts with a specific quality each may have exhibited. Tell the participants that you are glad about the level of participation and enthusiasm. Create positive emotions while the quiz session ends.	It will help if the team leaders are praised while in the classroom. It is essential to arouse positive emotions in each of the students by the time class ends. This is important for incremental participation in future exercises.

Inculcating self-directed learning in engineering students

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Self-directed learning is best described by Knowles (1975, p.18) as below:

> *"In its broadest meaning, self-directed learning describes a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes".*

Needless to say, for students to become life-long learners, it is imperative that they acquire the ability for self-directed learning. While projects that students do in their final semester is a way of helping students to embark on the self-directed learning mode, it is often too late in the curriculum and/or the time constraints are severe to fully groom them for self-directed learning. Therefore, the question whether self-directed learning can be

inculcated in students at a much earlier stage was looming. It is in this backdrop that I decided to try out some aspects of inculcating self-directed learning in students for the course Biologics & Biosimilars (for the Integrated M. Tech Biotechnology students in the 8th semester).

Self-directed learning has several components, or steps, as Knowles outlines:

1. Identifying and formulating what one needs to learn
2. Identifying resources for learning
3. Implementing learning strategies
4. Evaluating learning outcomes

Goal 1 was achieved through discussions. Students read up on literature/news related to biologics or biosimilars and bring it up for discussion in the class. The discussions, while acknowledging the information that the student brings to the class, will steer towards what is unknown about it (formulating what needs to be learnt). Suppose that a student reads and brings up the information that most of the biologics in market today are monoclonal antibodies. The discussions in class were steered towards questions such as:

a) Why is that most of the biologics in market are monoclonal antibodies?
b) What are the different monoclonal antibodies in the market?
c) What are the diseases against which each of them is targeted at?
d) How are they produced?
e) What is the global market for them?

The questions were listed down, and if needed, categorized. Students then found answers to these either in class (they are allowed to use laptops/mobiles for this specific purpose), or, if time does not permit, they looked up and came back prepared with answers in the next class. The same strategy repeated in every contact hour. After a few contact hours, students themselves were able to articulate questions on the information brought in by their peers and this marked step 1 in self-directed learning ("identifying and formulating what one needs to learn"). Subsequently, *through discussion*, few more questions that were identified and pursued include "Are there ways in which monoclonal antibodies are produced other than hybridoma technology?, What are the ways in which biologics other than monoclonal antibodies are produced?, What are the cell lines used? Which cell lines are better for the production of biologics?". There was also some maneuvering from my part so that we 'covered' the syllabus. The difference between a flipped classroom model and this model is that, here, students find and articulate what they want to learn. In contrast, in the flipped model, the teacher/facilitator provides the students with what they need to prepare for the class discussion.

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Students were indeed bewildered by this approach. This was probably because all through their academic life their learning has always been "guided" by a textbook or a teacher. So, there was a great apprehension in them whether they were moving in the "right" direction of learning. This apprehension was important to be sustained for them to take in-charge of their own learning and I had to be extremely careful not to reveal the maneuvering that I had to do cover the syllabus. The bewilderment rose to a peak close to the CIA because they thought I would "teach" them something close to the exams when all I did was to recollect all the discussions we had in the classes. In some sense, I thought of this approach as a failure, particularly close to the CIA exam – because students had not understood that they had taken in

charge of their learning. However, after the exam (by their own words, "after seeing the QP"), they reported that they were able to consolidate their learning! This was one instance I realized how we can use assessments *for* learning. After the CIA-1, I abandoned this approach due to practical constraints and due to the fact that some portions did require the traditional teaching. However, I intend to pursue a few questions on inculcating self-directed learning such as:

For what kind of courses would such an approach work? When would be an appropriate time in the curriculum to adopt such a strategy to inculcate self-directed learning? What kind of mindsets/abilities should we nurture before we embark on inculcating such abilities?

References:

Knowles, M. (1975). *Self-directed learning: A guide for learners and teachers.* Association Press.

Lessons I Learnt from my Learners

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Teaching is in itself a learning process wherein we gain not only a deeper understanding of the concept that we are dealing, but we also continue to learn the art of keeping majority (60-75%) of students involved in the topic. One indicator of the success of a class room session lies in our ability to induce learners to get involved, to ask questions and participate in discussions. As teachers we know that this is not an easy task there are multiple factors that contribute to the active learning. One major determinant being the group diversity of learners that we are dealing with. At times if we are lucky we have a very enthusiastic and eager group. I still remember a batch of 2nd year biotech students two years back wherein not even one class of microbiology was devoid of questions. Such batches will be a blessing for us. At other times we might have an unresponsive group which we need to keep on prodding to get the learners involved. The other important determinants are nature of subject, time of the day at which we have the class etc. Majority of us would concur with me that pre- or post-lunch sessions are typically challenging to handle. Although the above said factors have an influence on active learning, I have observed that the more we are able to relate a topic to their life situation or current social/political scenario, the better are the chances that we can have them involved. Relating a given topic to the life situations of learners can be easily done in life sciences than in other fields. Situation analysis queries like: would you chose to stay at hospital/nearby hotel to care for your infected friend is likely to get majority of learners involved. Also at times we can split learners into groups and allow them to use gadgets (mobile phones) to gather specific detailed information about a topic, discuss among the group with their views about that topic. Short exercises like this will make them realize that they tend to gain/retain knowledge better when the learners make self efforts to gather knowledge than what they hear through lectures. In subjects like immunology, we can get the learners (a small group at least) interested, once we make them realize that they are actually getting to know, how their own immune system works. Here too that ability to relate to their real life situations is the key for the learners' involvement.

Ability to relate to their real life situations is the key for the learners' involvement.

Queries like why few in the class catch infection quickly, while others are quite resilient, hygiene hypothesis and its impact on immunity, why most of us do not have allergy; how we premake antibodies to foreign agents even before we get exposed, why we fight certain agents effectively and other agents not so well are likely to induce learners to get involved. We can also conduct a debate on host evasion strategies with interesting topics like: Does the pathogen know better immunology than what we do. The simple formula is to relate the topic with them

and get them interested. Once that initial momentum is created learning will take its own course. One can also look for new ideas to implement from other resources like TeamLEAD by Duke NUS. Learners are keen to adapt techniques followed by their counterparts in premier institutes for which good feedback/reviews are available. Sending them a video link for TeamLEAD (of course it should be short) will get them interested and would inspire them to try it out. In order to get them to read the shared material, after a short gap (one day after material sharing), I posted few queries on the topic with the condition that it has to be responded within a stipulated time. This prompted them to go over the material, which helped with the success of my first ever flipped class room mode that I experimented as an instructor I personally found that learners were more willing to try out such new methodologies and in fact 80% of the class came prepared for open ended Q/A session that was similar to TeamLEAD. Correspondingly, I did observe almost the majority of the class displayed relatively better performance during their internal assessment exams (CIA) on the topic that was offered in flipped class room mode, relative to topics covered by normal mode which underscores the fact that shifting onus of learning on the learners does result in enhanced learning. Here again nature of the subject could be a major determinant of success. Before any of these techniques can work it is important that we gain the confidence of learners. A few factors that can help in this confidence (mutual trust) building measures are: our intention and the way in which we interact with them, making eye contact with all learners during class session, encouraging them to ask questions, making sure not to affect their self-esteem, providing positive criticisms to their queries and responses. Lastly it is possible that we may not know answer for some of their queries, being honest about it and making efforts to get back on those queries during subsequent class will also aid in trust building. With mutual trust and positive interaction, learning will certainly become mutually beneficial process both for instructor and learner and will become a rewarding exercise in itself.

Project-based Learning in Microbiology and Food Biotechnology

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Project-based learning is an instructional methodology that allows students to learn by engaging in a project. This instructional method was used in my courses in Microbiology and Food Biotechnology (2nd and 3rd year B. Tech. Biotechnology respectively). In contrast to conventional PBL methods where the project is specified by the instructor, I chose to allow students to define their own projects after having taken them through necessary practical and theoretical exposures (after about 70% of the syllabus is completed). The following were the educational goals that I sought to enhance in the students through PBL.

Educational goals

- Ability to observe the world around and identify questions of interest to answer
- Ability to review the existing literature
- Ability to design experiments and execute them
- Ability to critically think in analysing and interpreting results
- Ability to work in teams
- Ability to communicate effectively orally and in written mode

My observations and outcomes

Students came up with the real and challenging problems that they saw/faced every day in their life. Some examples of projects that students came up with are given below.

- Exploration of biopreservatives and other suitable methods such as edible coatings, Pulsed electric field, UV treatment to extend the shelf life of food.

- Isolation of pesticide-degrading bacteria for the reduction of the organophosphorus biomagnification pesticide in soil
- Interestingly, another team came up with the investigation of adulterant in packaged commercial milk
- Estimation of nutrients in nuts of different variety and quality
- Prevention of fungal contamination in germinated sprouts
- Another set of teams was interested in finding alternatives for synthetic dyes for food application
- Exploration of skin-associated bacteria, and its drug resistance pattern
- Isolation of biofilm-forming bacteria from used paper cups

As the topic and work plan was designed by themselves, they showed utmost eagerness to complete the task by spending time after 5 pm and on Sundays as well. The hands-on activities nurtured the students to evolve a new idea, and inculcated in them the ability to execute a work within a given period of time. The project report helped them to apply for various fellowships because it showed their independent ability to design and execute a project. Further, these activities also helped students to identify their strengths as an individual and as a team, thereby increasing their self-esteem.

Feedback from students

Apart from my own observations, I also sought the feedback of students to know and nudge reflection of their own learning. The following is a brief summary of the feedback I have received.

- First experience to perform teamwork
- Gained new and more knowledge
- A better understanding of the subject
- Interesting and fun-filled
- Though we had a difference of opinions with the allotted team, the first time we handled ourselves as a team
- Learned to execute the work plan in the give time (time management)
- Learned to prepare the project report

Exams as a testing tool: A true assessment method or a vanity exercise?

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It is that month of the semester when students are increasingly concerned about their internal assessment marks and end semester grades. The student is thinking “How do the grades affect their CGPA, their future prospects in securing a good job postgraduation etc.” Everyone is preparing to perform their very best in the last of the internal assessment exam and/or in the final exam so as to improve their overall grade. They have no choice; it is how the system is set up. However, if an informal survey is done among students about exams, most of them will be happy not to write one. My personal opinion, based on student interaction, is that most students like to have an informal sort of assessment, rather than a formal one like an exam. There are several reasons for that – phobia, always a feeling of incomplete preparation etc. But, most faculty/teachers are of the opinion that while students may not appreciate the need and efficacy of assessments/tests now, they begin to realize its importance later and hence it is essential in maintaining high standards in the subject. The key question though is: Are exams merely a tool to assess student’s performance in a subject, is it a reflection of a student’s capability, aptitude, reasoning etc., in his chosen field?

From an academic stand point, assessments, either as quizzes or exams, are meant to test student learning, determine course outcomes (CO’s) and program outcomes (PO’s). It is already built into the syllabus document in which it is clearly outlined what the student is expected to learn after completion of the course. Course and program learning outcomes are nicely written with observable words such as *know, learn, understand, and appreciate*. With the

use of the Revised Bloom's Taxonomy, these terms are now replaced with quantifiable words such as *define, explain, calculate, solve, model, critique, and design*. Every question in the assessment method is mapped to the relevant CO's and the CO's to the appropriate PO's. If the student is able to answer a question in the exam, he/she would have met the defined CO and thereby the defined PO. Student performance is then evaluated on a year on year basis, and it is expected that overall outcome of the course improve by 10-20% each year. If a greater number of students meet the defined outcomes (i.e., CO's or PO's), it is assumed that this is a reflection of good instruction and student understanding. ***Or is it?***

*I start this section again with the words "**Or is it".*** The questions that I myself have never been able to answer are:

1. Do time-based exams, particularly in engineering domain wherein scientific and critical reasoning is paramount, improve student's life-long learning – or does it simply test student's remembrance of the subject/equation at the time the test is conducted.
2. If the expectation of the course is that the student should be able to *solve* or *design* based on a set of brand new varieties of parameters (engineering problems), then can it be done in a defined time-frame.
3. If not, what is the appropriate/best testing mode to determine student's learning?

Richard Felder (of North Carolina State University Chemical Engineering Department, and an expert in teaching/learning pedagogies) opined[1,2]:

Studies that have attempted to correlate grades of graduates with subsequent career success (as measured by promotions, salary increases, and employer evaluations) have found that the correlations are negligible. No one has ever demonstrated that students who can solve a quantitative problem in 20 minutes will do any better as engineers than students who need 35 minutes. In fact, students who are careful and methodical but slow may be better engineers than students who are quick but careless.

One should understand that the CO's and PO's or the syllabus do not specify the mode of testing student learning. Several universities in the world adopt a faculty-based model wherein the faculty teaching the course decides the mode of testing (*i.e,* time-based quizzes, exams, or assignments, subject paper submission, informal class based assessments). At the start of the semester/course, the faculty informs the students of the distribution of marks across the testing modes (*e.g.,* time-based quizzes – 10%, exams – 40%, assignments – 30%, and subject paper submission – 20%). It is true that evaluating student learning for large numbers of students in professional courses/subjects like engineering disciplines is less cumbersome in an exam mode and effective (without bias). However, holistic assessment minimizes student aversion to time-based testing tools and gives importance to other learning methods such as assignments and paper submission, increases his/her understanding of the more complex topics and problems (when not curtailed in a pre-defined time frame). This is something to consider and consensus building among academicians is required.

Given that time-based exams are the norm in today's academic setting, the next question that arises is: what is considered a fair test. According to Dr. Felder[1], students consider an exam unfair when:

(1) Problems are on content not covered in lectures or homework assignments
(2) Problems the students consider tricky, with unfamiliar twists that must be worked out on the spur of the moment
(3) Excessive length, so that only the best students can finish in the allotted time

(4) Excessively harsh grading, with little distinction being made between major conceptual errors and minor calculation mistakes
(5) Inconsistent grading.

If one reads through the above list, one would agree that most faculty/teachers have given exams at least once in their lifetime which would have met the above criteria, i.e., student considering the test unfair. Usually the faculty/teacher teaching the course is considered an expert in the subject (sort of), and therefore will have fair knowledge of how to solve a given problem. Faculty's level of knowledge in the subject is due to the fact that he/she has been trained to solve such problems/concepts over several years. However, faculty in their strong urge to test student's reasoning based on concepts taught in class; often twist the question too much that renders the purpose of student learning moot.

No one has ever presented evidence that testing students on unpracticed skills teaches them anything. Moreover, engineers and scientists are never presented with brand new varieties of quantitative problems and told that they have to solve them on the spot without consulting anyone. A student's ability to solve hard puzzles quickly should not be the main determinant of whether he or she should be certified to practice engineering or science[1].

Therefore, when faculty members do that, **it becomes a vanity exercise** because they expect student to know what they know. And this is a mistake. Therefore, it is important that faculty members follow some basic rules with regard to testing students in a time-based exam. I found Dr. Felder's suggestions good and I am recreating the highlights here. For more description, one should read his papers on the same (see footnotes)[123]

1) Test on what you teach – do not overreach
2) Solve open-ended or poorly defined problems or problems that call for critical or creative thinking in class, retest them in successive homework assignments and provide constructive feedback, and then ask similar problems on tests
3) Consider handing out a study guide one to two weeks before each test
4) Minimize speed as a factor in performance on tests - Students need time to stop and think about how to solve them
    a. If your test involves quantitative problem solving, you should be able to work out the test in less than one-third of the time your students will have to do it
    b. For quantitative – based subjects, provide equations relevant to the question if possible and test conceptual ability rather than expecting complete calculation
5) Always work out a test from scratch when you have what you think is the final version, then revise it to eliminate the flaws you discover and try it again
6) Set up multiple-part problems so that the parts are independent
7) Design questions such that 10-20% of them can be used to discriminate between A-level and B-level performance – that is the good and average student.
8) It is always beneficial to be a little lenient while grading time-based exams, and particularly

[1] Richard Felder. Designing tests to maximize learning. J. Prof. Issues in Engr. Education & Practice, 128 (1), 1–3 (2002).
[2] Richard Felder and Rebecca Brent. The 10 worst teaching mistakes ii. Mistakes 1–4
[3] Richard Felder and Rebecca Brent. The 10 worst teaching mistakes i. Mistakes 5-10

harsh in homework assignment when students are more careful in checking their answers

9) Ensure that the test caters to all students and not only to the bright students
10) And always be prepared to amend the testing and instructional pattern if the performance of students is lower than expected

Examinations are a tool not only to prepare students qualify enter the community of professionals by the time they graduate, but also to improve their life-long understanding of the subject. It is therefore prudent to use these guidelines and empower students in enhancing their performance in time-based exams.

Spot the Error: Zeroing my mistakes to enable Learning!

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Background & Motivation:

I teach courses that have good amount of numerical content such as Fluid mechanics, Chemical Engineering thermodynamics, for Chemical Engineering undergraduates at SASTRA. These are foundational courses across any typical Chemical Engineering degree curriculum. These core courses have earmarked tutorial hours wherein students are expected to practice their learning from lecture hours, solve problems and thereby better learn the concepts. Often, I find a few students taking one or another form of excuse in these tutorial hours. These include, but are not restricted to, reasons such as not bringing the calculator, not bringing the graph sheets, absenting for tutorial hours, coming to tutorial class without adequate preparation. In most tutorial class, I ask students to solve the problems, clarify the doubts, give leads etc. This invariably gave me a signal that in one or the other way I am helping the students find their mistakes. Often this ended up directly helping the students and at times this was indirect, wherein I pose a few prompting questions on the solution they have arrived at and they refine it further to get appropriate solution. Coupled with this, in a bench if one person involves himself / herself actively to solve a problem, others are most often passive and get to directly note down the solution. I was not happy with this kind of tutorial engagement. I wanted my students to be enabled to know by themselves or assess themselves the solution they have found. I thought may be students (possibly because of age or because of boredom of going through the same process in almost every tutorial hour of every other course) are not finding any greater interest or zeal and hence not taking up interest to solve. Also many a times when a similar problem is also asked in examination, students have hardship in not able to recheck their answers or identify the errors they commit on answer scripts in examination hall. One reason for this lapse could be perhaps that I as their teacher did not train them to identify the mistakes from a given solution. Hence, if I wish my students to do well in their exams, then I need to train them in skill of identifying the errors from a solution.

Objective

The objective of my maiden exercise is

- To enhance the engagement of students during tutorial hours
- To increase reflection on the concepts learnt during lecture hours during problem solving

Hypothesis

As a human, we might find it easy to identify and pin point others mistakes. One will be more active to spot errors of other person and in doing so will engage deeply with the given material.

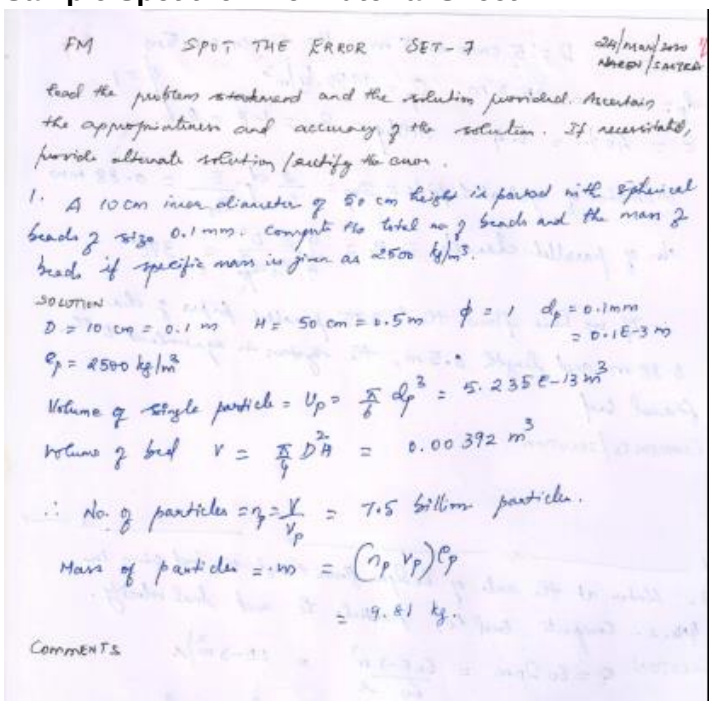
As a human, we might find it easy to identify and pin point others mistakes. One will be more active to spot errors of other person and in doing so will engage deeply with the given material.

Methodology: "Spot the Error" Tutorial Sheet

I reversed the process of tutorial class engagement. I gave tutorial sheets that contained questions and

solutions. The task for the student is to identify if the proposed solution in the tutorial sheet is acceptable. If the solution is not acceptable or found inappropriate, then the student should propose a solution or rectify the solution provided.

Sample Spot the Error Tutorial Sheet



FM SPOT THE ERROR SET-7

Read the problem statement and the solution provided. Ascertain the appropriateness and accuracy of the solution. If necessitated, provide alternate solution / rectify the error.

1. A 10 cm inner diameter of 50 cm height is packed with spherical beads of size 0.1 mm. Compute the total no of beads and the mass of beads if specific mass is given as 2500 kg/m3.

SOLUTION

D = 10 cm = 0.1 m H = 50 cm = 0.5 m ϕ = 1 d_p = 0.1 mm = 0.1E-3 m

ρ_p = 2500 kg/m3

Volume of single particle = $V_p = \frac{\pi}{6} d_p^3$ = 5.235E-13 m3

Volume of bed $V = \frac{\pi}{4} D^2 H$ = 0.00392 m3

∴ No. of particles = $n_p = \frac{V}{V_p}$ = 7.5 billion particles.

Mass of particles = $m = (n_p V_p)\rho_p$

= 9.81 kg.

COMMENTS

Expected Outcome

- To be able to spot the mistake, a student should first know the applicable theory/concept, know how to solve it themselves and then verify the appropriateness of the solution provided. Hence, increase in reflection of the learnt concept is expected among students
- Student will get trained in identifying the mistakes from a solution, eventually might not repeat this mistakes in exams.
- These tutorial sheets at the end of the exercise are given back to students. During exam preparation this can aid them to know where possibly mistakes occur and they get to cross check their own answers and possibly will help to mitigate careless mistakes

Guidelines / Tips for "Spot the Error"

- Not every solution in the "Spot the Error" tutorial sheet will necessarily be erroneous. It is to be kept random. In some sheets, all solution can be correct and in some all can be erroneous. This makes students to read through all problems and solutions with more interest. Patterning might kill the curiosity.
- Error can be conceptual error in the manner solution is provided or could also be a unit conversion error, error in numerical solving etc.
- Typically the "Spot the Error" tutorial is designed as follows
    - 30 min task for students to analyze and make comments
    - 15 min for discussion in class
- This can be done as a group or as an individual activity
- Not every tutorial class need to have this activity. We can keep this on a week after the conventional tutorial class to seek if students have indeed learnt to solve the problem
- This exercise can be done offline (through google classroom also), wherein I release the key to this sheet after about 3 or 4 days. However the flip side, is that here active participation may not be guaranteed.

Discussion

I observed a distinctive interest in students in identifying the mistake on solution. Perhaps now they are identifying not "their mistake" but "my mistake". I typically did this as a group activity, wherein student in a bench formed the team. I prepared two sets – Set A and set B and gave one set alternatively to every bench. At times, a few teams completed one set and asked for another set. One interesting observation is that a few asked to give more such spot the error exercises after CIA-1.

I also had a few who felt this was not a good way of solving problems for they did not primarily know how to solve themselves and hence find this task very tough than a conventional tutorial class.

Teaching-Learning Newsletter

Volume 01 | Issue 01 | May 2020

School of Chemical & Biotechnology

Summary

The exercise at the outset seems to be a different tutorial than a conventional tutorial and welcoming.

I conducted a blind feedback yesterday (after the online CIA) among my students, and here are a few excerpts from the students' feedback on Spot the Error tutorials'. 38 students out of 52 in B. Tech. Chemical Engineering, 4th semester responded to this feedback.

Feedback Question: Specific learning from Spot the error:

Sample Responses:

- Learnt how to solve the problem
- Learnt where one could possibly make mistake
- Learnt how to identify my mistake
- Improved me to focus on my numerical calculations

Feedback Question: Recollect one specific example that you found useful or helped them

Sample Responses:

- If I am not wrong, I think in Set 5 that flow is horizontal or vertical, Laminar or Turbulent that cleared me in understanding friction losses better.
- I learnt the difference between which diameter to use in the 4th sum of set 7
- I can recognize where I will make mistake by without reading questions properly.
- Spot the error on Bernoulli equation helped as initially I couldn't identify any mistake therefore I needed twice the concentration and attention to detail which was very useful
- From this I can calculate superficial velocity which is based on bed diameter and not based on pipe diameter
- Yes, I remember one where laminar parabolic flow profile was supposed to be verified. I understood fully developed flow concept very clearly only after I can across that question.

Feedback Question: What are the key takeaways and learnings from this spot the error tutorial in comparison with regular tutorial?

Sample Responses:

- During Revision, spot error is more time efficient than the normal tutorial when one knows the concept to solve before.
- Tutorial problems make us feel there is always a correct answer and we need to find that. But practically it is very tough for us to apply that. But from this spot the error, it proves and makes us realize not everything has defect in it. Practically this will be more useful
- This spot the error makes quick learning possible. It is interesting when compared to the regular tutorial.
- They are brain storming and challenging
- When compared to the regular tutorial, it was less time consuming and yet conceptual knowledge was necessary to solve it. Further by intentionally making a few commonly errors in a sum, it helps us to understand where we could go wrong, and thus be cautious.
- Once we solve the spot the error tutorial, I feel that it's quite impossible to forget that type of problem and it's easy to identify the same type of problem anywhere.
- The regular tutorial is just the conventional way of solving problem and essentially is plugging in the numbers to formulae but this tutorial imbibes more skills to students like attention to detail (which I personally am lackadaisical to), it helped me identify where one could go wrong while solving, it also helps us in troubleshooting the problems when we correct we don't make the same mistake again. So this is learning by failing and is very essential I strongly request this to be continued for the upcoming due courses
- By regular tutorial frankly I felt like a boring activity but it's bit interesting
- I think regular tutorials were better. Only a four or five questions from the spot the errors really provoked critical thinking. Some of the questions were spotting calculation mistakes

and wrong substitution with the correct formula type mistakes which I personally didn't find useful as they require practice rather than single examples. Some questions which were based on concept application were good. It would be better if concept oriented questions were only there because I feel that is where the more important mistakes happen and spotting those errors is more important than substitution mistakes or calculation mistakes.

Did this exercise improve my students' marks?

I did not do any quantitative analysis to arrive at concrete conclusion for the above question nor tried to map this pedagogical experiment with evaluation outcome of the student in terms of their CIA scores. I have my own apprehensions for doing this mapping. I think, not necessarily everything in learning, of learning and to do with learning is to be validated with evaluation. Learning is also experience and I am not sure how to quantify the cherishment of learning experience into numbers. This is more of a pedagogical experiment, an experience between me and my students, as we travelled together in the journey to explore fluid mechanics concepts. I enjoyed the journey. I hope my students as well enjoyed this experiment. Probably I would like to start a new experiment for a greater pleasure of learning than to put this experiment into a number game validation!

Some upcoming conferences on teaching

Many of the below conferences are either cancelled or postponed. Nevertheless, we thought we would include them here for our general information on such events.

1. Sustainable education through SOTL: Practices and Cultures; ISSOTL 2020, https://www.issotl.com/2020
2. Joint Sig1 & 4 Conference on Exploring Research Synergies to Learn from Each Other, 22 – 25 June, 2020, Spain, https://earli.org/SIG1andSIG4-Cadiz2020
3. 36th annual Distance Teaching & Learning Conference, August 4-6, 2020 in Madison, https://dtlconference.wisc.edu/
4. Educause Annual Conference, 26 – 29 October, 2020, Boston, https://events.educause.edu/annual-conference
5. Accelerate 2020, Online Learning Consortium, November 17 -20, 2020, Florida, https://onlinelearningconsortium.org/attend-2020/accelerate/

New Books/Journals

We have the following new book related to teaching learning in the reference section of our library now.

1. *Teaching Engineering* by Philip C. Wankat and Frank S. Oreovicz

Below is an excerpt from this book articulating the need to state objectives in the course plan.

"*To meet any of the objectives, students must have the opportunity to practice and receive feedback. If you want them to meet certain objectives, share these objectives with them and test for the objectives. Students will work to learn the stated objectives in the course. If objectives are not clearly stated or are unclear, they will work to learn what they think you want. Remove the mystery and tell them what you want with clear objectives.*"

SASTRA will also be very soon having subscription to the journal "***Change: The Magazine of Higher Learning***"

Journals of Interest

Below are some journals on science and engineering education relevant for us

1. **Education for Chemical Engineers**: https://www.sciencedirect.com/journal/education-for-chemical-engineers
2. **International Journal of Science Education**: https://www.tandfonline.com/toc/tsed20/current

3. **Journal of microbiology and biology education**: https://www.asmscience.org/content/journal/jmbe
4. **Biochemistry and Molecular Biology Education**: https://iubmb.onlinelibrary.wiley.com/journal/15393429

Forthcoming issues

We are yet to form an editorial team for this newsletter. If you are interested to be part of the editorial team, please do write to vignesh@scbt.sastra.edu with a copy to our Dean (ksrajan@chem.sastra.edu).

We welcome articles for this newsletter from all of you along various dimensions of the teaching-learning process. It is being planned that the newsletter will be released just before the vacation period starts every semester. A call for articles will be made once the semester begins. However, you don't really have to wait until then to plan for it!