



Active Learning: An Approach to Teaching Electronics course

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Abstract- This paper considered the effectiveness of active teaching when compared to passive teaching of electronics to National Diploma students of the Federal Polytechnic Ede. The students exhibited poor performance not only in tests and in examinations but also when asked questions that require direct and indirect application of the knowledge of electronics. This was attributed to the low long-term retention of the course content and the habit of memorization just for the purpose of passing exams because there is no proper understanding of the course. In a quest to solve the outlined problems, student centered method of teaching and learning was introduced to replace the traditional teacher centered method of teaching and learning. The student centered method of teaching is a way of making a learning process active, that is to make the student think about what they are learning as they are being taught. A three-stage process based on student centered teaching and learning method was designed to gradually move the teaching of electronics course from a passive method to an active one. The performance of the students was found to have improved after implementing the process at the end of the semester. There was a noticeable improvement in their exams scores; their innovative abilities and their ability to transfer knowledge was also improved. Against this backdrop, the three-stage process would still be honed to accommodate innovations in the field of engineering pedagogy owing to the visible positive impact of the process.

Keywords; Active learning, student centered, engineering pedagogy, exams scores, long-term retention, teaching

1. Introduction

Teaching and learning go hand in hand, where there is no form of teaching learning cannot take place. As engineering academics there is a need for us to learn teaching and learning methods (which some might think is just for the educationist) in order to deliver rightly our engineering knowledge.

In the last five years of teaching electronics, low long-term retention was observed in the first and second year students of the Electrical/Electronic Engineering Department of the Federal Polytechnic Ede. The course was perceived to be difficult and abstract (they could not connect theory to practical life). This feedback prompted the search for a way to make the course user friendly thereby increasing not just the retention level but also making the students see the relevance of the course to their daily activities and in engineering as a whole. There are no two classes that are the same; hence, the learning needs of each class differ. There is a need to be able to match the learning needs of the students with teaching approach while all the individual learning needs in a class cannot be attended to, it is important for the teaching approach to cater for the majority of the learning needs.

There are several methods of teaching and they are categorized based on their focal points. Not all teaching methods lend themselves to active learning. Active learning does not refer to a particular method but to several activities incorporated into a teaching method to increase student participation in a learning process instead of passively listening to transmitted information.

In this paper, the need for change in teaching approach for electronics as a subject is raised based on feedback from students' long-term retention and performance after going through an introductory course

in electronics and a second part of the course. A critical look is taken at the shortfalls of the traditional teaching method of electronics and improvements that can be made.

2. Teaching Methods

In Nigeria today, engineering academics are not formally trained in areas that directly influence engineering education (knowledge of pedagogy, developmental psychology, communication theory and others) (Wankat, et al. 2002). Teaching is creating the appropriate environment for learning to take place and different methods have been categorized based on research. (Kapranos & Tsakiropoulos, 2008). The manner in which information is disseminated plays a crucial role in learning (Abanador, et al. 2014).

There are different types of teaching methods, which can be categorized into three broad types. These are teacher-centered methods, learner-centered methods, content-focused methods and interactive/participative methods. (Makokha and Ongwae, 1997)

(a) Instructor/Teacher Centered Methods

Here the teacher casts himself/herself in the role of being a master of the subject matter. The teacher is looked upon by the learners as an expert or an authority. Learners on the other hand are presumed to be passive and copious recipients of knowledge from the teacher. Examples of such methods are expository or lecture methods - which require little or no involvement of learners in the teaching process. It is also for this lack of involvement of the learners in what they are taught, that such methods are called “closed-ended”. (Makokha and Ongwae ,1997).

In teacher-centered education, students put all of their focus on the teacher. The teacher talks while the students exclusively listen. During activities, students work alone, and collaboration is discouraged. Teacher-centered learning fosters a culture whereby the learner does not outgrow his dependency on the supervising instructors and teachers. One of the main goals of modern pedagogy by contrast is to create strong self-directed learners. A teacher- centered learning environment does by definition neither facilitate nor empower a learner’s autonomous study-skills and subsequently lifelong learning skills (Trilling and Fadel, 2009).

In the teacher-centered paradigm (which is usually lecture or exposition type) much emphasis is placed on the faster pace and greater bulk of knowledge transmitted from teacher to student. In the teacher-centered classroom, students receive knowledge passively, Higher cognitive skills including abilities like analysis, synthesis, evaluation, critical thinking, interpretation and self-regulation. Meta-cognitive skills such as facilitated in Problem-Based Learning include the questioning about the justification and validity of arguments, not just the given reasons themselves. Teacher-centered learning most often does not address the importance of open inquiry, which can occur at any stage of the learning process. (Kompa, 2012).

(b) Learner/Student-centered methods

In learner-centered methods, the teacher/instructor is both a teacher and a learner at the same time. The teacher plays a dual role as a learner as well “so that in his classroom extends rather than constricts his intellectual horizons”. The teacher also learns new things every day, which he/she did not know in the process of teaching. The teacher “becomes a resource rather than an authority (Makokha and Ongwae, 1997).

When a classroom operates with student-centered instruction, students and instructors *share* the focus. Instead of listening to the teacher exclusively, students and teachers interact equally. Group work is encouraged, and students learn to collaborate and communicate with one another. Student-centered teaching tends to improve student satisfaction with the learning experience and deepen students’ understanding of how the knowledge may be valued in their own lives.

Learner Centered methods have the following advantages in the following areas as enumerated by (Knilt, 2009):

- i. **Development of thinking skills:** Problem solving teaches students to consider multiple perspectives on a given situation or phenomenon. This develops flexibility in thinking and reasoning skills, as students compare and contrast various possibilities in order to draw their conclusions. The students tap into their prior knowledge and experience as they attempt to solve a problem. Thus, students continually integrate new knowledge into existing knowledge, thereby providing context and creating a personal "storage room" of resources that will be available for future problem-solving needs. They learn to synthesize several sources of information and references in order to draw conclusions and then evaluate these conclusions. Students learn to question ideas and knowledge through the process of comparing and contrasting alternative ideas and contexts. Insight is experienced as they think through a problem or inquiry activity, and draw inferences that allow them to go beyond the simple acquisition of facts and information by learning how to see implications and apply them to other situations.
- ii. **Development of communication and social skills:** Students must learn how to clearly articulate their ideas as well as to collaborate on tasks effectively by sharing the burden of group projects. Students must therefore exchange ideas and so must learn to "negotiate" with others and to evaluate their contributions in a socially acceptable manner. This is essential to success in the real world, since they will always be exposed to a variety of experiences in which they will have to navigate among others' ideas. The students learn how to communicate their ideas and findings with others. This becomes a self-assessment activity, whereby the students gain more insight into how well or poorly they actually understand the concepts at hand.
- iii. **Encourages alternative methods of assessment:** Traditional assessment is based on pen-and-paper tests whereby students demonstrate or reproduce knowledge in the form of short responses and multiple-choice selection, which often inspire little personal engagement. Constructivist assessment engages the students' initiative and personal investment through journals, research reports, physical models, and artistic representations. Engaging the creative instincts develops a student's ability to express knowledge through a variety of ways. The student is also more likely to retain and transfer the new knowledge to real life.
- iv. **Helps students transfer skills to the real world:** Students adapt learning to the real world, gaining problem-solving skills and ability to do a critical analysis of a given set of data. These skills enable the student to adapt to a constantly changing real-world environment. Thus, classroom learning does not result in (only) acquisition of a canon of absolute "truth"; it also results in a resource of personal knowledge.
- v. **Promotes intrinsic motivation to learn:** Constructivism recognizes and validates the student's point of view, so that rather than being "wrong" or "right," the student reevaluates and readjusts his knowledge and understanding. Such an emphasis generates confidence and self-esteem, which, in turn, motivate the student to tackle more complex problems and themes.

c. Content-focused methods

In this category of methods, both the teacher and the learners have to fit into the content that is taught. Generally, this means the information and skills to be taught are regarded as sacrosanct or very important. A lot of emphasis is laid on the clarity and careful analyses of content. Both the teacher and the learners cannot alter or become critical of anything to do with the content. An example of a method which subordinates the interests of the teacher and learners to the content is the programmed learning approach. (Makokha and Ongwae, 1997).

Content-Focused Coaching is a professional development model designed to promote student learning and achievement by having a coach and a teacher work jointly in specific settings, guided by conceptual tools. This last method of teaching centers on students' learning in the lessons but is also about teachers' learning from the process. In the short term, teachers refine how they teach particular lessons to specific groups of students. In the long term, they develop professional habits of mind and general teaching

expertise. Expert teachers know both their subject and the best pedagogical practices by which to bring the subject to their students. The teaching centered method is a passive method while the student centered and the content focused methods are active.

3. Way Forward

Today in most Nigerian tertiary institutions, the traditional method of teaching is what is still obtainable. While examining a class of second year electrical and computer engineering students on their long term retention of the previous semester's electronic course content. It was discovered that less than 10% of the class was able to remember the salient points of the course. To solve this problem, introduction of innovative teaching methods to the classroom is to be embarked upon thereby improving the quality of teaching and students' experience.

Numerous studies have suggested that the student's attention span during a lecture class is roughly between eight-fifteen minutes (Prince, 2004), (Bradbury, 2016), after which the number of students paying attention starts dropping coupled with a loss in retention of lecture material. In electrical engineering where a typical lecture is usually between 90 -120 minutes, other factors such as smart phones or other technological toys also contribute to loss of attention in a lecture class. (Blake, 2016).

It was reported by (Scott, Eddy, McDonough, Smith, Okoroafor, & Jordt, 2014) that students in classes with traditional lecturing were 1.5 times likely to fail than were students in classes with active learning. They reported about 6% improvement in examination scores of students in active learning classes compared to their counterparts in traditional learning sections. Some limitations as highlighted by (Damodharan and Rengarajan, 2011) have been observed in the national diploma Electrical and Computer-engineering students of the Federal Polytechnic Ede that may prevail in traditional teaching methods amongst which are:

- Teaching in class room using chalk and talk is one-way flow of information
- Teacher talking continuously for more than half period without feedback from students.
- Materials based only on lecturer's notes and textbooks
- More emphasis on theory without any practical and real life time situations
- Memorization rather than understanding
- Marks rather than results oriented.

Learner/Students Centered teaching method shifts the focus of activity from the teachers to the learners. Active learning is method in which students are engaged in the learning process. They are required to do meaningful learning activities and to think about what they are doing in contrast to the traditional lecture where students passively receive information from the instructor (Prince , 2004). It Is anything a student can do actively to facilitate learning other than passively listening to lecture. Techniques of active learning are those activities which are incorporates into the classroom to foster active learning (Perry, 2016).

The electronics classes in a semester follows the course below:

Introductory Lecture: to welcome the students to the class, give the course modules course material and schedule test dates in the course of the semester. Other class formalities are done and ground rules are made.

Lectures based on the course modules weekly classes are held to treat the course material and test held at the designated dates. The classes follow a typical lecture method of teaching. Assignments are given when deemed necessary. End of semester examination is conducted to measure the amount of knowledge that can be produce by the students.

Observations:

- The performance of the students was not encouraging in terms of their scores.
- The students were found lacking to the ability to transfer the knowledge of their electronics course to simple day to day issues bordering of electronics engineering.
- The long term retention of the students of the course material after the semester was very low.

In view of the above, a three- stage process was designed based on the student centered teaching and learning. The feedback from each stage is used to refine the approach at the next stage. The Pyramid below shows the contribution different learning activities to retention of information.

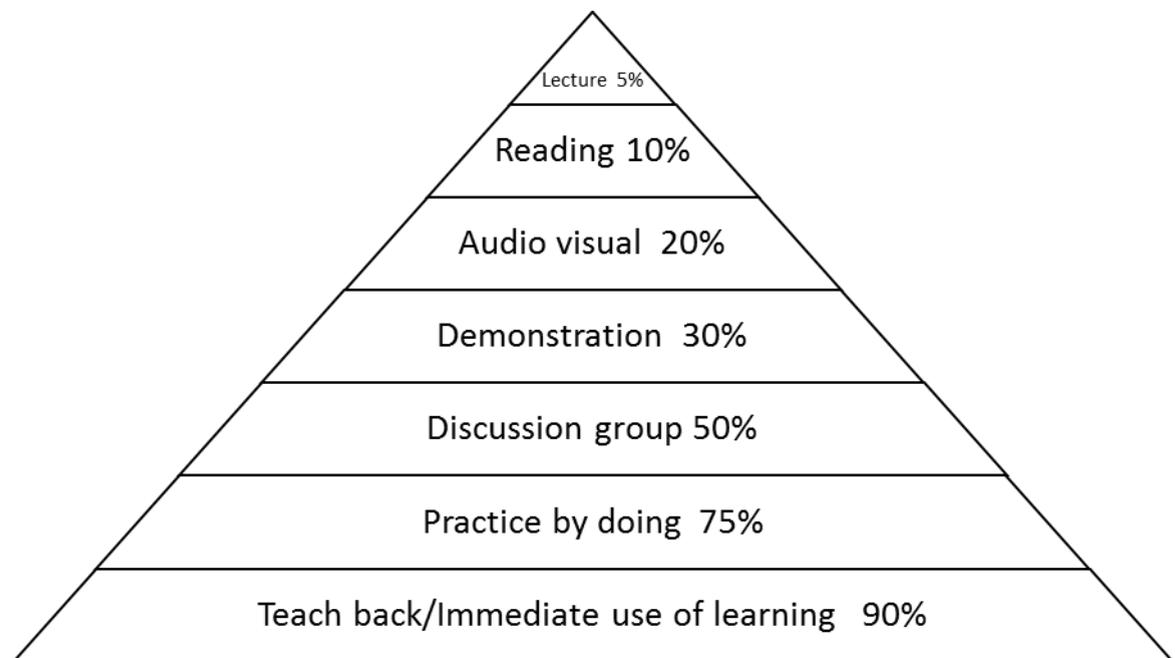


Figure 1: Contribution of Different Teaching Style to Retention of Information (Source: Perry 2016)

Stage One

It comprises of the following steps:

- Introduction: the course is introduced to the students. Its history, development importance and relevance to the present day are taught. This is to increase the level of curiosity of the students and to make them bring the course into their daily life.
- The method of teaching is explained: this is necessary because they are not used to active learning. They need to be carried along so as to adjust to the incorporated activities which are not present in the passive classroom.
- The lecture hour structure is explained: the types of activities the could be expected are enumerated for different segments of the lecture hour. The lecture hour is not spent just on lecture delivery, for every principle, taught activities to drive home the point are done in the classroom.

Stage Two

It comprises of the following steps:

- Pairing and grouping: The students are grouped in fours or a maximum of five at the beginning of the semester and would be expected to seat in their group for each class. This is to enhance communication skills and teamwork.
- Group activities: At several points in the class, a task which is to solved by group brainstorming is given to them (between 10secs to 2 minutes) relating to the subject matter. They are then

stopped after the allotted time. Responses are called for from individuals, the lecturer can also provide a response if necessary then the teaching continues.

- Demonstrations: Because of the size of typical class, demonstrations are pre-taped and played via multimedia during the class to allow all students see what is being demonstrated. This is apart from the accompanying practical classes.

Stage Three.

- The third stage is mainly hands on: In the electrical and electronics engineering department of the Federal polytechnic Ede, students are provided with a personal tool bag which contains a digital multi meter, breadboard, tester, soldering iron, solder to mention a few. Simple circuits are to be designed and given to the students as personal hands on to help in understanding topics are they are taught. The circuits are first demonstrated in class as stated in stage two.
- A mini project is to be given the students which would be carried out in groups. The projects would be assessed based on innovation and understanding of underlying principles.

The above steps have produced a major boost in learning according to (Felder and Brent ,2003), (Wang, 2005), (Bullard, Felder and Raubenheimer, 2008), It breaks the monotony, wakes students up. Academically weak students get the benefits of being tutored by stronger classmates and the stronger ones have a deeper understanding as a result of teaching someone else.

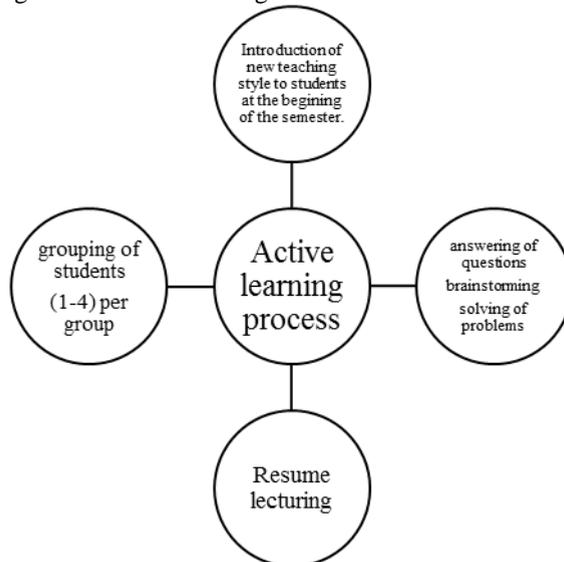


Fig 2: Procedure for Active Learning based on the three stages

On the part of the teacher, more preparatory work would be done in the short term to get the class up and running while in the long term once the teacher is adjusted to the new approach would find it easier taking the class. This is because the course curriculum would have been totally adapted to active learning.

4. Conclusion

The performance of the students was noticeably better than that of the previous semester when there was no form of active learning activities in the classroom. The manner in which the students answered their examination questions showed that a larger percentage of them had a better understanding of the course when compared to the previous prerequisite. Their scores were impressive and the end of the semester examination. There was a more than 50% improvement in their scores when compared with the previous year. The ability of the students to relate the theory of electronics with its practical use was also improved. There was a remarkable increase in the willingness of the students to increase their scope of learning in order to keep abreast happenings in the world of electronics engineering. This work is an ongoing process as different classes have different learning needs. It is anticipated that this whole process

would create a solid structure on ground for student centered learning in electronics as a course which can be duplicated by lecturers expected to the course.

It is also expected that with every new intake, the students would be better engineering students with a more encompassing outlook on electrical and electronics engineering as a course of study. It is also expected that the students' capacity for innovation would be awoken to bring about the much-needed progress in the engineering and technology landscape of the country.

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