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Teacher's Perception of a Blended Thermodynamics Course

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Abstract:- There is ample research evidence [01] to claim that thermodynamics is one of the difficult subjects to learn as well to teach. Though there are good number of research contributions in analysing different reasons and different possible solution approaches [02], learning difficulties in thermodynamics is still a concern at large [03]. 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 online or blended thermal learning systems is not evident. 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. many of the existing thermal learning systems have either overlooked or failed to effectively integrate the pain points of practicing thermal teachers. At the same time even the practicing teachers need to get acquainted with the essential features of blended system so that they can effectively utilise the LMS. This work is the first step in understanding the gap between the requirements of an effective LMS and teacher's idea of what makes an LMS an effective one. Teacher's perception was measured in a Likert scale through a set of 16 questions and evaluated.

Keywords- *Student Centric Learning, Teacher Centric Learning, Thermodynamics, Blended Learning, LMS.*

I. THERMODYNAMICS: LEARNING DIFFICULTIES AND SOME REASONS

A comprehensive understanding of the problem is essential pre-requisite before attempting a solution. From the review of literature it is clear that there are enough learning difficulties in thermodynamics. Some literature is also available to understand why these difficulties occur and with some possible remedial approaches.

There is huge inventory of research on learning difficulties associated with thermodynamics from elementary to undergraduate level. Some of the studies include - student conceptual difficulties of heat and temperature (e.g., Erickson, 1979; Brook, Briggs, Bell & Driver, 1984; 1980; 1985; Grayson, Harrison & Treagust, 1995; Harrison, Grayson &Treagust, 1999; Lewis & Linn, 1994; Linn & Songer, 1991), Students' conceptual difficulties about several thermodynamic ideas such as heat and temperature (Sozbilir, 2003b), energy (e.g., Duit, 1987; Goedhart & Kaper, 2002), equilibrium (e.g., Banerjee, 1995; MacDonald, 1990; Thomas, 1997, Van Driel & Gräber, 2002) and the second law of thermodynamics (e.g., Duit & Kesidou, 1988; Kesidou & Duit, 1993)

Solution approach has begun well in the early eighteenth century (1824) when Sodi Carnot the famous physician who invented the heat engine has attempted the analogy approach. But it is surprising to note that the research exploration of why the learning problems occur continues even now [5]. To quote an example, in 2015 researchers in Ethiopian University reported a number learning difficulties in thermal related areas like lack of fundamental thermodynamic concepts, memorization of laws and statements without understanding, inappropriate overgeneralization, confusion of fundamental ideas, defining fundamental ideas according to their usage in everyday language, etc.

II. THERMODYNAMICS: SOME OF THE SOLUTION APPROACHES

A good number of fruitful attempts have been made since 60s in analyzing the cause and developed systems and strategies for thermal related topics. Scenario approach[6], Video based learning [7], interactive learning system[8] , Online homework system[9], Day to day events based learning approach[10], simulation approach[11], CBI based learning systems[12] , Project based problem driven approach[13], Fallacy approach, Simulation approach[14], Video game based learning[15], bilingual learning [16] and many more. Some thermal and related learning systems also have been developed like Thermo CD[17], Cycle Pad[18], Australian award winning power plant website[19], eBook[20] etc

In spite of an impressive and high promising beginning the, the growth of online courses has began to fall by 2005, especially in engineering programs (Allen, Artis, Afful-Dadzie, & Allam, 2013; Kinney, Liu, & Thornton, 2012; Bourne, Harris, & Mayadas, 2005). Most of the teachers are hesitant to attempt to teach difficult subjects, such as engineering and mathematics and thermodynamics online. (Bourne et al., 2005; Kinney et al., 2012).

Why the online learning has not taken over by the traditional learning system? That too In spite of emergence of a number of ICT based models and their reported success in enhancing the learning gain, not only in thermal related subjects but in almost every engineering subject as well. To what extent the traditional learning has taken over by ICT based technology enhanced learning? Why it is still the traditional Teaching Learning system that is dominating the engineering institutions. These are the relevant worthy research questions not yet comprehensively attempted.

III. BLENDED LEARNING SOLUTION APPROACH IN THERMODYNAMICS

Though the absence of a clear cut specific & universally acceptable definition in the literature continues even now [2013 Blended Meta analysis], Elearnspace's definition (2005) "integration of face-to-face classroom instruction learning with distance/e-learning" is a good reference to begin with. What is more important in designing a blended environment is in its pedagogical strategy to "Gain the best of both worlds (traditional and ICT) and creates an improved learning experience for the student". The pedagogical strategy of a blended learning environment is based on the assumption that "there are inherent benefits in face-to-face interaction" and "there are advantages to using online methods". Researchers have claimed that such an environment promotes student-centered learning and encourages increased student interaction (Carmody & Berge, 2005; Davies & Graff, 2005; Gallini & Barron, 2002).

Patuakhali Science and Technology University, Bangladesh have developed a website to learn in the Blend mode in local language adopting Self Regulated Learning (SRL) strategy in 2014[4].

Stubbs, Martin et al designed a Blend to cater to the specific needs for first year module. The pedagogical strategy adopted was "the tutor as expert of last resort". This was designed in by allowing access to tutors only for those students who had engaged with the online environment.

Though there are a good number of "blended learning" success stories to refer in different engineering subjects across the globe, almost nil in Engineering thermodynamics. This brightens the relevance, importance and worthiness of the present work. But the absence of well established research illustrations, guidelines and norms to fall back is an equal risk as well.

IV. HYBRID LEARNING AND THE CHALLENGES

As early as 2002, the president of Pennsylvania State University stated that "hybrid instruction is the single greatest unrecognized trend in higher education today" (Young, 2002, p. A33). Similarly, in 2003, the American Society for Training and Development identified blended learning as among the top 10 trends to emerge in the knowledge delivery industry (Rooney, 2003).

"How much to blend, to be a real blend?" Is the operational question very essential for any researcher attempting to develop a LMS in a blended environment. Barbara, Yukie Toyama et al attempted this research question in 2013 and evolved an operational definition recommending a minimum of 25% as the "substantial portion" for the blended environment.

Learning technology center at University of Wisconsin has identified three challenges facing the hybrid learning. 1. Creating a formal FDP for teaching hybrid courses, 2.Redesigning and the time factor involved and 3.Preparing students to effectively learn from a hybrid course. When the teachers were given the details of this study report some of them were changed their evaluation from 2 to 4. This is a clear indication of the need to understand the teacher's perception and to orient, if required.

V. METHODOLOGY

Thermal practicing Teachers (who are handling basic thermodynamics and those who have earlier handled the subject) were apprised about the proposed work and their individual responses to the set of questionnaires collected. Questionnaires were broadly classified into two categories. (a)Information about the teacher's acquaintance of a Blended/Online learning system (b) Teacher's awareness of a blended/hybrid learning systems.

Table 1 gives details of acquaintance parameters. These are the essential prerequisite information before trying to understand a teacher's perspectives of a blended thermal learning system. Evaluation of each of the 7 parameters was done in a Likert scale of 0 to 9. A "0" evaluation for question 7 means that in the teacher's perception it is extremely IMPOSSIBLE to practically implement a blended learning course for engineering thermodynamics.

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Sr. No	Acquaintance Parameters	Your Evaluation
1	Are you using any blended/Hybrid learning system?	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
2	Your awareness and exposure of an online learning system	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
3	Your awareness and exposure of a Blended / Hybrid learning system	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
4	You are willing to implement a Blended / Hybrid learning system	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
5	How do you rate the thermal learning management system/Course you have experiences?	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
6	Do you need some exposure/training/orientation is required for effective implementation from your end?	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
7	Do you Strongly feel that it is not practically implementable for our circumstances	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9

Table 1:- Evaluation Format of Teachers Acquaintance of a Blended Thermal Learning System

In the next phase a set of 16 questions are given to each of the teacher. Please refer table 2 for the set questions posed. Responses was measured in a Likert scale of 0 to 9. It is ensured that no teacher responds to this second set of questions without responding to the first set of questions shown in Table 1. A "0" evaluation to the question number 7 "Importance of Pedagogy in designing a basic thermodynamics course that I have taught for effective implementation for the course " means that in the opinion of this teacher PEDAGOGY has ABSOLUTELY NO ROLE in effective implementation of the course. These responses are the pre-evaluation of the teacher's perceptions of a blended learning system.

Sr. No	Teacher's Perception	Evaluation
1	This does not provide any opportunity for me the intellectual capability	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
2	This does not provide any opportunity for my style of teaching.	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
3	Assignments in online / Blended is not a practically implementable	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
4	PROBLEMS cannot be solved online	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
5	Monitoring students not possible	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
6	University does not recognize the course	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
7	Importance of Pedagogy in designing a basic thermodynamics course that I have taught for effective implementation for the course	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
8	Importance of technological tools in designing a basic thermodynamics course that I have taught for effective implementation for the course	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
9	Importance of learning theorem in designing a basic thermodynamics course that I have taught for effective implementation for the course	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
10	Redundancy is one of the major Issue	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
11	Who benefits the Most – Academic Slow Learner	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
12	Who benefits the Most – Academic Mediocre	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
13	Who benefits the Most – Academic performers	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
14	Student vs Teacher centric design	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
15	Is it possible to use recorded videos for active learning	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9
16	How effectively the discussion forums can be used in collaborative learning without much diversion	0, 1, 2, 3, 4, 5, 6, 7 , 8, 9

Table 2:- Evaluation Format of Teachers Perception of a Blended Thermal Learning System

VI. RESULTS AND DISCUSSIONS

First part of the evaluation response in terms of the central tendency is shown in Table -3. This gives an idea of where a common practicing thermal teacher stands as for as each of the acquaintance parameters are concerned.

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Sr. No	Acquaintance Parameters	Mode
1	Are you using any blended/Hybrid learning system for your regular course?	0
2	Your awareness and exposure of an online learning system	5
3	Your awareness and exposure of a Blended / Hybrid learning system	2
4	Your willingness to implement a Blended / Hybrid learning system	4
5	How do you rate the thermal learning management system/Course you have experiences?	3
6	Do you need some exposure/training/orientation for effective course implementation?	6
7	Do you Strongly feel that it is not practically implementable for your classroom	2

Table 3:- Central Tendency of the "Acquaintance Status" of a Thermal Practicing Teacher

- Most of the practicing teachers have rated the h-LMS the hybrid or blended learning system they have experienced as poor (Mode 2)
- Most of the teachers feel uncomfortable in using any of the existing online courses irrespective of their content quality.
- Many of the teachers are acquainted with at least some of the technological strategies and their importance in running a successful course.
- Interestingly most of the teachers have shown little inclination in getting acquainted with pedagogical strategies and learning theorems adopted in developing the learning contents.

It is interesting to note that more than 85% of respondents expressed their awareness of any one of the learning courses in thermodynamics either online or blended. Though there is in some awareness of online/blended courses in thermodynamics amongst the engineering college teachers, specific exposure to the usage in their classroom is less. Blended system usage is less popular in comparison to the online learning. It is very clear that in spite of fair awareness about at least one of the thermodynamics learning system almost none of them are at present using a blended learning system in their class. It is also surprising to note that there is fairly a good inclination to get trained but not to implement in their class rooms. This could possibly explain through the response Q7. There is a strong perception that it is not practically implementable under their specific situations.

The second stage is broadly designed to address the reasoning behind the practicing teacher's perception. This possibly gives a right insight about "Why these problems exist?"

Sr. No	Teacher's Perception Parameter	Mode
1	This does not provide any opportunity for my intellectual capability	8
2	This does not provide any opportunity for my style of teaching.	7
3	Assignments in online / Blended is not a practically implementable	8
4	PROBLEMS cannot be solved online (0 = Very much possible , 9= Extremely impossible)	8
5	Possibility of Monitoring students academic progress (0 = possible, 9= Impossible)	7
6	Willing to implement effectively - only if the University/Institution recognize the course - Even without the mandate	 4 3
7	Importance of Pedagogy in designing a basic thermodynamics course that I have taught for effective implementation for the course	2
8	Importance of technological tools in designing a basic thermodynamics course that I have taught for effective implementation for the course	2
9	Importance of learning theorem in designing a basic thermodynamics course that I have taught for effective implementation for the course	2
10	Redundancy is one of the major Issue	7
11	Who benefits the Most – Academic Slow Learner	3
12	Who benefits the Most – Academic Mediocre	5
13	Who benefits the Most – Academic performers	8
14	Student vs Teacher centric design. Teacher centric – 0 , Student centric – 10 ,	3
15	Is it possible to use recorded videos for active learning	2
16	How effectively the discussion forums can be used in collaborative learning without much diversion	4

Table 4:- Comparison of Pre Evaluation and Post Evaluation of a Thermal Practicing Teachers Perception

In the perception of a practicing teacher any shift from the traditional teaching to Blended learning greatly deprives them of their intellectual capability and their own style of teaching (Mode of 8 & 7 respectively).

Only the traditional system in their view can effectively solve thermodynamic problems, monitoring the students progress is best possible only in the traditional learning environment and the teacher cannot use blended learning system for assignments (Mode of 8, 7 and 8 respectively). Only the physical face-to-face interaction of the student could ensure his academic progress monitoring especially in subjects like thermodynamics.

Practicing teachers think that only the academically performing students have the maxim benefit from the blended learning system where as the teacher centric traditional methods is the "RAMA BAANA" for the academically non-performing students. The benefit for the mediocre standing in-between (Mode of 3, 5 and 8).

Response 16 deals with the learning management systems ability to handle a collaborative learning environment. This is the net effect of the learning system's capability to handle active learning. Thermal practicing teacher's opinion of "discussion forums" in an online platform has more diversifying effect and assists less in active learning.

Redundancy is one of the major concerns of the teacher. (Mode 7) Most of the teachers who have used some of the other learning systems encountered this problem.This problem is common for teacher handling any subject in technical universities due to its time table driven feature, limited teaching hours available , absence of students for reasons beyond the quality of teaching etc. This problem of redundancy is specifically true for thermal teacher. In student's perception thermodynamics is one of the most difficult subjects to learn. This is a global phenomenon. Abstractness of the course is the added pain.

Question 14 was about the practicing teacher's choice between student centric and teacher centric instructional delivery system.Most of the practicing teacher think that only a teacher centric thermodynamic learning system could deliver an effective learning outcome.

The last perceptional parameter is the recognition & "mandate to implement" Q6, certainly the most important one, because of its inseparable dependency on all other factors. Most of the practicing teachers are unwilling to implement a blended learning system even if it is mandated by the authorities.

Most of the teachers are not acquainted with the typical features of different LMS like pedagogy, technology and learning theorems and its relevance. Redundancy is one of the practical problem faced by a thermal teacher wherein he has to use other's (Probably contents prepared by domain experts like from IITs) contents. In most of the cases a teacher will be redelivering the same contents in his own style and adapting to his specific focused needs.

Practicing teachers think that the classroom discussions are totally focused on any one specific thermodynamics topic unlike the other collaborative platforms like facebook and alike networking, wherein the group's discussions are largely unfocused.A similar inference can be drawn for response 15 that deals with active learning element. A teacher is more influenced by the Thermodynamic learning videos that they are generally exposed to and aware of. Most of the videos are too long to retain even the attention of the student or even if some such videos are available both in youtube and other thermodynamics learning systems, they are not developed with the built in design to incorporate the active learning strategy into it.

"Student centric learning" is one of the conceptual shifts in the strategy the contemporary technical education system must adopt. This is one of the key strategies which is not understood properly by most of the thermal teachers and wrongly understood by many. Only the teachers actively involved in educational research or innovative practice have the complete operational clarity of "Student centric, Content centric and community centric" design. But most of the practicing teachers are thoroughly misunderstanding the "Student Centric" as "minimised role or the marginalized importance of a teacher". Unfortunately even some of the educational administrators are also guided by this perception.

Many practicing teachers expressed the apprehension that a full-fledged implementation of such a system may be misused from the management in either replacing them or giving additional responsibility.

The lack of awareness and lack of exposure on content specific pedagogical, technological & learning theorems could also be the influencing factors.

These findings are in line with the earlier research recommendations of a "full fledged redesign" and "need of training courses for the tutorial assistants."Further the study has clearly indicated a strong need to properly orient the practicing thermal teachers about the design parameters and only a content and context specific orientation will enable the reaches ineffective and efficient utilisation of a Thermodynamic blended learning management system.

VII. SCOPE FOR FUTURE WORK

Evaluation without exposure may not give a valid inference and hence an evaluation process after "h-LMS" orientation could be the next stage in understanding a teacher's perception. Study need to be carried out with larger sample size and followed with t-test for significance of results.

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