

Implementation of Strategic Tools to Promote Student Centered Learning Activities in Engineering

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Abstract— Over the last few years the growth of mobile phones and computing power has brought tremendous changes in the teaching industry. This has both its positive edge of making the learning resources available at finger tips to anyone who needs it. However, at the same time there is a setback for the students weaker in studies who tend to use or misuse the communication technology devices and applications. Giving exercises and assignments to these kind of students was not getting the fruits or the end results. Students tend to quickly take picture snaps on WhatsApp and share the answers with others. Hence the learning potential was reduced. In order to overcome this problem and improve the quality of learning among such students it has been decided to develop a simple low cost application using Microsoft excel programming. This application will help the teaching staff generate multiple questions and answer keys on numerical problems and graphs while maintaining the same level of difficulty or challenges for the students. The deployment of such a tool to build unique assessment for the students will help improve the student's analytical abilities. This in turn will prepare the students to face the challenges of the outside world more effectively.

Keywords— *Students, Probation, Mobile data, Whatsapp, Microsoft Office Excel, Unique questions, CGPA, answer keys, generate graphs*

I. INTRODUCTION

The fast growth in the communication technology has brought a paradigm shift in way the education system is being promoted worldwide. Many tools and educational software have been developed that come with a price. Several student centered learning strategies have been proposed[1-5]. The growth in computing power of mobile devices has further widened the platform for sharing and imparting knowledge seamlessly across the globe. Technological innovations come with their own pros and cons. In olden days assignments and class exercises played a positive role in promoting the lifelong learning process. However in today's scenario the issue of plagiarism and sharing of solutions has become widespread over the mobile devices. This in turn impacts the learning potential among many students if not all. This effect is more prominent in analytical subjects that require complex calculations for engineering applications. The work done by students with good CGPA record is copied or shared by other students. Many students at probation level (having a low

CGPA) end up scoring good in assignments by having their problems solved by others or copied from others but eventually do not perform well in their final exams. This problem led to exploring of ways to curb the misuse of technology. For descriptive subjects there are software's on plagiarism such as Turnitin and new writing tools such as Revision Assistant. Turnitin help to check and maintain academic integrity and curtail or minimize the duplication of work done by others. The revision assistant helps teachers with formative writing [6-7]. However for analytical subject with numerical calculations it has been a challenging task for teachers to set multiple question and also find the keys. Errors could creep with the use of traditional scientific calculators when done manually. Niche software such as MATLAB do exist offering specific solutions to engineering problems and applications. However such software is not within easy reach of all teachers [9-10]. Though there are many free open source software available on the web not all it teaching fraternity are accustomed to it as are the simple Microsoft tools such as Excel. Hence in the present work an effort has been made to use Microsoft Office Excel as a tool to create question template and answer keys for assessment[4]. This application was chosen as it is very cost effective and widely available and within easy reaches of most of the teachers and students as well.

II. CASE STUDIES

A. A Case Study for generating multiple question in Microsoft Excel

Engineering Materials was chosen as a course where students study physical and mechanical properties of materials both in theory classes and by doing laboratory exercises. Assignments are also given to students. For our sample study we chose simple problem to find the mass of a material required based on the density values of a material. In another exercise students had to find Vickers Hardness based on unique indentation values given to them. Evaluation of stress and strain and drawing of stress strain graphs was also partially automated using Microsoft excel to help teachers with the assessment.

Below is a sample illustration of five rows created in Microsoft Excel for a problem given below:

“The density of liquid A1 is 13480. What will be the mass of a 1.15 metre column of liquid A1 in a barometer tube whose inside diameter is 5 mm ?”

From the above standard question the variables were separated from the text and entered in row number 3 as shown below in Figure 1. The teachers need to create only two rows (row 3 and row 4) maintaining a fixed difference between the upper and the lower rows. More rows with multiple values were created using the simple drag and drop function of Microsoft Excel. Samples of 40 different values were thus created but depending on need more could be created.

Volume calculations done in cell F2 using Excel functions are shown below.

$$=PI()*POWER(D2, 2)*E2/4000000$$

The mass in grams is calculated using the command below in cell G2: The value is rounded to nearest two decimals using the standard formatting options of Microsoft Excel

$$=(C2*F2)*1000$$

	A	B	C	D	E	F	G	H
1	EX-1 Q1				EX-1 Q2			
2	Q1 Key	Material	Density	Diameter (mm)	Height (m)	Volume (cu m)	Mass (grams)	Volume (Cubic mm)
3	*1	mercury	13534	5.5	1.35	3.21E-05	434.09	31847.13
4	*2	liquid A1	13480	5	1.15	2.26E-05	304.38	109259.26
5	*3	liquid A2	13426	4.5	0.95	1.51E-05	202.85	38031.32
6	*4	liquid A3	13372	4	0.75	9.42E-06	126.03	44000.00
7	*5	liquid A4	13318	3.5	0.55	5.29E-06	70.47	367521.37

Figure 1: Sample variable for Density Calculations

The question (text form) was coded in cell H2 using the CONCATENATE function command as below:

$$=CONCATENATE("The density of ",B2, " is ", C2, ". ", "What will be the mass of a ", E2, " metre column of ", B2, " in a barometer tube whose inside diameter is ", D2, " mm ?")$$

A simple drag and drop operation created all the questions required. A sample of five questions generated are illustrated in figure 2 below.

	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Exercise Question												
2	The density of mercury is 13534. What will be the mass of a 1.35 metre column of mercury in a barometer tube whose inside diameter is 5.5 mm ?												
3	The density of liquid A1 is 13480. What will be the mass of a 1.15 metre column of liquid A1 in a barometer tube whose inside diameter is 5 mm ?												
4	The density of liquid A2 is 13426. What will be the mass of a 0.95 metre column of liquid A2 in a barometer tube whose inside diameter is 4.5 mm ?												
5	The density of liquid A3 is 13372. What will be the mass of a 0.75 metre column of liquid A3 in a barometer tube whose inside diameter is 4 mm ?												
6	The density of liquid A4 is 13318. What will be the mass of a 0.55 metre column of liquid A4 in a barometer tube whose inside diameter is 3.5 mm ?												
7	The density of liquid A5 is 13264. What will be the mass of a 0.35 metre column of liquid A5 in a barometer tube whose inside diameter is 3 mm ?												

Figure 2: Table of Multiple Questions generated on Excel

The power of Microsoft Excel was fully exploited to create unique questions for each student with the use of trigonometric functions and one such case study is shown below for evaluating the Vickers Hardness number of a material. The standard question is illustrated below:

A load of 30 Kgf is applied on to a sample material. The value of the mean diagonal measured on the microscope was 325 microns. Determine the Vickers hardness value of the given material.

The standard formula for Vickers Hardness is given below:

$$HV = \frac{2P \sin\left(\frac{\alpha}{2}\right)}{D_{mean}^2}$$

As in the above case study the values are separated from the text and entered in the table below. Only two rows needs to be entered with a finite difference between the upper cell and the lower cell for each row.

The below formula entered in cell E2 is shown below

$$=2*B2*SIN((C2*PI()/2)/180)/POWER(D2/1000,2)$$

	A	B	C	D	E
	Key	Load (Kgf)	ALPHA	D (microns)	HBW
1					
2	*1	30	136	325	526.68
3	*2	40	136	335	660.95
4	*3	50	136	345	778.98
5	*4	60	136	355	882.86
6	*5	70	136	365	974.33

Figure 3: Vickers Hardness Parameter on Excel

The commands to generate the text are entered in cell F2 is shown below:

$$=CONCATENATE("A load of ",B2, "Kgf is applied on to a sample material. If the value of the mean diagonal is ", D2, " microns then determine the Vickers hardness value of the given material. ")$$

The generated questions are illustrated in the figure 4 below:

	F
1	Question
2	A load of 30Kgf is applied on to a sample material. If the value of the mean diagonal is 325 microns then determine the Vickers hardness value of the given material.
3	A load of 40Kgf is applied on to a sample material. If the value of the mean diagonal is 335 microns then determine the Vickers hardness value of the given material.
4	A load of 50Kgf is applied on to a sample material. If the value of the mean diagonal is 345 microns then determine the Vickers hardness value of the given material.
5	A load of 60Kgf is applied on to a sample material. If the value of the mean diagonal is 355 microns then determine the Vickers hardness value of the given material.
6	A load of 70Kgf is applied on to a sample material. If the value of the mean diagonal is 365 microns then determine the Vickers hardness value of the given material.

Figure 4: Questions generated for Vickers Hardness

B. A Case Study for generating Experimental Stress-Strain Data and Graphs

Below is a sample stress-strain graph generated for the laboratory exercise on Tensile testing of a non-ferrous material. Here the students were given a demonstration on how the experiment is conducted. In addition to the demonstration students were given hypothetical values and were asked to estimate the stress-strain value and plot the same manually.

The standard question is given and the values generated using excel and shown below:

“A tension test was performed on a specimen having an original diameter of 12.5 mm and a gauge length of 50 mm. Using the data listed in the table, plot the stress-strain curve”. The data hypothetically created is listed in figure 5:

	A	B	C	D	E	F	G	H
3		Diameter =	12.5	mm				
4		Area =	122.71846	mm ²				
5		Gauge Length =	50	mm				
6								
7		Load kN	Elongation (mm)	Area (sq mm)	Gauge Length mm	Strain	Stress (MPa)	
8		0	0	122.72	50	0	0	
9		11.1	0.0175	122.72	50	0.00035	90.45	
10		31.9	0.06	122.72	50	0.0012	259.94	
11		37.8	0.102	122.72	50	0.00204	308.02	
12		40.9	0.165	122.72	50	0.0033	333.28	
13		43.6	0.249	122.72	50	0.00498	355.28	
14		53.4	1.016	122.72	50	0.02032	435.14	
15		62.3	3.048	122.72	50	0.06096	507.66	
16		64.5	6.35	122.72	50	0.127	525.59	
17		62.3	8.89	122.72	50	0.1778	507.66	
18		58.8	11.938	122.72	50	0.23876	479.14	
19								

Figure 5: Tensile Stress-Strain data

The stress-strain curve generated is shown below:

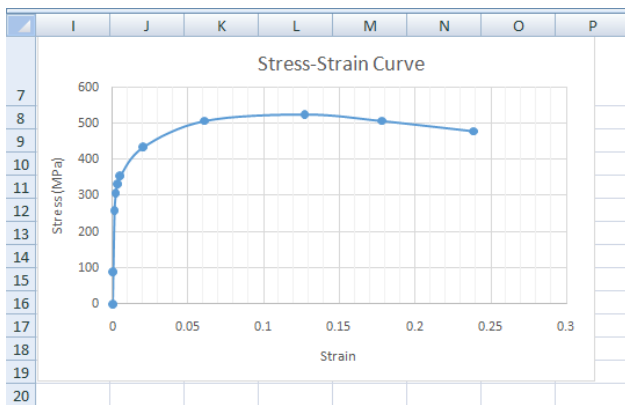


Figure 6: Tensile stress-strain curve

C. Generating the final questions on Microsoft Word Document

In this step the excel sheet created in the above case studies can be used as input database or recipient to generate multiple question papers. The “Insert Merge Field” option of “MAIL MERGE” allows in strategically placing the questions on the Microsoft document where needed and building as many unique copies of question papers as needed [5].

The advantage of using Mail Merge is to have documents with identical layout, formatting text, and graphics. Only specific sections of each document vary based on the columns selected in the Excel. More details on how Mail Merge works are provided in the reference [6].

III. RESULTS AND DISCUSSIONS

The use of Microsoft Office tools such as Excel and Word helped in generating multiple assignments and lab quiz for students. These options are simple and easy to use by teachers without having the need to develop or deploy other third party software’s to support building of such unique question papers.

The use of such a strategy of hypothetically generating the questions and numerical data using the simpler Microsoft Office tools reduced the chances of plagiarism and copying significantly. Each and every student of the class had a unique question paper and had to put in effort to do his own calculations. Students with low CGPA instead of copying down the answers started asking the teacher and their peers on

the methods to solve the problem. This greatly increased the opportunity for learning and doing the numerical calculations on their own. An opportunity was thus provided where students learning potential can be significantly increased.

Multiple sets of load elongation data created by varying the length and the cross sectional area of the specimen while keeping stress and strain constant. This helps the students in the laboratory to do their own calculations and analysis of the results instead of reproducing the values and inferences obtained by others. All students arrive at the same value of stress and strain and makes the task of teacher much easier. In giving multiple assignments also the students had to put their own individual efforts and the use or misuse of communication applications such as Whatsapp was significantly reduced or eliminated altogether for analytical and numerical problems.

Below are the list of command in Excel shown in figure 7 that can be deployed for creating and generating multiple questions and answer keys in other fields of engineering as well [4].

S. No.	Mathematical Functions	EXCEL COMMAND
1	Merge variable (numerical) and text	CONCATENATE("text within quotes", CellNumber,)
2	Number raised to a power of n	x^n POWER(CellNumber, n)
3	CONVERT DEGREE TO RADIANS	CellNumber*(PI()/180) <<no arguments for pi Or RADIAN(Cell number)
4	SINE of angle (in radians)	SIN() << within brackets enter cell number or value from 3 above
5	COSINE of angle (in radians)	COS()
6	TANGENT of angle (in radians)	TAN()
7	INVERSE FUNCTION \sin^{-1} (CellNumber)	ASIN()
8	INVERSE FUNCTION \cos^{-1} (CellNumber)	ACOS()
9	INVERSE FUNCTION \tan^{-1} (CellNumber)	ATAN()
10	ABSOLUTE VALUE OF NUMBER	ABS() <<returns positive value of number

Figure 7: List of Excel Commands for Engineering courses

Students especially those had a poor CGPA who normally complete a given task for example measuring density in the laboratory who used to take one hour now spent increased time in the laboratory as each and every student had to learn to do the calculations independently. The teachers are now equipped with a very simple but powerful tool to provide multiple unique tasks to students and also asses the same with ease. The burden of manually typing multiple questions and calculating the answers several times even with a calculator was significantly cut down.

IV. CONCLUSIONS

The strategic deployment of Microsoft office tools greatly benefitted both the teachers and students in promoting active learning environment inside and outside the classrooms. It significantly curtailed the use and misuse of communication applications such as Whatsapp and Instagram. As this software is economical and easily available it can be readily deployed for all other courses in Engineering that require numerical calculations and analysis.

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