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A Multimedia Solution Approach to the Social-learning Problem - A case study of thermodynamics

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Abstract : Engineering student's absence during the first week of opening of the semester is almost an inevitable social problem. A quasi-experimental study on III semester mechanical-engineering students with a convenient sampling size for the course BTD basic Thermodynamics of VTU is conducted. The objective of the case study is to analyse and evaluate the effectiveness of the multimedia solution approach in solving the social-learning problem. Those who were absent (15) and present (17) are classified under treatment and control group respectively. Control group were taught conventionally and the experimental group were given the content "Basic fundamental concepts" exclusively designed and developed for the case study purpose. A post-test was administered both for the control group and the experimental group. Descriptive statistic (mean, %, sd) and inferential statistic (t-test) is used to analyse the effectiveness of the developed content.

The descriptive data analysis (acceptance level 2.1 & 2.3) showed that the developed content was fairly accepted by the experimental group also thought that the contents ware useful (usefulness perception level 2.5 & 2.8) for their course understanding. Multimedia contents in their view helped them in solving the social-learning problem of ―course beginning absenteeism‖. It is interesting to note that the students had a marginal preference to custom built multimedia contents over the open source contents. The t-test reveals that there is no significant different in the post test mean score between treatment group (m = 8) and the control group (m = 12).

Keywords : ultimedia, Thermodynamics, Social learning, MOOCs, h-LMS hybrid- Learning Management system, LMS

1. Introduction

Higher education in general and the STEM subjects in particular is prone to learning difficulties. Criticism of prevailing teaching learning process is perpetuating deep both across the globe and at home. There is no dearth of evidence to prove the difficulties associated with the teaching – learning processes in many engineering subjects including thermodynamics. As thermodynamics is a basic science that deals with abstract concepts of Heat & Work and those properties of substance that hold a relation to Heat and Work, almost all the stakeholders namely students, teachers and the Institutional academic administrators think that thermodynamics subject is not only difficult but horrible.

As per University regulations in India a student is mandated to attend a minimum of 75% of stipulated classes in every subject. Thus, it provides license for abstaining to a maximum of 25% of classes in every

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semester. There is common tendency of the students in late reporting to college which is sometimes misused. This results in lack of vital input about the fundamental concepts of every subject. The deficiency results in poor performance in most of the abstract subjects like thermodynamics. Hence it is considered as a social learning problem.

The literature in technical education and educational psychology has mentioned methods that have been shown to facilitate learning more effectively than the traditional lecturing approach. The literature is full of articles by researchers who have tried new methods and written about the results. There are ample research evidences [1] [2] [3] to claim that thermodynamics is one of the difficult subjects to teach as well to learn. Though there are good number of research contributions in analyzing different reasons , different views of analysis and different possible solution approaches [4] [5], learning difficulties in thermodynamics is still a concern at large [6]. Unfortunately, these developments so far had relatively little impact on engineering education in India. Although their content has changed in some ways and the students are exposed to different ICT enabled learning methods, good number of multimedia contents is developed for thermodynamics; many engineering classes in 2019 are taught in exactly the same way that engineering classes in 1980s were taught.

2. Solution Approahes In Basic Thermodynamics

A good number of fruitful TEL attempts have been made since 60s in analyzing the cause and claimed learning gains in thermal related topics using different learning strategies. Scenario approach[7], Video based learning [8], ICT-based interactive learning system[9] , Online homework system[10], Day to day events based learning approach[11], [12], simulation approach[13] [14], CBI based learning systems[15] , Project based design-driven approach [16], Fallacy approach[17], Video game based learning[18], bilingual learning [19] and many more. Some thermal and related learning systems also have been developed like Thermo CD [20], Cycle Pad [21], Australian award-winning power plant website [22], eBook [23] etc.

In spite of emergence of online learning systems, number of IT based models in thermodynamics and their reported success in enhancing the learning gain and some limited efforts in developing a blended learning environment, the effective and efficient precipitation of multimedia learning solutions in thermal learning systems is not encouraging. It is especially true in the traditional teacher centric time table driven university affiliated technical institutions in the developing countries where the teacher's role is pivotal. Specific to India no such work is evident for the Engineering basic thermodynamics course.

At large there is lack of systematic approach in understanding the nature of the problem before rushing into a solution. Student's absence at the semester beginning is one such socio-cultural problem which is neither recognized nor attempted to in any of the available work across the globe. The present work is an attempt in providing a "multimedia" solution to this socio-cultural problem in India.

3. Problem Being Addressed

It is a very common scenario in most of the VTU affiliated engineering colleges that few students report to the classes on the day of reopening of every semester. This scenario is almost the same even in other universities as well. The best administrative efforts and proctoring /counseling at the most may reduce the absentee's number but certainly not eliminate. There are some 1 solution approaches adopted by different colleges like "GO SLOW on syllabus coverage", Repetition classes, cover easier portions first, etc. Especially for a subject like "basic thermodynamics" most of these existing approaches don't work because of the quantum of syllabus and heavy dependency on fundamental concepts.

Hence through this paper an attempt is made to investigate on "How best a multimedia technological /pedagogical intervention can solve this real time social learning problem".

4. Research Design

On the day one of III semester reopening 21 of the students were present in the class out of 43. Table 1 gives the highlights of the sampling framework adopted for the experimentation purpose. Out of the students who were absent 15 are either from outstation or have gone outstation to their natives/relatives/long tour and expected to return only after a week or 10 days. Those students are grouped in to "Treatment group" and the 17 students who were expected to attend the classes regularly are grouped together in to

"Control Group". First unit – the fundamental concepts are taught to the Control group through the traditional class room method. Please refer Table 3 for the concise research design plan.

Treatment group which was absent during the traditional classes were expected to score Zero marks in a highly complex course like thermodynamics. Hence the group was provided with 5 videos and animations for the topics covered in traditional class room in order to improve the scoring. Out of the 5 videos one video was prepared by the teacher and it was compulsory for the experimental group to watch it before attending to the class. Other four were optional. A post-test was administered both for the control group and the treatment group covering the topic. The same test was conducted for both the groups and the results are tabulated and analyzed statistically.

Table 1: Sampling Framework

Details	Control Group	Treatment Group
Size	17	15
Classification Criteria	Regularly present during the first week of III Semester commencement	Regularly absent during the first week of III Semester commencement
Treatment	Traditional Teaching	Multimedia contents developed exclusively for the purpose
Pre-Test	No	No
Post Test	Yes	Yes

The first sessional test performance of both the groups were recorded and statistically analysed to find out the midterm learning gains. A descriptive data evaluation is conducted through the "User experience feedback form" analysis. Table 2 gives the five specific feedback questions F1, F2, F3, F4 and F5 considered for the evaluation of student's satisfaction level. Each of the descriptive feedback is measured in the likert scale of 0-5. Zero representing the lowest measure and 5 represents the highest measure. Again the numerical measure in the Likert scale is classified under three major macro levels namely Low levels for 0-2.4 , Medium level for 2.5 - 3.4 and High level – for above 3.4. This macrolevel classification of Likert score into low, medium and high level will help in understanding the post-test performance in a more simplistic way.

Table 2: User experience Feedback Questions

FB#	User experience feedback question
F1	To what extent you have used the "open source" multimedia content given by the teacher
F2	To what extent you have used the "Custom built" multimedia content given by the teacher
F3	How helpful was the "open source" multimedia content given by the teacher
F4	How helpful was the "Custom built" multimedia content given by the teacher
F5	To what extent the content prepared has helped you to catch up with the "regular students"

FB# Feedback number

Table 3: Research Design details

Sr. No	Title	Description
1	Type of Research	Quasi- Experimental
2	Sample Type	Purposive Sampling
3	Sampling size	41 (Experimental group strength)
4	Intervention Topic	Some basic concepts of thermodynamic
5	Multimedia Used	Mp4 Videos
6	Technological Strategy	Screen-o-cast, YouTube
7	Evaluation Methodology	Descriptive statistics
8	Pre-test Instrument	Not Applicable
9	Post-test Instrument	20 questions Evaluation quiz
10	Multimedia Used	Mp4 Videos, Screen -o-cast videos
11	Decision criteria for dividing the experimental group in to Treatment and control group	Inherent Social-learning challenge typical to the Indian university context

5. Results And Discussions

Post-test performance and the user experience feedback (Refer Table 4) were used as the tool to compare and evaluate the learning gain. User experience feedback was administered only for the experimental group in terms of a numerical Likert. Measure for each of the feedback is ranging between 0-5 in a Likert scale and classified under three different macro levels.

Unlike some of the other courses of third semester mechanical engineering, basic thermodynamics fundamental concepts have inevitable dependency on learning the subsequent syllabus. Students who were absent for the initial weeks of commencement of the class were aware that this reality.

Table 4: User Experience Feedback Result

	Measured in Likert scale 1- 5	
FB#	Mean	Level
F1	2.1	Low
F2	2.3	Low
F3	2.5	Medium
F4	2.8	Medium
F5	3.4	Near High

It is evident from the user experience feedback (Refer Table 4) that the measure of acceptance as expressed in the Likert scale for the "multimedia contents" by the treatment group (F1=2.1 and F2=2.3) is of LOW LEVEL irrespective of whether the contents are custom built or the readily available from the open source like you tube. Custom built contents are developed specific to the course syllabus and considering the students profile. There is a marginal preference to use the "custom built" multimedia contents (F2 mean 2.3) over the open resource contents (F1 mean 2.1). Though the multimedia intervention could not make an effective perceptual impact about its "helpfulness", the treatment group students found both the open source and custom-built multimedia contents of midlevel usefulness (F3 mean 2.5 and F4 mean 2.8).

It is interesting to note that despite a low level of usage of both the custom built and open source multimedia contents; the treatment group student's confidence to catch up with the control group students was worth noting (F5 near high level of 3.4). This is indeed one of the vital outcomes of the present work.

It could be a gross error to draw any conceptual inference in isolation without considering the t-test results. t- tests are the most commonly adopted validation tools in experimental studies. It is often used for hypothesis testing to understand whether the process adopted actually has an effect on the population of interest. It will also tell whether the two groups are different from one another. In this study t-test is applied to validate the mean value of post-test performance of control group and experimental group.

The t-test results as indicated in Table 5 shows a

Table 5: t-test result on Post test

	Control	Treatment
Observations	17	15
Mean	12	08
Variance	2.125	1.857143
Hypothesized Mean difference	0	
t Stat	8.019*	
P(T<=t) two-tail	5.96E-09	
t Critical two-tail	2.04	

*Significant at 5% level

significant difference in the mean scores of two groups at 5% level. This can be interpreted as less than expected impacted improvement in terms of learning gain for the treatment group (less than 12). Though the interventions were perceived as helpful by the respondents, the improvement was not up to the targeted levels.

Irrespective of the actual learning gain as reflected by the post-test performance and t- test validation, the multimedia could create a "helpfulness" perception (High Level) amongst the non-attendees of III Semester mechanical students for the basic thermodynamics course. This result is altogether not a discouraging one considering the objective of the quasi-experimental case study (from expected zero to group mean score of 8).

Treatment group is a natural consequence of the socio-cultural reality and the researcher has no choice but to accept the inevitability of the absence of "normalizing" the two groups. Treatment group's marginal preference to the "custom built multimedia over the open source" indicates the need to custom build the multimedia interventions with an improvised content design.

6. Conclusion :

One of the significant outcomes of the experiment is the improvement of confidence to a near level (F5 = 3.4 in the likert scale of 0-5) of experimental group students to catch up with the control group students. Moderate level of acceptance of both the open source and custom-built multimedia contents (F1= 2.1 & F2=2.3) is an encouraging factor. Experiment also indicates the huge benefit for teachers to develop an effective multimedia to counter the socio-cultural problem of absenteeism. This is indicated by the marginal higher preference for the teacher customized videos (F2=2.3) over the public domain general videos(F1=2.1) in the likert scale.

Significant difference in the mean scores of two groups at 5% level (Table 5) infers the need to further redesign and develop the multimedia contents to reduce the mean difference between control and treatment groups.

It looks like under the given circumstances the absenteeism has less to do with student's personal trait but more a social habit. Any technological and pedagogical intervention must accept this socio-cultural reality. This is in conformity with earlier researches [24] that advocated the socio-cultural adoptability and the need to develop learning systems to the local geo-cultural realities.

7. Scope For Future Work

Though this study has established that multimedia content can benefit the student in improving their scoring, there is enough scope for further improvising the developed multimedia content so as to improve both its acceptability and "helpfulness". A judicious choice of the pedagogical approach, the type of technological strategy and learning theorem are the potential gap areas that can be addressed in further research work.

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List of Abbreviations.

BTD : Basic Thermodynamics

Sd : Standard Deviation

% : Percentage

m : Mean score of post-test

VTU : Vishveshvaraya Technological University

LMS : Learning Management System

h- LMS : Hybrid - Learning Management System

STEM : Science, technology, engineering and mathematics.

MOOC : Massive Open Online Course.

ICT : Information Communications Technology

FB : Feedback

TEL : Technology enhanced learning

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