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Measuring Attitudinal Learning Outcomes in Electronics and Communication Engineering Experimental Instructions

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***Abstract:** In traditional time bound linear teaching practices, learning outcomes are difficult to measure from the actual learning happened, as autonomous learning is not explicitly considered. Research studies and documents available on the practice of Outcome Based Education and the subsequent design and development of Learning Outcomes for measuring core competencies along with skills and attitudes of learners, which specifically concentrating on the Laboratory experimental courses in Electronics and Communication engineering is very rare. This paper attempts to make an experimental study on a selected set of experiments, to draw conclusions on the effectiveness of measuring learning outcomes that actually encourage students for autonomous learning. Demography and the subjects considered for the experimental studies are presented along with statistical outputs. The results are encouraging and would throw more light for further research in this area. Besides, the results will be highly useful to the generic area of engineering education. Validation of the results is done by social survey method, which includes statistical analysis. The experimental students are however limited to Indian conditions (and the current practices followed) of engineering education.*

***Keywords**: Core competencies; Electronics and Communication Engineering; Laboratory practices; Learning attitudes; Learning Outcomes; Outcome Based Education; Skill learning.*

I. INTRODUCTION AND BACKGROUND

Outcomes Based Education (OBE) is an educational philosophy characterized with clearly spelt out principles and practices [1] which would be contrasting in many aspects of the traditional linear syllabus oriented education. Learning Outcomes (LOs) are what a student will be able or competent enough to do a core engineering task that is imbibed with the intended skills and holistic attitude of the learner. 'Mental model' for an LO, integrates conceptual distinction with the attitude (performance) and benefit to learner (payoffs), which is different from pure 'problem solving' ability [2]. These concluding remarks of the pioneers of OBE clearly indicate that the subject dependent abilities, such as the basic core knowledge and/or problem solving abilities must be imbibed with skill competencies like modern tool usage and/or attitudinal qualities such as team spirit or engineer and society responsibilities. Many similar published works indicate, that the learner's attitudes are measurable with the help of well spelt out LOs of the principles and philosophy of OBE. Literature also indicates that the LOs are describers of operationally defined skill and attitude, which are assimilated with the practical tasks of the core subject. This paper, attempts to investigate whether such integrated LOs are identifiable in the existing experimental instructions of Electronics and Communication Engineering (ECE), which forms a part of a whole research programme of the first author. The measurements for the intended LOs are carried out through experiments using analytical rubrics.

Electronics and Communication Engineering programme of the Kerala Technological University, India (university education of higher learning) has stipulated certain laboratory practices [3]. However the students undergo most of these laboratory practical sessions in isolation, without relating with the concerned theoretical concepts, as there is no proper concept level integration between theory and experiments. Besides, there is no mechanism which absorbs and integrates the skill and attitudinal abilities with the core competencies. Is it possible to identify whether skill and attitudinal competencies are existing (or represented) explicitly in the core competencies? Under this background a study has been undertaken by the authors of this paper. Learning strategies for measuring hard and soft skills which are not directly conceivable, but might be observable [4]. Concluding remarks drawn from the intended experiments will contribute to important utility values and also will throw more light for further research in OBE of ECE programmes.

II. LITERATURE REVIEW

It was reported (in sport science) that a student was able to translate the theoretical learning received in the lectures with hands-on data collection in a laboratory session [5]. This has proved that students would act on their own and personally involve in the learning process. Experiments of laboratory practice courses (in Engineering and Technology), provide systematic training to students [6] in their intended skills (for e.g purpose of achieving accuracy and speed of performance). Skills such as 'recall', 'creativity', and 'problem solving ability' also could be enriched or refined through experimental practices. Besides, opportunities to apply to individual student's native knowledge and aspirations are also high, which could be identified in laboratory practices. laboratory practical cannot be effective when components/materials/tools etc. are not made available in a flexible manner so that they (the learners) could cater to different needs for different

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nature of them (not all students learn the same). Whether effectiveness of these gadgets helps in acquiring skills and attitudes (or measurable learning outcomes)? Anders et. al [7] have carried out exhaustive studies on outcomes of open inquiry of Chemistry Laboratory Experiments. Investigation was to determine whether any two versions of experiments would result in two different types of outcomes? Interview and survey method was adopted for that study. Even though the role of teachers and students are different, both should correlate well with each other [4] for the purpose of identifying learning outcomes. Strategies for learning are generally not observable, but only conceivable. While the strategies adopted by teachers are comprehensible by both teachers and students, the strategies adopted and affected by students may not be noticed by the teachers. Strategies such as encouraging open ended laboratory experiments for effective learning of a related concept could easily be instructed by the teacher. Whether the students would accept such a strategy for effective learning is a matter of research. Open ended experiments were not always considered without criticisms [8].

III. METHODOLOGY AND EXPERIMENTAL SETUP

Experimental method on students who undergo laboratory practical classes is proposed, which includes observations and interview surveys for feedbacks. The titles considered for the experiments of the practical and the related portions pertaining to some theoretical concepts of ECE are presented in Table I.

Table- I: Laboratory Practices and Related Theory

Subject Code	Laboratory Title	Related Theory
S1	Electronics Engineering workshop	Introduction to Electronics Engineering
S3	Electronics Circuits Design Lab	Electronics Circuits
S4	Logic Circuit Design Lab	Logic Circuit Design
S4	Analog Integrated Circuits Lab	Analog Integrated Circuits
S5	Digital Signal Processing Lab	Digital Signal Processing
S6	Microcontroller Lab	Microprocessor and Micro controller

Strategies followed in the experiments:

1. Practical experimental gadgets, instruments and materials that were arranged in such a way to provide cues prior to students' own choice for experiments. Will such cues enhance attitude/skills that provide holistic learning?

2. Laboratory Instructors were advised to educate the students the importance of experiments and expectations from the students on intended learning outcomes.

3. Experimental hardware components were labelled and meticulously arranged so there wouldn't be any interruption needed for students, but would provide freedom for students themselves to form groups and open discussions.

Laboratory practices (Table I) are intended to measure the following intended LOs in i. core knowledge, ii. hard skills and iii. soft skills.

i. Core knowledge outcome: Problem solving abilities (measure: accuracy);

ii. Hard skill outcome: Modern tool usage (measure: improved performance);

iii. Soft skill outcome: Team spirit and Engineer and Society (measure: professional ethics).

Survey method has been chosen for obtaining feedbacks and for measuring the outcomes rubric instruments have been used. For the survey method, purposive sampling technique has been adapted [9]. The total number of sample size of '179' was considered in a similar experimental study [7]. The descriptors of the rubrics for measuring the intended skills and attitudes (along with core competencies) were developed using the cross reference of [10].

Demography:

ECE students and teachers have been selected from the university's constituent colleges and institutes located in the surroundings of Thiruvanandapuram, Kerala. Total number of ECE students considered for the survey: 128 (72 Male; 56 Female; 53 from Government Engineering colleges; and 85 from private Engineering Colleges). Total number of ECE teachers that are considered for the survey: 17 (6 Male; 11 Female; 8 from Government Engineering colleges; and 9 from private Engineering Colleges).

Questionnaire:

To student respondents: 1. "The variety of instruments, gadgets and materials/consumables facilitated to me has helped me in generating new ideas for devising my own experiment for solving the real world problem"; 2. "I am not familiar with different instruments, gadgets and materials; therefore I did not find it interesting"; 3. "The instructor has provided me with new learning opportunities that I have never tried before in the traditional classroom"; 4. "I enjoy sharing my knowledge with my peers and I feel beneficial in group practices".

To teacher respondents: 1. "The accuracy of results shown by students has increased, when I followed the tips of outcomes based Laboratory instruction"; 2. "The performance of the students in learning has improved, when I followed the tips of outcomes based Laboratory instruction"; 3. "In my opinion, the attitude of students towards societal responses and professional ethics have enhanced, when I followed the tips of outcomes based laboratory instruction".

The five point Likert's scale for measurement: 1. Strongly agree; 2. Agree; 3. Can't say; 4 Disagree; 5. Strongly disagree

IV. RESULT AND DISCUSSION

Table II: Students' Responses on Experiment S6

Question Number	Mean	Mode	Standard Deviation
1	1.6875	1.0000	0.71816
2	3.9844	4.0000	0.84167
3	2.1094	2.0000	0.84401
4	1.6797	1.0000	0.84120

Prior instructions given to a laboratory experiment might be better suited to some students than the others[7]. It is hence anticipated that there would be difference in feedbacks provided by the student respondents. The same is observed from Fig.1.0 to Fig 4.0.

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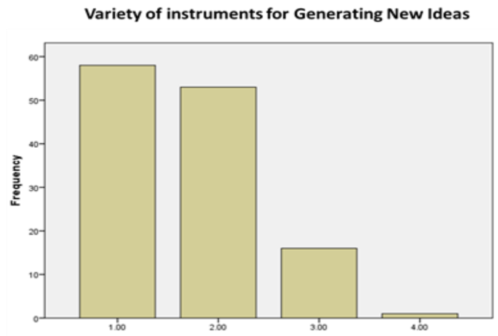

Figure 1.0 Students' Responses on Question 1 (S6)

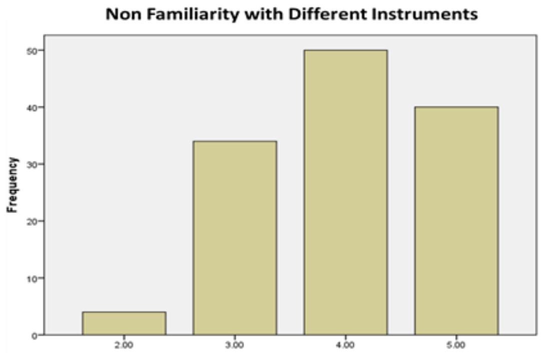

Figure 2.0 Students' Responses on Question 2 (S6)

Laboratory sessions with preparatory and reflective follow-up tasks could be used for further mathematical analysis [5]. Pooling of student data collected within laboratory sessions could be strategy for creating a descriptive database. This would give greater statistical power to any subsequent data analysis, which would provide more scope for cross-group comparisons, which has been found to be surprisingly motivating. In view of these questions 1 and 2 were designed opposing each other for the purpose of correlation study. Fig. 1.0 and Fig. 2.0 clearly show the feedbacks are actually opposing. Pearson's correlation coefficient (Table III) as shown in the table presents a negative correlation value (more than 0.5). The mode value of question 1 is 1.0000 while it is 4.0000 in the case of question 2, as seen in Table II. The standard deviations for all the variables (questions) are within 1.00 (Table II).

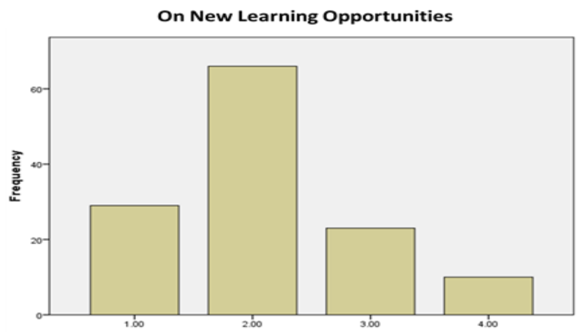

Figure 3.0 Students' Responses on Question 3 (S6)

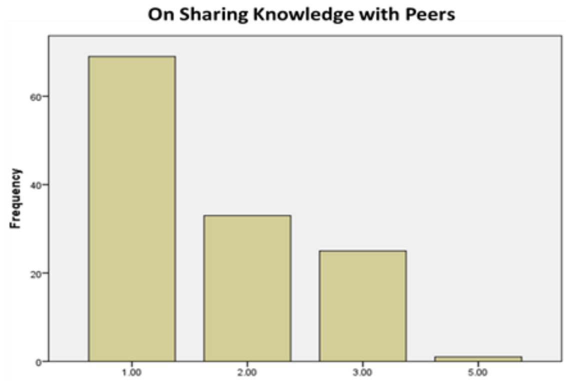

Figure 4.0 Students' Responses on Question 4 (S6)

The positive responses given by the respondents for questions 1, 3 and 4 clearly show (Figures 1.0, 3.0 and 4.0) that the principles of OBE when designed properly with LOs in laboratory experiments will motivate learners in autonomous learning process [11].

Table III: Pearson's correlation between Question 1 and 2 correlations

Question Number Mean		VAR00001	VAR00002
VAR001	Pearson correlation	1	-0.516
	Sig. (2-tailed)		0.000
	N	128	128
VAR002	Pearson correlation	-0.516	1
	Sig. (2-tailed)	0.000	
	N	128	128

The objective of this research work is not to show how to carry out a standard experimental procedure (unlike a non problematic subject content research reported by Hodson [8]. Results obtained by teacher responses for validating our research are actually encouraging, as seen from the figures 5.0, 6.0 and 7.0. Response analysis obtained from students is limited only to experiment S6 (for want of space). However teacher responses were analysed for experiments S6 and S4. This delimitation is due to the fact that, while S6 is highly problem related (in real world situation), and S4 is more theoretical, as per the teachers' views. Table IV provide statistical data on the responses for S6 and Table V for S4. The standard deviations for al the questions of S6 is much less than 1.0 (Table IV). It is very clear that the results are all highly positive for S6 as the mode values for all the responses are 1.0000.

Table IV. Teachers' Responses on Experiment S6

Question Number	Mean	Mode	Standard Deviation
1	1.4706	1.0000	0.51450
2	1.1765	1.0000	0.39292
3	1.2353	1.0000	0.43724

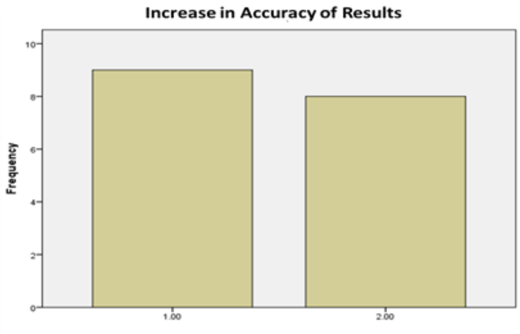

Figure 5.0 Teachers' Responses on Question 1 (S6)

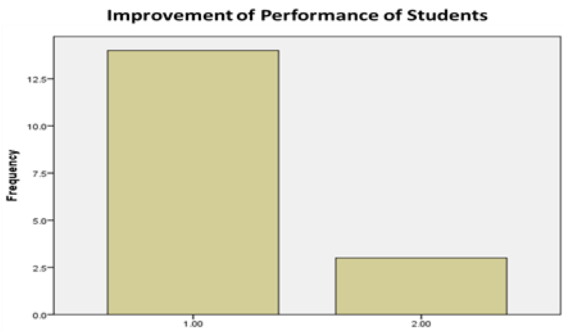

Figure 6.0 Teachers' Responses on Question 2 (S6)

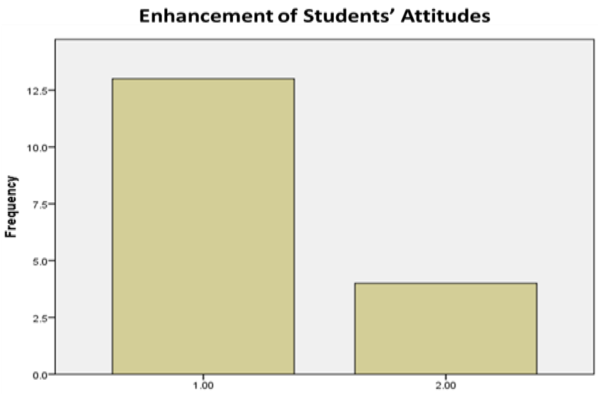

Figure 7.0 Teachers' Responses on Question 3 (S6)

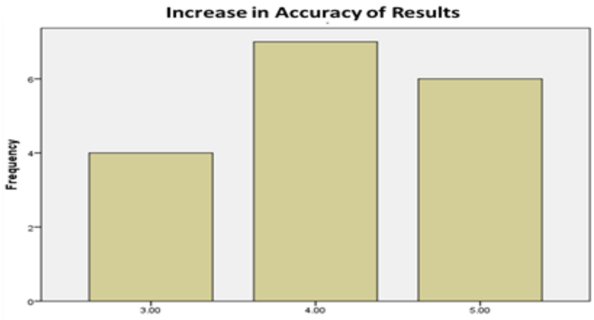

Figure 8.0 Teachers' Responses on Question 1 (S4)

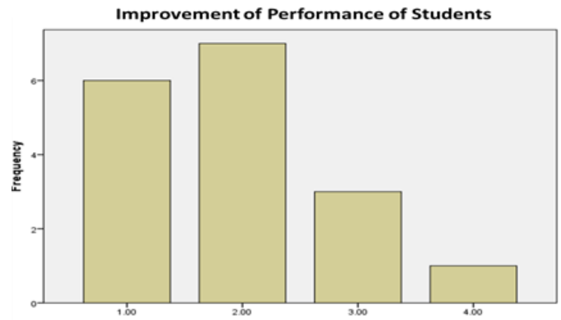

Figure 9.0 Teachers' Responses on Question 2 (S4)

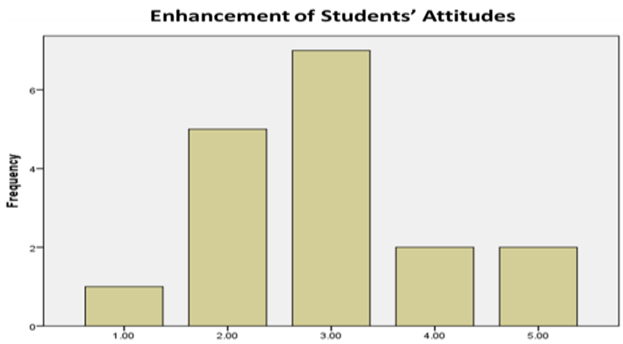

Figure 10.0 Teachers' Responses on Question 3 (S4)

When compared with the students' responses for S6, the responses obtained from the teachers show very clearly that the accuracy has increased (Figure 5.0), the improvements of students' performance has improved (Figure 6.0) and more interestingly the attitudes of students towards learning has enhanced (Figure 7.0).

This is not so, from the observations made from S4 as seen from Figures 8.0, 9.0 and 10.0. The responses are clearly mixed. This indicates that implementation of OBE practice in highly theoretical concepts in Laboratory practices require more research study.

Table V. Teachers' Responses on Experiment S4

Question Number	Mean	Mode	Standard Deviation
1	4.1176	4.0000	0.78121
2	1.9412	2.0000	0.89935
3	2.9412	3.0000	1.08804

V. CONCLUSION

The study conducted here was to measure the effectiveness of attitudinal learning outcomes in the Laboratory components of ECE curriculum. The integrated LO's are identifide in the experimental instructions of ECE programme as acontinuation of the core theory course. While the learning strategies are observable, it is concluded that problem solving abilities will increase in task centric core concepts such as Micro-processor and Micro-controller, but may not increase in non task oriented courses such as Analog Integrated Circuits, when outcomes based strategies are adopted. It is evident that the learning performance and attitude of students will increase visibly. The students' perspective in learning also will improve in Laboratory practices. It is observed that the outcome based strategies help the students to cooperate with peers in group activities which in-turn improve their performances by achieving the desired learning outcomes.

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Asha Murali Associate Professor in the Department of Electronics and Communication Engineering, Government Engineering College, Barton Hill Thiruvananthapuram. Graduated from TKM Engineering College under University of Kerala in Electronics and Communications Engineering in 1994. Thereafter completed Master's Degree in Information and Communication Systems from College of Engineering Guindy, under Anna University Chennai in 2006.

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She is having a blend of Industrial, Research and Teaching/Training experiences of twenty five years from various institutions in India. She had worked with institutions like Centre for Development of Imaging Technology (C-DIT), Kerala State Electricity Board, Model Engineering College, Rajiv Gandhi Institute of Technology, and College of Engineering Thiruvananthapuram.

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He is a Life member of Indian Society for Technical Education and Fellow of Institution of Engineers India. Also a Professional Engineer of Instituiton of Engineers India. Authored two editions of book on "Interactive Computer Graphics Aided Designs"and published 21 papers in peer reviewed Indian and International journals; presented 81 articles in National and International Conferences / Seminars; authored four Instructional modules in Computer Subjects; authored 'Self-Regulated Concurrent Practicing Work Material' for "Instructional System Design for OBE through CDIO Framework". As a Software professional, he had developed over 150,000 lines of coding on UNIX platform in India and abroad. In 1998, he was sponsored under World Bank to the Huddersfield University, UK, on "Curriculum Development in Computer Science Discipline". In 2000, he was nominated to Manila, Philippines on "Computer Applications in Technical Education & Training" under Colombo Plan. In 2017 he was nominated to Dhaka, Bangladesh on Technical/Vocational Education and Training under Colombo Plan Staff College programme on Outcome Based Education (OBE). He has worked in Riyadh, Saudi Arabia for 7 years as a s/w engineer. He has officially visited over 1000 Technical Institutions, on various academic committees in over 18 states of India. His areas of interest are concept extractions, Learning Grids and Computer Science Education, Instructional Designs, OBE-CDIO and e_Learning.