Multistage Learning Model for Better Learning: A Cognitive Science Perspective

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***Abstract*—Various learning models have been proposed till date. Many dimensions have been included in different learning models proposed by different researchers. This paper summarizes a number of dimensions important for consideration in learning models. An improved multistage learning model has been proposed which include a large number of factors proved successful earlier. Factors for successful learning have been included from cognitive science perspectives also. Use of this learning model is surely going to prove better for overall success in the learning process.**

Keywords— Learning model, outcome based learning, student-centered learning, project based learning.

I. INTRODUCTION

Learning is an important aspect of any education system. It is the process of acquiring new knowledge, ability and skills to solve given problems [1,6]. There are various ways in which the instructors can teach the students. The methods of teaching and learning have changed over time to time with the advancement in technology from traditional learning approach using chalk and talk to e-learning, problem based learning, project based learning and outcome based learning. This paper aims to present various learning styles and models proved suitable and successful from time to time. The objectives of the present research are to identify various aspects of learning style that are particularly significant in engineering education, to identify the teaching styles accepted by many instructors and to explore the new dimensions to add in the learning styles to improve learning from student's point of view.

Learning is a two way process. It is dependent on the capability of each individual teacher(i.e. educator) and each individual student(i.e. learner). A teacher teaches all students in a class in same way but the learning curve is different for all students. This is due to the fact that each individual has different capacity to understand and learn. Thus learning is found to be efficient for some students only when they get personalized training. Felder identified various characteristics of students from learning point of view[1,2]. According to the author, many engineering students could be in the states active, inductive, global, sensing and visual in learning. The engineering education found at many places was abstract i.e. intuitive, auditory, deductive, passive and also sequential. These mismatches are a hindrance in good learning and result in poor student performance and also to some extent, professorial frustration.

II. EXISTING LEARNING MODELS

In 1997, a transformation was proposed by Catalano and Catalano from teacher centered to student centered engineering education[3]. The roles of teacher were well explained in student centered education. These included:

i. Model the thinking skills
ii. Know where the educator wants his/her students to be congnitely
iii. Develop questions that facilitate student growth
iv. Use and teach students to use visual tools
v. Provide group learning settings for students
vi. Use analogies and metaphors
vii. Provide a no-risk mechanism for indirect interaction between student and educator

There were mixed reactions to this approach as the students may not be capable of coping with the responsibility of self learning and some educators may not be able to fully make students learn in a better way as compared to traditional learning models.

In 2000, e-learning concepts evolved at a quick pace. Regarding pedagogy of learning, according to Govindasamy, the software design of e-learning tools via the Internet does not stretch to pedagogy. The educators are to select the pedagogical manner in which these tools are used in teaching[5].

An e-learning instructional model was designed by Alonso et al. in 2005. They proposed a blended model of learning[11]. The blended learning consisted of self-paced learning and live e-learning facets. The properties of the blended learning identified were :

i. Blended learning is dynamic because the educators are available online, and quick access to latest information is available at real time.

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ii. Blended learning is collaborative because people learn from one another and experts both in and outside the institution.
iii. Blended learning is personalized because each student can select his or her activities from a personal menu of learning
iv. Blended learning is comprehensive because it provides learning events from many sources and many forms

Hadjerrouit proposed a system development approach which translated educational requirements into e-learning[13]. He proposed to implement learning theories to achieve three categories of e-Learning using information technologies from a pedagogical point of view:

(a) The behaviorist learning theory to support the transmission of knowledge from the educator to the learners.

(b)The constructivist learning theory to support task-based activities

(c)The collaborative learning to support learning, dialogue, and discussion with both the instructor and fellow learners through collaboration.

Bouslama et al. proposed an outcome based learning model in 2003, Zayed University Learning Outcome(ZULO)[7]. This model established various criteria in which all undergraduate students must demonstrate their accomplishments which included critical thinking and critical reasoning, use of information technology, ability to recognize information needs, work efficiently in a team taking lead roles to find answers to problems not only local communities but global communities. This involves reaction to various cultural interactions and challenges.

In 2003, Mills and Treagust concluded that engineering educators mostly use project based learning more successfully as compared to problem based learning[8]. According to a study by Katsioloudis and Fantz, the dominant preferred teaching style of the faculty members was the kinesthetic style. "In essence, faculty members are teaching the way they were taught. This is due to the learning style and comfort zone of the faculty. Further research is needed to determine how willing faculty members are to teach outside their comfort level to match the students' preferred learning styles"[15].

In 2009, the use of visualizations like graphics, animation, video, and illustrative images/photos help students understand abstract and highly abstract engineering subjects in engineering courses. A computer tutoring framework was developed and implemented incorporated with visualization learning objects including was found to be very effective in learning and teaching engineering courses[14].

The research results by Lee and Sidhu indicated that the engineering students have preferences in learning styles in decreasing order of activist, reflector and theorist. Pragmatist learning style was preferred very less[18]. The authors suggested that utilization of smart ICT tools should be used to support the broad range of learning styles by the education practitioners in enhancing the learning potential of engineering students.

According to the experiment by Guia et al. (2013), boredom was reduced as the number of completed or attempted problems increased. But boredom reported to be increased when the average time needed to complete the problems was increased. It also increased with average number of attempts allowed to solve a problem[19].

Results from many case studies form wide areas of the world are included in the present research. Table 1 summarizes these:

TABLE I. WORLD AREAS INCLUDED FOR CASE STUDY

Learning Approach/Model	University
Outcome based Educational Model	Zayed university, Abu-Dhabi, UAE[7]
Project based learning	Australia[8] Harvey Mudd College[10]
E-learning	Madrid Technical University, Spain[11], Agder University College, Kristiansand, Norway[13]
Problem based cooperative learning	University of Minnesota, Stanford University[9]
Visualization based Tutorial Framework	California State University, Long Beach[14]
Activist learning style	UNITEN, Malaysia[18]

Based on all the above theories and case study results, there are some key attributes and characteristics that have direct effect on a learning system. These are categorized based on instructor's level, student level and environment level. At the instructor's level, these include the teaching aid used (ICT tools, visualization, graphics, audio, video, chatting, e-learning etc.). The criteria for evaluation i.e. performance of the student is judged on the basis of outcome, solving problem or development of a project related to the learning done. Whether the individual was given personalized attention for learning or not.
At the student level, the ability to take initiative, level of understanding is each individual student and their motivation to learn is very important. All measures should be taken to improve these to improve learning. At the environment level, the main factors are whether the students are given problems or projects feasible in due course of time. A small group can prove better for learning as compared to a larger one.

All these factors are summarized in Figure 1:

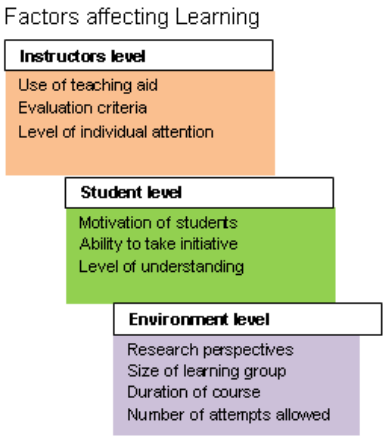

Fig. 1. Factors affecting learning process

III. Preparing for a New Learning Model

In order to propose a learning model, we need to analyze the learning process in existing system, find the limitations and identify areas of improvements.

1) Analysis of Learning Process in Existing Systems

There are four main dimensions in a learning process of a system: students, instructors, learning approach and the evaluation process. The factors for all these should be considered in a learning model.

2) Limitations of Learning Process in Existing Systems

Presently the learning process is mainly focusing on outcome based teaching which should be research oriented and student centric. The main emphasis is on letting the students understand as being told by the instructors. Also some studies emphasize on transformation from teacher-centric teaching to student centered learning, but this is not always successful due to different behavior of each individual to learn of its own.

3) Methods for Improvement of Learning Process

Certainly learning outcomes should be measured in order to prove the success of the learning process. Research based learning definitely has better outcomes as compared to only content based learning. Experiential learning is able to impart a rational learning provided there is sufficient timeframe where experiential learning can be included in learning process. The gap between the knowledge level of the students and the instructors is huge due to difference in age and experience. So the expectation should be only upto a limit according to their age and capacity and level of knowledge input. Many constraints which put the students behind in using their learning potentials fully should be identified and handled properly by the instructors. Cognitive science theories can provide help in identifying these hindrances in their psychological behavior and performance levels. Any learning model which includes these measures can surely result in improvement in learning curve of the students. As there are many type of learners like sensing learners, visual learners, active learners and sequential learners, each student behave and learn differently. Using the genome approach, the stability of behavior patterns for students and groups and their connection with student success in the course was analyzed by Guerray et al. The studies showed that genome is defined by some inherent characteristics of the user rather than a difficulty profile of the problems he/she solves[20] .

IV. Proposed Learning Model

All the methods suggested for improving the learning process are included in the proposed learning model. Diagrammatically, it is depicted in figure 2.

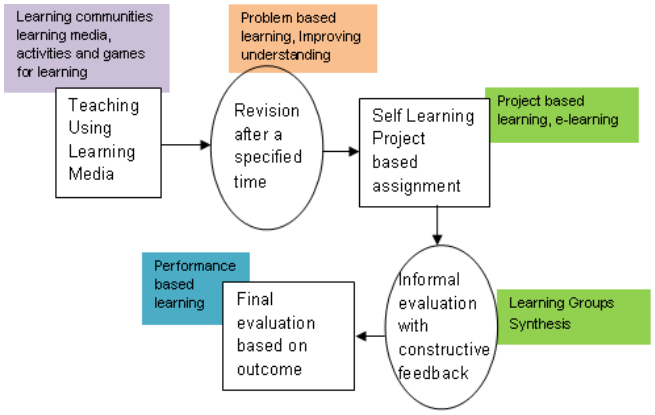

Fig. 2 Proposed Learning Model

There are mainly five steps in the proposed learning model. The first step is syntactic level learning i.e. teaching using learning media. The learning media may also use interactive visualization techniques and media like audio and video clips, graphics, some activities like quizzes, crossword puzzles, rapid fire rounds of multiple choice questions which should not be evaluated formally. This relieves the students from pressure and the learning improves. This different in representation of concepts can also make students remember things for a longer duration as compared to traditional ways of telling i.e. communication. This fact is also supported by Li et al. that with representation learning, the skills to learning improve in intelligent agents simulating a human student[16].

The second step is to give a time to pause in learning and revising what has already been taught. This refers to semantic level learning[8]. This is important to improve understanding and hence memorization as the concepts learned so far should be revised. The approach followed is problem based learning which helps in thinking big and thinking differently[9]. Also the individual student should be clarified about the doubts because as cognitive science has proved that each user has different characteristics and way to tackle a given problem and personalization makes learning efficient[20].

The third step is to learn at pragmatic level i.e. do some project based assignments[11]. This is necessary to check the

level of understanding of the students in applying the concepts learned so far in developing a project. According to Gureckis and Markant, on the cognitive side, self-directed learning allows individuals to focus effort on learning new useful information, and they can expose themselves to information that is inaccessible via passive observation[17].

The fourth step involves informal evaluation with constructive feedback. This is an additional step not found in most of the learning models. This is important for improving the outcome of the problem based and project based learning. Here many learning groups should collaborate together and compare the results and identify the areas of improvement. Feedback loop has proved successful for better learning[13]. The project scope and duration should be smaller and feasible within the duration specified. More number of completed assignments gives a moral boost to students and reduces boredom during learning[19].

The fifth step is final evaluation based on outcome. Thus the problem and projects assigned should be outcome based and that should be verified during evaluation process[4]. The assignment of projects to students also shifts the control of learning from teacher centered learning to student centered learning. This has proved to be a great success in learning as it puts the responsibility on student's shoulders for better learning[3]. Thus performance based learning has also been performed.

V. Conclusion And Future Scope

The aim of any university is to provide education to its students. The ability to learn is the basis for any successful education system. The learning model is the key factor in success of any education system. The methods and techniques for learning have evolved over last 3 decades. This paper outlines many learning modes using different successful approaches. A new multistage learning model proposed here takes into consideration the student point of view in learning and can definitely benefit the learners in better learning.

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