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Significance of Contemporary Core Logics for Measuring Learning Outcomes in Computer Science and Engineering

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Abstract: ***Principles and practices of Outcome Based Education, a recent paradigm for problem-based subjects such as Computer Science and Engineering, emphasizes on achieving student learning outcomes. This will ascertain attainment of competencies for what a student would do an engineering task, rather than merely understanding the concepts, at the end of a learning event. Thus learning outcomes are, in fact, combination of technical understanding along with enabling appropriate skills that imbibe inter and intra personal behavior of the learners. To accomplish this, the instructional contents cannot be mere topics, as practiced in traditional-linear-syllabus oriented educational systems. Rather the contents need to be anatomized into fundamental engineering core and contemporary cores that are temporal in nature due to changing scenario of industries. Literature on treating such differentiated cores in Computer Science & Engineering is rare. This paper therefore attempts to determine the need for differentiating the domain cores in every concept. Experiments with selective contemporary core in Computer software product have been administered and validated through social surveys based on holistic rubrics. The samples are however limited to the State of Kerala in India. Conclusions drawn out of the experiments will be of immense use to curriculum designers and also to researchers of Computer Science and Engineering education. The study also includes comparison between teachers and students of Computer Science & Engineering on lifelong learning of contemporary industry related cores. The results presented in the paper form a part of a whole research work on Outcome Based Education in Computer Science and Education.***

Keywords: ***Outcome Based Education; Contemporary core logics; Rubric designs.***

I. INTRODUCTION

Outcome based education (OBE) is an educational theory/philosophy which is founded for maintaining, monitoring and improving the quality of higher education, such as the Computer Science and Engineering (CSE) programme. Learning outcomes are essentially those which are obtained by the students through every activity of the educational processes, as per the OBE's principles (SPT Malan, 2000).

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Learning outcomes are therefore necessary and are to be measured, which is not explicitly considered in Traditional Linear Educational system (Bruce Mathew, et. al. 2019). Learning outcomes are measured on what the students could actually do (act on an engineering task) to demonstrate what the student has learnt at the end of any learning event.

Learning outcomes directly or indirectly represent the domain core knowledge obtained by the learner, however more importantly, which is imbibed with the ideas (skills), tools used (problem solving abilities) and the students' native behavior (SPT Malan, 2017). Statements of 'learning outcomes' should indicate end results of what a student would achieve at the end of an instruction (Carriveau, Ronald S, 2016), which are presented in the forms of course and programme outcomes. But most of the students would probably achieve the outcome in varying degrees of what was expected. Therefore verbs that are used in stating the learning outcomes (course / programme outcomes) should point out to what the instructor actually wants the students to be able 'to do'. The ability 'to do' lies with the acquaintance of contemporary core knowledge (which is temporal and depends on current industrial practices) of the domain. On the other hand, the fundamental core knowledge is generally the pure engineering concepts, which are transformed from scientific facts (John Davis, 2015. The contemporary cores are, in general, the products and services which are branded by industry. This segregation of fundamental and contemporary cores is necessary in effectively learning problem based domain contents such as the CSE. Therefore it is essential as per the principles of OBE that segregation of contemporary cores from the basic or fundamental core knowledge of a problem based domain content. This is much required for assessing the learning outcomes obtained by the students. Instructions which are based on learning outcomes cannot be objective specific but objective driven. Such instructions naturally commence with a real world (industrial) engineering task (the contemporary core). An engineering task is therefore obviously represents contemporary core (Gnana Sambanthan, T. et. al. 2018). Effective instruction imbibes skill and/or behavioral competencies as per the statement of learning outcome in a planned manner (Karen E. Hinton, 2012). Imbibing could be made both on contemporary as well as fundamental core contents.

In this background, the paper elaborates the importance of representing contemporary core knowledge in the instructions which measures the required learning outcomes. One of the contemporary core knowledge of CSE's 'Operating System' (course) is "*the business success of Microsoft products*".

It is generally believed that the student community of this current era is more equipped to have gained current knowledge of Information Technology products more than their teacher counterparts. The paper attempts to determine this issue.

The level of acquaintance of contemporary core knowledge by the students and teachers, on this real world problem (contemporary core knowledge) is considered as a case study as an experimental study.

The results presented in this paper throw lights on research and utility values. This should help in further investigating the characteristics for assessing contemporary core knowledge in any problem based programmes, which is essentially required by the OBE.

II. LITERATURE SUPPORT

Learning experience is one of the components of the shift of OBE from conventional education (Shavelson, 2010, Arjun, P, 1998). A change in a learner's knowledge and behavior over a period of time through the education process can be comprehended as 'learning experience'. For measuring meaningful learning outcomes, the outcomes should specify observable and measurable outcome that should describe the expected result of learning (Driscoll et. al, 2007). Hence the intended learning outcomes could be presented both the contemporary and fundamental core contents.

Accreditation process in higher education (such as the CSE) visualizes accountability for continuous improvements (Shavelson, 2010). Improvements in the learning are invariably visualized through learning outcomes, which include core knowledge, behavior and skill competencies. The Accreditation Board for Engineering and Technology (ABET), USA has specified a set of pre-defined Programme Outcomes (POs) which suggest that the programme of an institution need to specify their own outcomes that would be assessed periodically.

At least four core competencies in the form of knowledge (fundamental cores), (problem) analysis, design (mostly contemporary cores) and complex problem solving (mostly on contemporary core that use the knowledge of fundamental cores). As POs are periodically assessed, they must be reviewed and revised periodically (Haidar, 2017). It is clear that the literature on OBE emphasizes to study both fundamental domain core knowledge as well as the contemporary core knowledge for clearer understanding of the learning outcomes.

There is an uncertainty about the desired (students') learning outcomes, most of the time. In such cases students would have attained only pseudo-knowledge, pseudo-skills, pseudo-attitudes and pseudo-values. In view of this, six critical components have been stressed for imbibing learning outcomes in the core (Van der Horst and McDonald, 1997). They are: (i) Explicit Learning Outcomes for proficient standards, specifically on the contemporary cores; (ii) Flexibility in time-frame for mastering the skills, which includes appropriate application of the contemporary cores; (iii) Varieties of instructional activities (aptly segregating the contemporary core from the fundamental core); (iv) Criterion based assessments on both contemporary and fundamental cores; (v) Qualifications on demonstrated learning outcomes and (vi) Flexible choice based programs. The importance of comprehending the contemporary core is once again becomes evidenced from this published work.

In quality perspectives, the OBE aims at holistically imbibing necessary competencies (outcomes) in totality, which is obtained by the learners (SPT Malan, 2000). These competencies must be described in terms of core knowledge, skills, attitudes and values. Even the smallest unit of the core knowledge, skills and values are actually required for a real world situation (which may be different from the classroom practice). This indicates that the core should reveal the contemporary part. Soft skills such as broad abilities like ethical and societal responsibilities, critical thinking ability, team work, lifelong learning and communicating ability along with core knowledge can be achieved by capstone projects, case studies and contemporary (industrial) problems (Schmeckpeper et. al. 2014). The project works could be evaluated through group activities.

(Jonassen et. al. 1997) have stated on certain criterion which is for developing the learning outcome and is meant for 'conceptual distinction', while it is achieved by defining the learning outcome. Similarly the learning outcome is meant for 'performance', and it is achieved by measuring the learning outcome. The payoffs will be the effects of learning outcome that are attained by the student.

From the above documented studies (of the literature) it is evidenced that fundamental and contemporary cores (in any problem specific subject/programme such as the CSE) are to be deeply studied so as to determine whether learning outcomes are better attained.

III. METHODOLOGY

For addressing specified learning outcomes, (Carriveau, Ronald S, 2016) has recommended for identifying different categories of higher learning (which might be the contemporary and/or fundamental core knowledge). Criteria should be designed to specifically measure (describe) the degree (scores) to which a student could accurately score on the outcome. Using these verbs, two criteria for measuring the acquaintance of contemporary cores by a rubric (Schmeckpeper et. al. 2014) along with the corresponding learning outcomes is presented below (Jonassen et. al. 1997). A holistic rubric has thus been developed. Appropriate rubric descriptors have also been arrived at (Peter A. Facione et. al. 1994). The questions are focussed on the selected contemporary core, namely the success of the products of the Microsoft Inc.

1. Provide examples and rationale used to support your argument for the (international) success of PC brands, CPUs and OSs. **Expected learning outcome (Low level): "Acquiring bodies of information".**
2. What is the reason that contributed to the success of Microsoft Operating system in the International markets? **Expected learning outcome (High level): "Hypothesizing solution".**

Table 1.0 Holistic Rubric Descriptors for Measuring Acquaintance of Contemporary Core Knowledge

Score / Criteria	Exemplary (4)	Proficient (3)	Developing (2)	No concept (1)
Criterion 1	Insightful evidences to support and assimilation of appropriate information for the argument	Understanding of information and partial assumption for the argument	Partially correct assumption and assimilation of appropriate information for the argument	Inaccurate selection and irrational simplification of the argument
Criterion 2				

The methodology used is essentially 'experimental' on the learning process of the students in their level of knowledge of contemporary core.

Validation is done by survey method which applied the rubric. The sampling is based on purposive sampling (Sharma, 1988). Both students and teacher respondents belong to the CSE discipline of Kerala State Technical University, Kerala, India. Student respondents: 24; Teacher respondents: 13. The descriptors and the scores are presented in Table 1.0.

Students who are more involved with peers, faculty and staff – especially in learning activities (group discussions/activities), are more likely to persistently learn and graduate (Tinto, V, 2000). In group activities of students who get involved in project discussions, the learning outcome is proved to be more visible and effective. The student sample of 24 is further divided into 5 groups with 4, 5, 4, 5, and 6 respondents respectively. This formation was done on convenient sampling method. The rubric (Table 1.0) was administrated on these groups (in group discussions) by selected faculty evaluators. The same technique was adopted with the 13 teacher samples (3 groups with 5, 4 and 4 respectively). The same rubric was administered on the teacher respondents, so that a One way ANOVA could be applied. The experiments were carried out by the authors as part of a whole research project work leading to Ph.D work of the first author.

IV. EXPERIMENTS, RESULTS AND DISCUSSIONS

The group activities and the results obtained are grouped together into students (part 1) and the teacher responses are grouped together into teachers (part 2). They are elaborated below.

Students' Responses:

The Cronbach's alpha for reliability test has been checked in the student responses. Results obtained from the statistical analysis on reliability (Cronbach's alpha) are presented in Table 2.0

Table 2.0 Case Processing Summary

		N	%
Cases	Valid	24	100.0
	Excluded[a]	0	0.0
	Total	24	100.0

Reliability Statistics

Cronbach's Alpha	N of Items
0.831	2

The value of 0.831 (Table 2.0) of Cronbach's alpha clearly shows that the responses are reliable. The primary statistical data for the study on students is given in Table 3.0.

Table 3.0 Statistical Data of Student Results on Contemporary Cores

		Criterion 1	Criterion 2
N	Valid	24	24
	Missing	0	0
Mean		3.0833	2.0417
Median		3.0000	2.0000
Mode		4.00	1.00
Std. Deviation		0.97431	0.99909
Variance		0.949	0.998
Minimum		1.00	1.00
Maximum		4.00	4.00

The median and mode values (Table 3.0) for the first criterion (current information of contemporary core) obtained by the students' show high scores (3.00 and 4.00 respectively). They are low (2.00 and 1.00) for the second question (reasoning). The standard deviation of near to 1.00 (.97431 and .99909) shown in Table 3.0 indicates the wide distribution of scoring by the students. The results of students' scores are graphically represented in Figure 1.0.

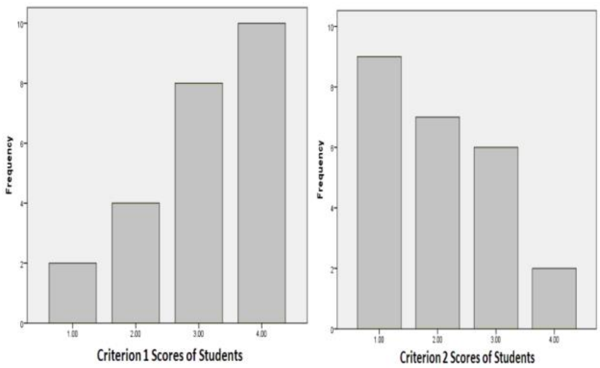

Figure 2.0 Teachers' Scores on the Knowledge of Contemporary Core

Observation:

It is clear from the distribution of responses (Figure 2.0) that the trend is highly negative on both the questions. The mode values (Table 4.0) also agree with the graphical scenes. It is inferred that the teachers are less aware of the contemporary core knowledge as they may not go through the internet and other material on contemporary news/information of the products/services.

Inference 1

The results shown in Figures 1.0 and 2.0 clearly indicate that the students as well as teachers are generally not able to reason out the state of contemporary core, as they struggle to find out the logics.

Comparative Studies between Students and Teachers on Contemporary Core Knowledge:

A One way ANOVA was performed on the results of criterion 1, between the students and teachers responses. Table 5.0 provides statistical results.

Table 5.0 One Way ANOVA on Students and Teachers on the Knowledge of Contemporary Cores

	Sum of Squares	Degrees of freedom	Mean Square	F	Sig.
Between Groups	2.123	2	1.062	1.206	.339
Within Groups	8.800	10	.880		
Total	10.923	12			

As F (1.206) value shown in Table 5.0 is more than the critical value .339. This indicates that, there is a significance difference between the distribution of responses of students and the teachers on criterion 1. Similar study is also conducted on criterion 2.

A One way ANOVA was performed of the results of criterion 2, between the students and the teachers (responses) which is presented in Table 6.0.

Table 6.0 One Way ANOVA on Students and Teachers on Reasons on the Specific Contemporary Core

	Sum of Squares	Degrees of freedom	Mean Square	F	Sig.
Between Groups	4.841	2	2.420	3.532	.060
Within Groups	8.909	13	.685		
Total	13.750	15			

As F (3.532) value of Table 6.0 is more than the critical value 0.060, there is a significance difference between the distribution of responses of the students and the teachers on criterion 2.

Inference 2

It is clear that students tend to indulge in autonomous or self -regulated learning, particularly on contemporary core knowledge, but are not properly assessed with learning outcomes by the teachers. It is clear that teachers are poorer in autonomous or self-regulated learning on contemporary core studies.

V. CONCLUSIONS AND RECOMMENDATIONS

It is concluded that segregation of CSE domain (core) information or concept into fundamental and contemporary knowledge for the sake of imbibing learning outcomes effectively.

CSE students of the current era are more aware of the contemporary core knowledge more than their own teachers' awareness.

Students' 'reasoning' competency need to be properly assessed through appropriately designed holistic rubrics on contemporary cores.

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Bruce Mathew, has completed his M.Phil in CS after the MCA Degree and is a full time PhD research scholar at NITTTR, Chennai in the area of Outcome Based Education. His area of Interest includes Information Systems, Data Mining, Knowledge Management and Operating Systems. He has a teaching Experience of 17 years and has published 5 papers in journals including IEEE. He is an active member of CSI India. He is a trainer for the popular LMS MOODLE for the past 8 years.

Dr. T. Gnana Sambanthan, ME, PhD is a pioneer in the area of outcome based education. He was a professor in the department of computer science at NITTTR, Chennai,), a centrally funded Institution of the Ministry of Human Resource Development, Govt. of India, in Chennai. He has obtained a blend of Industrial, Research and Teaching/Training experiences of several years from India and abroad. He also had a two years stint with the state council for Science & Technology coordinating Industry- Institute-Interaction cell. He has produced 13 PhDs and his area of interest include concept-based extractions, grid computing, Instructional Design and E-Learning.