

# UNDERGRADUATE PHYSICS STUDENTS' CONCEPTUAL UNDERSTANDING IN THE LEARNING OF KINEMATICS USING A BLENDED APPROACH

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## Abstract

Undergraduate students' understanding of physics concepts plays a significant role in the students' interest in the subject and its content. Kinematics as an introductory concept at first year level can be used to stimulate and develop students' interest in the subject. Undergraduate will have more ambition to pursue careers in physics or to be competent in the subject knowledge in their different study fields. The study was conducted with 1<sup>st</sup> year B. Ed (SP and FET) Natural Science specialization students at Central University of Technology, Free State (CUT) in Bloemfontein. The study investigated how blended learning enhance 1<sup>st</sup> year physics students teachers' conceptual understanding of 1-D Kinematics. Physics Education Research (PER) groups emphasized the significance of "active engagement" of students with the concepts to be fully comprehended or known. An open-ended question paper on kinematics from high school exam was administered as a pre-test to introductory physics students. The results showed that more than 70 % of the students could not remember and or recall what they did in high school. A mixed feeling of opinions was obtained and somehow majority of them were even discouraged from this research pre-test and wanted to drop out if that's what is expected of them at university. The researcher had to allay their fears and they were put into an intervention programme through blended learning to gain their self-confidence. A follow-up questionnaire was administered to them and the results indicated an improved performance and competence of over 85% due to understanding the concept than learning to pass.

**Keywords:** kinematics, subject knowledge, conceptual understanding, blended learning, Physics Education Research

## 1. INTRODUCTION

We are living in a digital era where technology is in the forefront of our day to day life. This led to teachers and students being provided with new innovative ways like blended learning that stimulates and enhances teaching and learning of new concepts like kinematics (López-Pérez, Pérez-López & Rodríguez-Ariza 2011). López-Pérez et al., 2011 further indicated that there is a positive impact of blended learning in that it has led to the reduction in the rates of tertiary dropout, and improvement in the final examination results. Furthermore perceptions of students on blended learning tasks have been found to be consistent with their final results and dependent on age, background and rate of class attendance of the students.

In the teaching and learning systems especially at higher education institutions (tertiary level), various methodologies are used to teach and learn. In terms of technology advancement, blended learning in the form of e-learning has become prominent to enhance teaching and learning at the higher education institutions. This type of blended has been used previously in the classroom as a combination of traditional face to face and online or computer-based methods of instruction (Bonk & Graham, 2012).

The traditional face to face teaching and learning strategies for blended learning include classroom situation

in the form of lectures, textbooks, laboratory work (experiment), worksheets or printouts (notes), etc. (Singh, 2003). Singh (2003), emphasized that blended is mainly dependent and based on the idea that learning is not a once off thing, but a continuous process and it has many and different advantages as compared to a single medium of teaching and learning. It actually does not completely replace traditional methods of instruction, i.e. classroom-based teaching and learning practices, but it is meant to support and enhance it (Dept of Physics, UWC, 2016).

The deliverance of subject matter and its audience have been investigated to be highly dependent on the teaching and learning methodologies, but it is not possible to find one that will apply for everyone (Chew & Wee, 2009). Berman and Netshia, 2018, mentioned that there was a need to avoid the tendency to polarise the classroom and therefore a means to promote curriculum and develop a pedagogical strategies for this purpose. Their finding was based on the events that lead and transpired during tertiary students' #FeesMustFall and the call to decolonise higher education/ curricula protests in South Africa. They further argued that tertiary institution educators were faced with a challenge to engage more appropriate teaching and learning methodologies towards relevant and revisited strategies in their sector.

Laws, 1991 stated that computer applications in first-year university physics comprises of new and general tools that have to be adapted to. Th tools involved begin with collection of data and graphing/virtual representation, analysis and interpretation of data and graphs and problem-solving. These are the core and underlying aspects of kinematics, an introductory concepts in the first-year undergraduate physics. She further argued that computer tools should be selected in such a way that purports the aims and objectives of the course it is intended for, which moves the concept from a tradition view, a structured theories, to a computational view, i.e. the basic understanding of what physics is actually about. The essential part of computers is that they now provide a researchers and students with a constructivist approach of laws and principles of physics through direct observation (Laws, 1991). She further states that the Computer Assisted Instruction tool is required for the reinforcement of textbook method but is not a supplementary of an envisaged textbook.

It is for this reason that educators have realised that without computers, it will be difficult to learn and understand physics and its role should be same in the classroom as it is in the research laboratory (Laws, 1991). Computer applications should therefore be easy to grasp and relate in a real educational environment or situation.

According to National Education Association (NEC), (2017), students' learning should be taught and emphasized through their active engagement in order for them to develop a way of retaining and processing information. This will help them to do be rhetoric, think deep and able to solve problems. A constructivism approach of learning will hence be developed through various active engagement strategies, viz., repetition, trial and error, and pose questions and this will enhance increase their performance in the final results (NEC,2007).

Teachers have to think outside the box in their lecturing. The teacher should equip their students with skills and concepts that will enhance them to draw their own conclusion in a constructive and scaffolding manners (NEC, 2017). Cooperative learning especially online assist students to focus on the subject matter and give them the ability in the new information processing. In this manner students will develop skills in posing questions, manipulation of information and linking what they already know with what they have just learned or new. Students will further develop through active engagements that reinforces their learning and assist them to achieve long lasting knowledge. Inquiry and inductive will be stimulate amongst students to make their learning fun and interesting towards achievement of their desired or induced goals (NEC, 2017).

Idaho Digital Learning, (2014) mentioned that schools are seeking to give students experiences of learning that is personalized through a combination of face to face learning and online instruction. It stated statistics have proved that blended learning yields improved results as compared to non-hybrid equivalents of face to face. This emanates from students' gained experience in flexibility and personalized learning allowing teachers to broaden time on their learning facilitation.

The ideal companion for any teacher interested in the use of technology in the language classroom, "Blended Learning" has therefore been to be more suitable for teaching in a classroom when using technology as a language of instruction (Dziuban, C.D., Hartman, J.L., and Moskal, P.D., 2004). Dziuban et al., 2004 argues that basic information for novice technology users is combined with complex ideas in the utilization of technology for teaching and learning environment. Students' learning is enhanced and supported by their teachers who gained practical suggestions and ideas into ways of technology usage. In this way, it will generally have a greater impact in the methodology of teaching.

Phage (2015) citing previous researchers (e.g., McDermott & Redish, 1999; Basson, 2002; Beichner, 1994)

indicated that integration of mathematics (algebraic) knowledge hamper students' conceptual understanding of kinematics. The comprehension of variable like position, velocity and acceleration versus time seem to pose a problem and confusion amongst students. Phage (2015) investigated that students have difficulty with analysis, presentation and interpretation of data and graphs in kinematics. Friel et al. (2001) stated that students' confusion and difficulty are borne in the skills to predict and solve physics graphs and their inability to use knowledge and background gained in a mathematics class of functions and graphs. These inabilities and difficulties have hampered the effective teaching and learning of kinematics.

The researcher therefore investigated how blended teaching and learning through e-learning could improve the conceptual knowledge and understanding of kinematics.

## **2. PROBLEM STATEMENT**

The study was prompted by a high tendency of full-time students to absent themselves from classes. Except there are continuous disruptions of classes in higher education institutions due to students protests for various reasons. The study also culminated from a recent "Fee Must Fall" protests to decolonise tertiary education in 2016 in South Africa. Academics and students were faced forced to use technology to be in pace with the academic study, while protests were barring students from coming to class, and they had to be prepared for the final examinations at the end of the year. A blending approach of e-learning was used to enforce teaching and learning outside the classroom. The approach showed an improved performance in the students' end of year results as compared to their normal face to face class. Kinematics is a starting concept in the undergraduate introductory physics and research have proved that students have a deficiency in the conceptual understanding and knowledge of it (Phage, 2015; Phage, Lemmer and Hitge, 2017).

## **3. AIM OF THE STUDY**

The aim of the study was to investigate how blended learning enhances first-year undergraduate physics students teachers' conceptual understanding of 1-D Kinematics.

## **4. OBJECTIVES**

- To determine the conceptual understanding of kinematics by first-year B.Ed. (SP and FET) physics students through blended teaching approach.
- To investigate the knowledge of kinematics by first-year B.Ed. (SP and FET) physics students.
- To identify blended learning tools that can enhance performance of first-year B.Ed. (SP and FET) physics students in kinematics.

## **5. RESEARCH QUESTIONS**

- What criteria was used to determine the conceptual understanding of kinematics by first-year B.Ed. (SP and FET) physics students?
- What knowledge do first-year B.Ed. (SP and FET) physics students have on kinematics?
- What possible blended learning tools can be used to enhance performance first-year B.Ed. (SP and FET) physics students in kinematics?

## **6. SIGNIFICANCE OF THE STUDY**

The study will make physics high school teachers and lecturers to take cognizance of the blended learning approach to enhance students' conceptual understanding and knowledge of 1-D kinematics. This will also help students to appreciate the fundamental basics of 1-D kinematics in physics and be able to apply them. Thus, leading to improved performance and matric results in physics.

## **7. RESEARCH METHODOLOGY**

A mixed- method approach was used in this study. An open-ended question paper on kinematics from high school exam was administered as a pre-test to 20 introductory B. Ed. (SP and FET) physics students. The instruments used were questionnaires and follow up interviews with a focus group. The questionnaire was verified for validity and reliability by fellow colleagues. The study materials and tasks were posted on the Blackboard (e-learning tool) to a convenient and available sample of 78 first-year B.Ed. (SP and FET) physics students. A discussion platform was created on ear-learning to engage with the students. Task and feedbacks were done online. The population was made of 120 at University of Technology (UoT), in Bloemfontein, Free State Province, South Africa. A follow-up interviews was conducted with 10 of the respondents. The respondents undertook to participate voluntarily in the study according to the research

ethics.

## 8. RESULTS AND DATA ANALYSIS

With this background in mind an exploratory study was undertaken in 2016 with the first year B.Ed. (SP and FET) physics students to identify the problem and the impact of technological use, the blended approach, in the teaching and learning of 1-D Kinematics. First, the researcher established their general pass level (symbols) and the levels of difficulty of the topics in physics before determining their understanding of kinematics. The participants were thus asked to state the grade (symbol) with which they passed physical science in their matric results. Table 1 shows a breakdown of the grades obtained by the students in this subject.

**Table 1. Physical Science Matric Symbols (n = 78)**

Symbol	Physical science	
	No. of students	%
7	4	80 and above
6	7	70 – 79
5	19	60 – 69
4	35	50 – 59
3	10	40 – 49
Blank	3	-
Total	78	100%

It should be noted that students are admitted into B.Ed. Natural Science studies if they obtained a symbol 4 and above, i.e., 50% and above in physical science. Those who got a symbol of 3 (between 40 and 49%) are given second chance by writing a selection test, which if they pass it, they were able to be admitted into programme.

From the table 1, 10 students (about 13%) were admitted after writing and passing the selection test while three (about 4%) did not specify the symbol in their matric result. It can be seen that the majority of the students (35) had passed the subject with a symbol 4 while 30 passed above symbol 4 (60% and above). This says a lot about their level of understanding of physical science, particularly in physics.

Participants were also asked which topics they find difficulty from and to rank them according to the level of difficulty accord Linkert scale. The frequencies of most difficult topics were recorded as follows

**Table 2. Topics in physics (n = 78)**

Topic	Frequency	%
Electricity	17	21.8
Mechanics	48	61.5
• Vectors and scalars	22	28.2
• Kinematics	19	24.4
• Momentum	7	9
Others	13	16.6

Table 2 shows the problem areas that the students identified in terms of physics sections/topics in the senior certificate physical science results. It indicates the percentage difficulties students had in answering these

topics. Kinematics was the second most topic they were unable to answer or or get correct answers.

On analysis of the pre-test results, more than 70 % of the students could not remember and or recall what they did in high school. A mixed feeling of opinions was obtained and somehow majority of them were even discouraged from this research pre-test and wanted to drop out of physics if that's what is expected of them at university. The researcher had to allay their fears and they were put into an intervention programme through blended learning to gain their self-confidence Hence this study investigated how blended learning through e-learning could improve the performance in the topic.

A follow-up questionnaire was administered to them and the results indicated an improved performance and competence of over 85% due to understanding the concept than learning to pass. The results after intervention indicated that with use of technology of online teaching and learning, students gained confidence and were motivated to study to study physics and enjoyed the topic. Students also showed a great performance improvement in the topic. It was also obvious that blended learning through e-learning was the choice prefer to be taught and learn with as the results and feedback are immediate and spontaneous and they can quickly rectify their mistake unlike having to wait for a class.

## **9. DISCUSSION AND CONCLUSION**

The study indicated that participants did have difficulties with methodologies and approaches used in the teaching and learning of kinematics but not actual physics concept. This suggests that with available resources and constant practice and use, blended approach in the teaching and learning of kinematics enable students to grasp basic concepts and knowledge and hence enhanced performance. Using cooperative/active learning in the form of online group discussions, tasks assessments, peer learning and immediate feedback also constructivist learning. As an instructional tool, which sometimes is underutilized due to cost factors and unavailability of resources. The understanding and application of kinematics in physics could rely on the use of technology, suggesting that more resources in the form of tablets, computers and internet (data or WIFI) should be made available towards its effective teaching and learning.

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