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# New patterns in learning and teaching Mathematics and Statistics

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## **Abstract**

Undergraduate students generally seem to lack interest, motivation and enthusiasm to engage with mathematics/statistics service courses. This could be due to a variety of factors such as inadequate understanding of the courses' relevance to students' respective degree programmes/career paths, cultural/academic diversity in student backgrounds and/or pre-conceived negative notions of mathematics/statistics.

This paper will discuss strategies developed to achieve excellence in learning and teaching for mathematics/statistics service courses, which positively contributed towards enhancing student motivation, engagement and enthusiasm. Further, they kindled students' interest in mathematical/statistical applications relevant to practical situations and transformed their attitudes from lack of interest to keen interest in the subjects.

The strategies worked extremely well in seminars of about 15 students as well as lectures to large audiences of about 300 students. Another desirable outcome was their impact on boosting students' confidence to actively participate in seminar activities and contribute to discussions on problem solving that involved applying mathematical/statistical theories to practical situations. This made a positive contribution to enhancing students' academic self-efficacy and the learning climate in teaching rooms.

The author mainly used a student-centred approach to create interest in the subjects by the effective use of formative assessments endeavouring to set these using scenarios that are of students' interest. The rationale behind this was to reduce their test anxiety and improve student engagement by choosing problem-solving themes they can relate to.

The feedback on formative assessments was made interactive which enabled students to reflect on their work and develop self-evaluative skills helping them to continue improving their future work.

The author argues that the discussed approach could achieve greater student participation, promote student interaction/engagement and enhance their graduate employability profile.

### **Keywords**

Assessment, student-engagement, feedback, academic self-efficacy, learning experience.

## **1. Introduction**

Undergraduates often find mathematics/statistics courses intimidating, cumbersome and irrelevant to their degree programmes. The reasons behind these attitudes include students' negative perceptions of the subjects, unpleasant memories of their previous learning experiences and/or diversity in their academic/cultural backgrounds. They generally associate learning mathematics/statistics with variables and notations that require decoding, questions they find difficult to approach/solve, failure, poor grades, hard work without achieving much and several other associations that negatively contribute to the subjects' images.

These negative associations manifest themselves as a series of emotions such as fear, intense dislike, frustration, anger and despondency which obstruct student engagement with the subjects and impede learning (Gal & Ginsburg 1994; Kotecha, M. 2011c). "...students in the UK and India often opt for certain career paths thinking that this will help them avoid Mathematics because of their misconceptions about the subject" (Kotecha, M. 2010a)

Teaching and learning strategies designed to successfully address these areas/barriers should enhance student engagement, their enthusiasm and the learning climate in teaching rooms.

## **2. Foci**

Seminars and lectures are designed focusing on breaking the negative patterns students have developed by addressing their unpleasant associations with learning mathematics/statistics. This is done using a "multi-dimensional approach" (Kotecha, M 2011d) to address the issues that arise from students' academic/cultural diversity and making effective use of formative assessments followed by constructive feedback. The aim is to enhance the undergraduates' learning experience of mathematics/statistics.

### **3. Central points**

A considerable amount of time is spent on planning how the sessions are opened and concluded (Kotecha, M. 2011 c/e) while designing lectures/seminars. Getting the students' attention is the most central point in this approach and is addressed by kindling their interest. A variety of activities are included in seminars/lectures to liven up the sessions, enhance the learning climate, encourage student engagement and promote interaction.

#### **3.1 New patterns**

The author teaches mathematics and statistics courses to first year undergraduates on a variety of degree programs such as Government and Economics, Accounting and Finance, Management, Philosophy and Economics, Environmental Policy with Economics, Management Sciences, Geography with Economics, Human Resource Management and Employment Relations, Mathematics and Economics, Business Mathematics and Statistics and Social Policy and Economics.

Lectures as well as seminars are opened by displaying a short question/multiple choice question (MCQ) on the screen which instantly gets the students' attention and engagement. This is followed by the answer and brief explanation. Students who get this correct become receptive to the rest of the session and the others get the satisfaction of learning something new. This process is repeated half way through the lectures and at the end of each lecture which extends student interaction beyond the lecture halls. Students are put at ease by the author emphasising that the purpose of these questions is to help/support their learning which breaks the pattern of "test anxiety" (Benson 1989; Kotecha M, 2011 c) associated with students' prior learning experiences.

MCQs are carefully set on key concepts that are generally misunderstood by students. An example is as below:

Type II error, associated with hypothesis testing is committed when the researcher

- a) Rejects the null hypothesis when the alternative hypothesis is true.
- b) Rejects the null hypothesis when it is true.
- c) Fails to reject the null hypothesis when it is not true.

Seminars are generally used to provide feedback on the weekly submitted formative assignments which makes it tempting for teachers to work through detailed solutions by writing them on the white board. This works well for the minority of students who have not submitted their work for any reason. However the author argues that students with robust mathematical/statistical backgrounds could get extremely bored and dissatisfied with this approach because they do not need to go over the solutions at such a slow pace and are ready for new challenges. Further, students who have submitted their work do not usually require the full solutions even if they have weaker statistical/mathematical backgrounds. The main issue that needs to be addressed is the academic diversity of the student backgrounds. Hence, the author's devised approach makes effective use of technology to display detailed workings using PowerPoint transition/animation. This optimises the seminar time and works extremely well for the majority of students irrespective of their diverse academic backgrounds. Further, this approach offers an excellent opportunity to highlight important concepts and problem areas, point out the most recurrent students' mistakes related to the particular assignment and advise students on how to avoid such mistakes in their future work. This helps reinforce the main ideas and efficiently addresses students' queries.

The author's PowerPoint approach allows flexibility in the pace at which the solutions are displayed. Further, it creates extra time for new group work problem solving questions especially set for the seminars. The author advises students to attempt these questions in a workshop setting under the author's guidance/supervision. This enhances student interaction helping them to develop the transferable skills as well as the practical application subject specific skills of MSOR (Maths, Stats and Operational Research) graduates (QAA, 2007). This improves their employability by enhancing their graduate profile as they engage in actively contributing to discussing the suitable approach to problem solving. It helps students develop reasoning and team working skills as they work together and convince their peers of a certain approach.

Further, these problem solving questions are set around themes of students' interest which improves the learning climate in the teaching rooms, livens up the lecture/seminar rooms and have always been a huge success with the author's students (Kotecha, M 2011 b).

### **3.2 Methodology-students' feedback**

This is considered to be an integral aspect of teaching by the author who uses formal, informal, and unprompted feedback in addition to the university teaching survey feedback rather than exclusively relying upon the university teaching surveys outcomes. Further, additional feedback is obtained by the author through at least two informal, open ended questionnaires over the academic year making it optional to prevent it being perceived by students as an imposition.

The author's rationale behind this is that the responses to the university teaching evaluation surveys depend upon a variety of factors such as the topic of the week, group dynamics, other distractions at the university, teaching rooms, technology related problems encountered during the lecture/seminar and incidents contributing to how the students felt at the time they completed the surveys. This justifies the extra effort and time invested to gauge how the students viewed the author's teaching.

Students' unprompted feedback is a highly valued source to gauge students' perceptions of author's lectures and seminars because of its spontaneity (Kotecha, M. 2011e). Further, indicators such as coursework assignment standards, attendance, students' attendance of the author's office hours and responses to sought feedback are used to evaluate the impact of the strategies used.

#### **4. Outcome-students' perceptions and attitudes**

Students' responses to sought feedback show that they appreciate the opportunity to provide feedback and actively participate in the process by responding to the optional questionnaires with a high degree of cooperation (Kotecha, M. 2011b/c). They respond promptly and provide detailed feedback on all aspects of author's lectures/seminars. Further, they are put at ease by the author to make suggestions on changes that would enhance their learning experience. The author argues that it is important to follow up such comments with some action communicating the fact that students' comments are taken seriously.

The discussed approach enhanced students' perceptions of the course, seminars, lectures and the subjects. They actively engaged and participated with the seminar activities. Attendance improved and students' coursework standard/presentation improved. The author achieved almost 100 % average attendances for Fridays' 6pm sessions, generally the slots with the lowest attendance rate because of the time/day of the session, which demonstrated greater commitment on the part of the students. The students acknowledged the extra effort invested by the author in designing the lectures/seminars and felt obliged to reciprocate by displaying a responsible attitude.

## **5. Benefits**

Students begin to experience the thrill of getting questions right and are pleasantly surprised to encounter questions they enjoy working on. They show greater commitment to the course and actively engage with the seminar questions. Further, their attendance, engagement and participation in the author's lectures and seminars are enhanced. They start associating Mathematics/Statistics questions with pleasant experiences and begin to view the subjects, as well as their practical applications, enthusiastically. This positively contributes towards enhancing their confidence and academic self-efficacy. This has a significant impact on their attitudes towards the course and may enhance their academic progress. "Efficacy beliefs influence how people feel, think, motivate themselves and behave" (Bandura, A. 1993; Kotecha, M. 2011c/e). Students' comments indicate that they enjoy working on questions because they are able to relate to the scenarios. This justifies the additional time and effort spent by the author on writing such questions and contributes to enhancing the image of the subjects without trivialising them.

## **6. Issues**

In adopting this approach, the main issue is the amount of time required. The author spends a considerable amount of time preparing for lectures and seminars, sending/responding to students' e-mails (in relation to feedback) writing MCQs/short questions/seminar questions, seeking students' feedback and following up their comments/requests with appropriate action. The group work questions have to be revised and amended every year, taking into account students' academic/cultural backgrounds and other factors, which creates further work. The enhanced engagement/interaction can make the lecture halls noisy but the situation can be improved as students get used to time keeping. This is necessary for preserving the structured format of seminars/lectures, as required by the author's teaching approach, despite the fact that it requires additional planning and effort.

## **7. Conclusion and future**

The discussed teaching approach and strategies have significantly enhanced student engagement and their attitudes towards mathematics/statistics. This justifies the additional work the author's teaching approach requires.

The author continues with the approach and hopes to further expand/extend it to make it applicable to other courses in mathematics and statistics.

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