

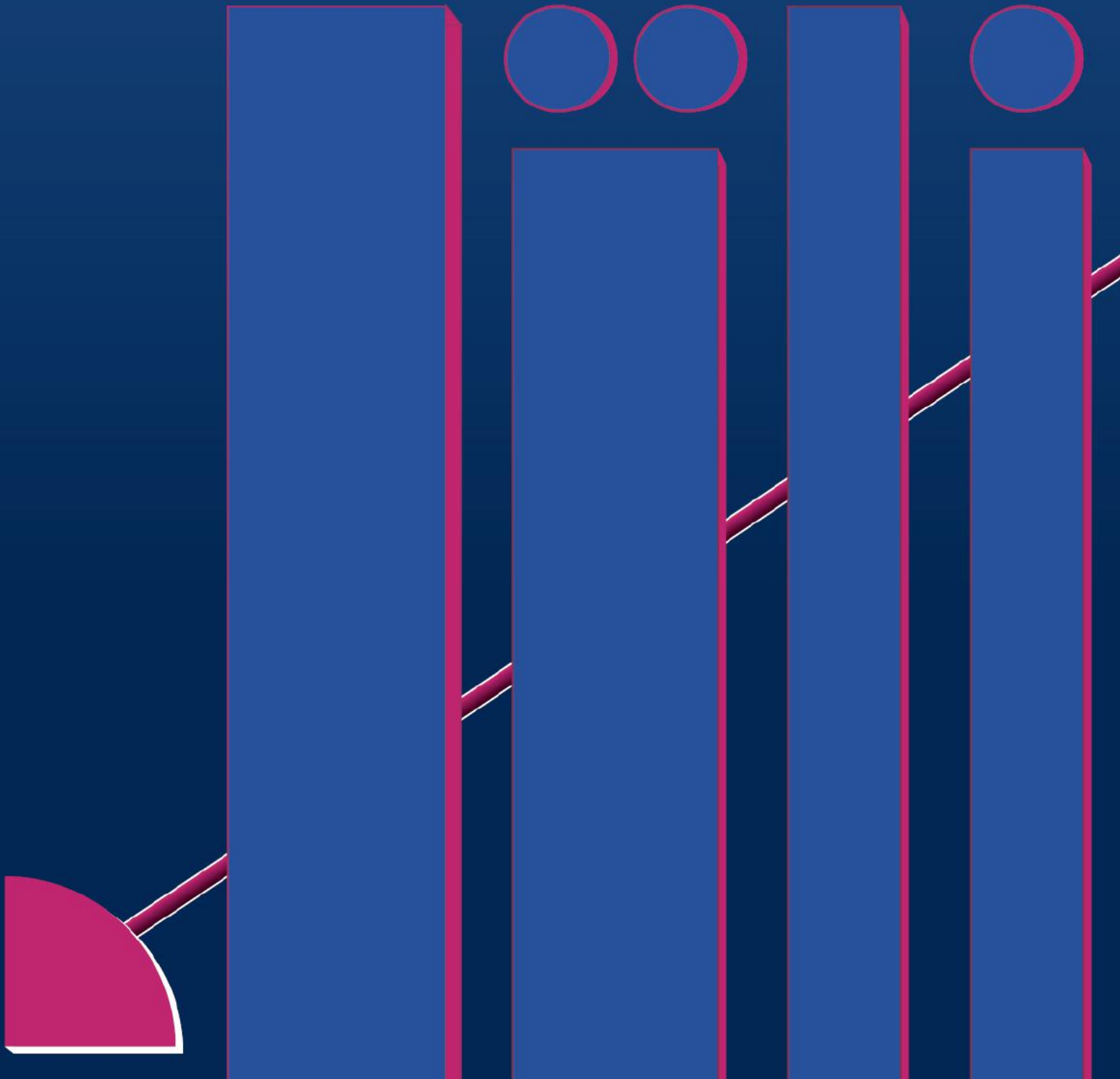
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MODERN TEACHING METHODS OF PHYSICS

A PROPOSAL FOR TEACHING THE ABSTRACT CONCEPT OF VECTOR SPACES



ABSTRACT

This work provides an insightful view into the traditional methods of science teaching. Through an extensive review of the available literature, the author seeks to criticise what they deem an inefficient way of fomenting learning in science students, and to propose an alternative of their own design, considering the multiple intelligence model and the notions of *educere* and *educare* as ideological foundations of an innovative method of teaching.

RESUMEN

El presente trabajo proporciona una mirada incisiva hacia el interior de los métodos tradicionales de la enseñanza en las ciencias. A través de una extensa revisión de la literatura disponible, el autor busca hacer una crítica de lo que considera una manera ineficiente de fomentar el aprendizaje en los alumnos de las ciencias, y al mismo tiempo propone una alternativa producto de su propio diseño, considerando el modelo de inteligencias múltiples y las nociones de *educere* y *educare* como fundamentos ideológicos de un innovador método de enseñanza.

INTRODUCTION

According to Donald Bligh's findings in his book titled *What is the Use of Lectures*, the traditional teaching and learning method is not working [1]; it puts the lecturer/tutor completely in charge, and relies on economic assessment of all teaching and learning resources. Such method renders students into passive learners.

Modern teaching and learning should make learners independent, according to Muijs and Reynolds [2]; and according to Brooks and Brooks [3], a proper assessment should be integrated. The strategic approach to modern teaching is focused on "why we want to teach?" using the two methodologies of *educere* and *educare* from the Latin meaning of general education.

Every topic in education, including Physics, must have a method that makes learning active, according to Edgar Dale and "The learning pyramid" [4].

The seven laws of teaching by John Milton Gregory [5] has had the most influence on modern teaching and learning; furthermore, communication between teacher and learner is also important in modern teaching according to Petty [6].

The three theories of learning: *Behaviorism*, *Cognitivism* and *Humanism* are used in different areas: Behaviorism is used with young learners, Cognitivism in higher education, and Humanism with mature students.

The best way of assessing teaching and learning is by using Tummons' method [7].

Teaching and learning is an old practice that has existed for many thousands of years; however, higher education has been in existence for six hundred years without any major change. We measure education in the twenty-first century by how many students have graduated, and such measure does not relate to the real outcome of education, even when we try to relate education with employment. Therefore, the question is "why do we educate?" When we find the answer to that question, then we will be able to measure the performance of education

THE TRADITIONAL WAY OF TEACHING AND LEARNING

Traditional teaching lasted 600 hundred years since the middle ages without major changes. This continuous traditional way of teaching is failing in the twenty-first century. Some higher education performance assessments are mainly based on the growth of the number of students enrolling in universities worldwide. According to the University of Oxford on its report of International Trends in Higher Education 2016-17 [8], the number of people entering higher education has increased from 14 % to 32 % in the two decades prior to 2012.

According to Robert Goddard, the number of students around the globe enrolled in higher education will reach 262 million by 2025, up from 178 million in 2010.

According to Philip Altbach, from the Center for International Higher Education at Boston College in the US, only two countries in the world will be responsible for much of the increase in the students' enrolment numbers in Higher Education. Therefore, the Chinese are rethinking expansion as they are beginning to have more unemployment of university graduates. Andreas Schleicher, the OECD's head of education, has written that China now opens the equivalent of a new university every week [9].

Such financial modelling measurement of Higher Education performance focuses on the expansion of students' numbers, rather than on the

quality of teaching and learning. What happens to the remaining percentages of students that never reach Universities? The current teaching style is based on production measurement of supply and demand. This production chain system serves only a small section of the job market. In response to the increase of student's enrolments, universities build larger lecture theatres; except for a few universities in European countries, like Germany, Denmark, and Finland, where teaching and learning use other methods than lecturing.

Donald Bligh, in his research on teaching in higher education, summarizes:

"Lecturing is inefficient and any other present methods of teaching are much better compared to the traditional lecturing."

The traditional teaching and learning method puts the lecturer/tutor in complete charge of the classroom/theater, where teaching relies mainly on textbooks and emphasizes basic skills; additionally, learning assessment is placed as a separate entity from the number of study hours, rather than on lecturing hours.

Lecture rooms are still extensively used because they are economical and meet universities' budgets.

In the university where I teach Physical Science students, I found students have a culture of listening, and thus become passive learners. In Physics, students are required to participate in teaching and learning, laboratory experiments, workshops, and other methods that make teaching and learning interactive and use a participative approach.

THE MODERN TEACHING AND LEARNING

The modern teaching method is effective because the learner learns through sociable interactive environments and becomes an independent learner [2].

This method is hands-on based on the big idea of practical workshops. Therefore, assessment is an activity integrated with teaching and learning, and occurs through portfolios and observation [3].

The strategic approach to modern teaching is focused on "why we want to teach". This question will lead us to consider the culture of the individual classroom, its diversity, the students' background, experience, knowledge, environment, and learning goals. Explanation-and-demonstration is the new way of teaching in today's modern world.

This leads to considering the two methods that may come from the ancient Latin words *educere* and *educare*. In modern teaching, if the two methods are used as a combination, it may provide

good results throughout the learning age of students.

From my own experience, the *educare* style may be used for primary education, it will later overlap with the *educere* style in secondary education and then fade away, when *educere* will take over and prevail up to higher education.

My new approach to teaching and learning was implemented with physics students in higher education sessions. I begin by posing a physics problem and draw out several answers or solutions from the students. Then I go on to explore and build a lesson plan on the suggestions that emerge from the discussion. The best example is when I posed the questions "What is the definition of friction?", "Where can we experience such phenomenon?", "How can we reduce its negative effect to save energy?", and "What consequences in our everyday life will be there if we do not?"

A great way of inviting students to participate in teaching and learning is to create an atmosphere that encourages student participation by giving them a coursework or assignment that is relevant to their everyday life, a method that will make their learning relatable and constructive to what they learn. In the classroom, I use a discussion approach to discuss their assignments in groups and use the feedback and comments from the whole class. When I give such opportunity to students to contribute to their learning, they feel confident and assertive, particularly when I pose challenges to their ideas. This can lead to constructive debates that encourage students to engage with the subject of physics. I found such approach thought-provoking, and adequate to present different points of view on any given topic. Finally, I do away with an approach that relies on only certain views as the best accounts for evidence.

The learning theory that I found works better with students learning physics is based on "The learning pyramid" on the active learning section [4].

I used a combination of three teaching and learning styles from the multiple intelligence model: visual, kinesthetic and logical and mathematical. These three styles are adapted from the Seven Laws of Teaching by John Milton Gregory [5], which has an important influence on my teaching. Lecturing must take into account the seven important factors of teaching and learning:

- (1) The Teacher is the one with the *knowledge*, and the *method* on how to convey the right information to the learner with the right balance of learning capacity.

- (2) The learner who attends has immense interest and passion to learn.
- (3) The *language* used must be the fundamental *medium* between teacher and learner and it has to be common to both.
- (4) The teacher must explain the lesson using the knowledge of the learner.
- (5) The teacher uses the learners mind to grasp the desired thought or art of the knowledge required from the lesson.
- (6) The teacher must fully understand the crucial thinking in the learner's own understanding of a new idea, truth, or knowledge.
- (7) The reviewing process must include reviewing, rethinking, re-knowing, reproducing, and applying.

Communication in teaching is also the most important factor to convey information to learners. Any ineffective communication or distortion thereof may lead to wrong information or even misunderstandings. Petty [6] noted: "In practice, a number of barriers present themselves, preventing or inhibiting effective communication".

I have successfully explored the main three theories of learning, Behaviorism, Cognitivism, and Humanism, in the communication with learners. I have examined these theories against my own teaching practice, and I have found them to overcome barriers to learning by students from different cultural backgrounds.

The theory of behaviorism as a theory of learning, I found it to be effective on young learners as a direct response to the continued application of specific stimuli, where it is used to positively reinforce and encourage wanted behavior and negatively reinforcing and discouraging unwanted behavior. Reece and Walker [10] expressed this theory by their comment: "thought that sensations, feelings, and instinct were not a necessary part of the study of learning. The only area of interest is what the 'subject' is doing in response to the stimuli".

I found this theory of behaviorism to work well in motivating the learners by praising them for their good work. Such approach is helpful to overcome their difficulties on punctuality and attendance, and to provide stimuli to the course.

I found the theory of Cognitivism to go a step further than the Behaviorism theory, because it is based on "teaching for understanding." As Petty [6] notes:

"... new learning is built on existing learning [...] cognitivist theory called 'constructivism' is now almost universally accepted by all experts on the brain or the mind. They all agree that learning occurs when students construct their own meanings, usually out of their prior learning and experience, and of course out of their instructional experience".

I found such theory helpful when teaching higher education students, where group learning and workshops take place; particularly, discussion sessions after watching a video clip on a certain topic. I use this method to overcome barriers such as lack of practice with social interaction.

The theory of Humanism proved to be more suitable for mature and experienced learners, what Reece and Walker describe as a 'meaningful context to the information learned' [10].

Also by Petty's comment [6]:

"The humanistic school believes that emotional factors, and personal growth and development, are the highest values,...that society, schools and colleges exist to meet the needs of the individual learner' and that 'Teachers are encouraged to help each learner choose what knowledge and skills they want to learn".

The assessment of teaching and learning we use is the one that assesses the new skills learned by the student and it has been adapted from Tummons [7], particularly the last part of his definition:

"discover whether or not the learner could perform a specified task in a workshop, or to judge the extent to which the learner has mastered a new skill or a new body of theoretical knowledge".

The usefulness of this method is to assess the new skills learned by the student using the kinesthetic method.

In the twenty-first century, education performance is measured by how many students are graduated, which is a financial approach. This measure has no compatibility with education or students' employment prospects. The future market of china and India also has a trend of incompatibility of such measure according to their own standards. Therefore, what is the solution?

Education programmes worldwide are frameworks that require learners to fit within them, rather than the programme fit each learner's requirements. Education programmes would be better if they could be suited to each individual learner,

by introducing Individual learning Plans (ILP). The strategy of each session would be better planned by introducing a lesson plan structured into three stages: Stage 1 is for conveying information to the learners by the teacher or lecturer, using visual and audio methods. The second stage would be in the form of a workshop for learners to explore what they learned and carry out experiments on the knowledge they gained from the first third of the session. The third stage of the session would be used for discussing, debating and developing their understanding of the session's topic.

ACKNOWLEDGEMENTS

I would like to thank my partner Dr. Ibrahim Serroukh for his tremendous contribution to the research, and the resources and involvement of his Physics Science department at the Autonomous University of Queretaro. I would also like to thank Marie Sayers and Professor Cliff Huggett from Canterbury University for their wonderful support.

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