

Provided Mathematics and Engineering Formulae sheets for exams: Good or poor Approach?

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Abstract - Over a very long time the debate about using Mathematics/Engineering formulae sheet/booklet as an aid during assessments, tests and exams has become an ongoing issue and there seems to be an everlasting discussion about it. Some teachers/lecturers make memorizing formulas and fact sheets obligatory and oppose any type of "aids" in any form during tests and exams. Other colleges/university/teachers do allow for the use of only complicated expressions, formulae and equations. However, students are expected to understand these formulae and their application as well as other simple and basic formulae that may not be provided during exams. After an extensive search and consulting many Mathematics/Engineering formula booklets, one has been found that could be readily adapted for use in Engineering colleges and Universities.

I. INTRODUCTION

The memory-oriented problem sets are usually and relatively easier and may discourage learners from gaining deep understanding and having less proficiency. As the mathematics is in a large part thinking and is a key element of engineering courses, lecturers/teachers may think that it is beneficial to students to let them focus on problem solving rather than recalling and calculating. There may be a need for a good memory in other areas such as law and medicine where the nature of the work depends on a time-constrained environment. However, in Mathematics and Engineering the focus would be more on problem-solving rather than memorizing a set of formulae. On the other hand, memory-oriented teaching may not be considered as a relic of the past. In this article, an attempt was made to provide answers to the two fundamental questions in connection to examination approaches; what are the advantages of memory-oriented teaching? And what are the disadvantages of allowing aids during tests/exams?

II. DISCUSSIONS

Orlin [1] believes that formulae sheets/booklets should be allowed as they can be beneficial in application courses. So the focus can be where it should be and has concluded the following; "Many University and College Mathematics / physics / engineering instructors / lecturers

ponder the choice between "open text" exams versus "facts and formulae et" exams. Other alternatives are closed book/closed notes exams or an instructor-prepared sheet of facts and relevant formulas. There is no agreement on merit, advantages and disadvantages on each these approaches. Reh fuss¹ strongly opposes allowing students to use formula sheets while taking physics exams despite acknowledging that such use is common practice in many institutions. Cone [2] responded to Reh fuss [3] by defending the use of such sheets and outlining the benefits of a "cheat sheet". Debate over the use of a "cheat sheet" or other resources during exams is not limited to the physics and Mathematics community, but extends to the Engineering and science communities as well. Skidmore and Aagaard [4] studied the relationship between testing conditions and student test scores for students in teacher education. Two decades earlier Boniface [5] Dorsal and Cundiff [6], and Hindman [7] published papers on the use of texts and/or sheets during examinations in psychology and education. The sense of meaning is what separates memorisation from learning. When someone memorizes a fact, it's arbitrary, interchangeable and it would make no difference to him/her whether sine π , cosine π or tan π is one, zero, negative one or undefined. But when someone learns a fact, it's bound to others by a web of logic and it could be no other way. Pullen et al., [8] in their study have focused on studying the discarded formulae sheets or formulae booklets themselves. Moreover, The New York Times [9] reported an unusual museum exhibit the various ways learners had used or misused these formulae sheet at different colleges and universities. On the other hand, memorisation's defenders are right, and their argument based on saying that; it's a mistake to downplay factual knowledge, as if students could learn to think critically without any information to reason. One could argue that memorization's opponents are right too, and their point of view is based on that memorized knowledge isn't half as useful as knowledge that's understood. More valuable studies and researches have been produced by different scholars and scientists from various academic background; Lou [10], Meltzer [11], Podolefsky and Finkelstein [12].

According to some feedback from undergraduate students; many of them believe that providing formula sheets did not make it too easy. Then, there's the matter that we weren't tested on plugging into formulas- we were tested

on; the application of formulae and solving problems in real-life context. By allowing these sheets, the lectures/teachers would make students focus more on the application of Mathematics and application of physics than memorizing a bunch of formulas.

III. “An Ideal” Formulae Handbook:

After extensive research, a formulae booklet (titled Formula Handbook) has been found that, it could be readily adapted for use in Engineering colleges and universities in Libya. This booklet is non-commercial, available and accessible for all with no copyright restrictions except Share and Share Alike. It is also available as an electronic version and published under a Creative Commons Licence [13].

However, it is worth discussing this approach further and attempt to answer many questions that could be asked by managers, students and lectures. Someone may ask: Why is a formulae booklet or formulae sheets beneficial to learners in the short-term and long-term? As we all know that in the workplace, information is freely available and its use is actively encouraged to the extent that it is expected that employees will consult the relevant documentation when they are unsure about a procedure. An error made due to a faulty memory would not be accepted and when the aim is to insist that students remember formulae, this may restrict what can be asked by them. Also, providing a list of formulae for use in only one context, may lead to students losing the ability to judge which formulae would be applicable in a different context, different cases and in similar and non-similar situations.

On the other hand, a formulae booklet would have an impact on learning and teaching especially in Science and engineering faculties. If the formulae booklets are supplied, then it would be possible to ask more searching questions with regard to understanding. The Formula Handbook suggested, gives almost all the formulae used in the Engineering courses in National, European and international colleges. So the student must search for the formulae required and its precise use. They need to know what they are looking for and their algebra skills need to be good enough to manipulate the formulae given. Also, the Handbook (especially the electronic version) has links to materials available on the internet and some book references in order to aid learning. There is also an associated website (www.mathsforengineering.com) and depending on the intended use, there are more links or different links could be added.

Regarding whether the handbook would improve the achievements of students in an academic environment, one has to bear in mind that not necessarily all improvements will be reflected in the exam results.

It should allow students to improve their understanding of engineering concepts and make them able to converse more productively with other engineers. More time could be allocated to using maths to solve engineering problems and improve students' perception of the

usefulness of maths. Also, more time could be spent on numerical methods of solving problems rather than learning traditional maths. Mathcad or other computer algebra systems (CAS) are used extensively in industry but in order to use a CAS efficiently, good working knowledge of maths is required. One of the main criticisms of maths from former students is that they have never used any of the maths they learned at college in the workplace. That could be due to the lack of algebraic skills. In some establishments, it might be possible to argue that the use of the handbook would allow greater time to be spent on developing algebra skills. Where algebra skills are good, then it could be argued that the use of an incorrect formula negates any benefit that these skills might have had.

One may ask again about the impact of using the formula handbook in industry. Firstly, it would allow both employers and prospective students to know what would be taught in the associated college or university. The links provide extra materials for qualified employees to allow them to tutor trainees on what is required. As the handbook is broken up into topics, it might be helpful in industry to be able to look up the relevant formulae for the task in hand. In the electronic version, there are hyperlinks within the book that allow users to find the related mathematics. The proposed handbook has most of the formulae required for students following mathematically based courses (primarily Electrical and Mechanical Engineering) in further education colleges in Scotland. As it is on a Creative Commons licence, it can be edited to suit any course as long as attribution is given to the author [14]. An Editable Version of the booklet can be found on: <https://drive.google.com/file/d/0BxVFFxKqVrNjMWJtUGFWUEtDLWc/view?usp=sharing>.

IV. CONCLUSIONS

As a lecturer of Engineering Mathematics, I've written a set of key formulas on the exam for students to use and let students use them during exams and tests for an obvious reason. the aim of these exams and tests were to assess students' ability to solve problems rather than to examine their ability to memorise. The learning goals in my courses (Engineering Mathematics and Fundamental Engineering courses) tend to revolve around demonstrating a mix of conceptual understanding and ability to apply the right concepts and methods to solve problems. Memorization is not just a major skill I'm trying to promote or test. Moreover, we live in a modern era where most of basic human knowledge, including scientific formulas, can be looked up anywhere instantly using small devices. What the scientists and citizens of our global future will need to contribute is an ability to analyse complex situations and take the right first steps towards finding solutions. On the other hand, the challenge is to produce a comprehensive formulae sheets/formulae booklet that would be used effectively by engineering students during their exams or tests. A suitable formulae booklet is recommended to be used for engineering institutions. It is hoped that the

Formula Handbook is useful both as it is and as a framework to develop different versions and one should realise that it is a concept rather than a finished document.

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