Using the cellphone in an interactive lecture demonstration in the subject Vector Algebra, addition and subtraction of vectors

José Orozco Martínez[1, 2], **César Mora**[1], **Rubén Sánchez Sánchez**[1]
[1]*Instituto Politécnico Nacional. Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada. Av. Legaria # 694, Col. Irrigación, Del. Miguel Hidalgo C.P. 11500, México D. F.*
[2]*Instituto Politécnico Nacional. Centro de Estudios Científicos y Tecnológicos #11 Wilfrido Massieu Av. de los Maestros No. 217, Col. Casco de Santo Tomás, Del. Miguel Hidalgo, C.P. 11340 Tels. 57296000, Ext. 63639.*

E-mail: joorozco@gmail.com

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Abstract

Interactive Lecture Demonstration (ILD) is a methodology developed by Sokoloff and Thornton [1] for teaching physics, and has proven that it promotes learning in introductory physics courses at university level; sometimes the ILD requires the use of computer and video projector, to develop the activity.In this paper presents the results of using an ILD strategy in teaching physics by using cell phones. This strategy was applied in high school level 16 and 17 years old learners. The theme used to apply this methodology was vector algebra, addition and subtraction of vectors, which is part of the Physics I curriculum at Centro de Estudios Científicos y Tecnológicos 11 Wilfrido Massieu in Instituto Politécnico Nacional University (CECYT 11).

Keywords: Active learning, cell phone, mobile device, vectors.

Resumen

Las Clases Interactivas Demostrativas (CID) son una metodología desarrollada por Sokoloff y Thornton [1] para la física educativa, usando esta en los cursos de física introductoria a nivel universitario; en ocasiones las CDI requiere el uso de una computadora y un video proyector, para realizar la actividad. Se utilizo una CID la cual emplea el teléfono celular, en este artículo se presentan los resultados obtenidos. Esta estrategia se aplico a nivel bachillerato en alumnos con edades de 16 a 17 años. El tema que se cubrió con esta metodología fue algebra vectorial, suma y resta de vectores, el cual es parte del currículo del Centro de Estudios Científicos y Tecnológicos 11 Wilfrido Massieu del Instituto Politécnico Nacional (CECYT 11).

Palabras clave: Aprendizaje activo, teléfono celular, dispositivos móviles, vectores.

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I. INTRODUCTION

High school students at Mexican Republic the first contact of the students with the vectors and their algebra is, in physics class. In order to be able to solve the physics exercises, the students need to manipulate vectorial algebra suitably.

The physics is a particularly difficult subject for the majority of the students. One of aspects that influence so that this is thus is that they must learn “to add” of different way; when they havelearn how to "add" differently, when they have to solve problems involving vectors, are the great contradiction: How is that 5 plus 2 is not equal to 7?

In our research, we found that "since late last century in various research groups have shown the Physical Education negative consequences of continuing with traditional teaching (McDermott and Redish, 1999)" [2]. Mora also mentions: "One of the best alternatives to traditional teaching techniques are Active Learning in Physics, this position is supported by educational research in the last twenty years (Sokoloff, 2006, p.10)" [2]. Building on this research, this paper proposes the design of an educational activity through which learners construct their knowledge, using the basic fundamentals of Physics Active Learning (PAL).

II. THEORETICAL FRAMEWORK

This work uses the theoretical framework proposed by Redish [3] "which is based on five principles that come from the lessons learned by psychologists and educators".

1. Constructivist principle.
2. The context principle.
3. The change principle.
4. The distribution function principle.
5. The social learning principle.

It is from these principles that have several strategies for teaching physics in the Active Learning.

Of the various active learning methodologies selected the proposed ILD Sokoloff and Thornton [1] because they utilize a methodology that is used for numerous groups, as is the case of groups in the CECYT 11, in addition to rely on ICT, these tools are not used in the "Introductory Physics Tutorials" from McDermott. The "Workshop Physics" Laws' replace traditional classes, which use computer equipment and highly specific sensors, which are difficult to achieve in our school.

III. THE USE OF CELLPHONES IN EDUCATION

With the introduction in the market of personal computers (PC) in the decade of the eighties, thanks to lower prices of these devices, more people own a personal computer, but has nevertheless has not been possible lead the computer for a student lounge, as intended to make the project "One Laptop per Child" [4]. In our search for computational resources to be used in the classroom, we found the cell phone multimedia, which have capacities of data processing in excess of a personal computer of the 80's, and even equal the processing power of computers mid 90's. In this respect, Prensky [5] comments:

"A billion and half people around the world, is walking down the street with high capacity computers in their pockets. The fact is that they do not realize this, because people do not identify as computers. Today's high-performance cell phones have the same capacity as the PC of the mid 90's, but cell phones, consume only one-hundredth of energy. Even the simplest cell phones that only have voice capability, more powerful microprocessors operate the computer aboard the spacecraft that landed on the moon in 1969. "In the same paper the author mentions the statistics of cell phone penetration in different countries in the period from 2004 to 2005, reporting a cell phone penetration ranging from 90% to over 100% in some European countries".

The proposal made in this work on cell phone use in the classroom, in most cases is not well regarded by teachers as described Gilroy [6] "... 85% of teachers indicated that they want considered banning cell phones in the classroom". In CECYT 11 One of the recommendations given to the students, do not carry cell phones, MP3 players or laptops, the school also informs them that the school is not responsible for any of these objects value, yet we find that 97% of students take their phone to school.

Kolb [7] mentions the following reasons for mobile devices to use in school:

- "The cell phone use has students use technology in the school daily".
- "If these devices are used as a tool for:
  - The construction of knowledge.
  - Data collection activities in.
  - Collaborative Communication.

Help students to become more competitive in the digital world".

Another advantage we found is that you can design applications that fit the themes of the curriculum.

The CECYT 11 students bring every day the cell phone to school, despite the reluctance of teachers and the authorities of this, which does not imply an additional cost if we use as a teaching resource, and if we want students relate what you see in class with their daily lives, what better example than the technology they use, Kolb [7] writes about:

There is a "digital disconnect" between how students use technology for their everyday communication and how to use technology in the classroom.

This author also justifies the use of cell phones in the classroom, saying that in this century, is part of our job as educators to help students manage technology and navigate the world of information flowing consistently, efficiently and safely.

To use these devices in classroom, we consider its capabilities, which were adapted for use with Active Learning in Physics, specifically with the ILD.

IV. THE USE OF CELL PHONES WITH ILD

Using as a reference the vector ILD proposed by Sokoloff and Thornton, a new ILD was developed using cell phones to its application. To make it, seven programs were designed in Java2 Micro Edition, to run on cell phones. The ILD was applied in CECYT 11 to an experimental group, and a control group was used.In the follow table we show some changes was made to Sokoloff ILD teachers guide with ours activity.

TABLE I. Some changes were made to Sokoloff ILD teachers guide with ours activity.

Original Guide (Sokolof & Thornton, 2004)	Ours teacher guide
General Notes on Preparation and Equipment: They wrote about a Visualizer it's a software package that provides a "vector playground", they give the internet link to download this software and a tutorial too.	General Notes on Preparation and Equipment: Teacher gives software to students, and then students install it in them cellphones.
Teacher draws two vectors in screen. Ask students to predict the sum of the two vectors and record their individual predictions on a prediction sheet	Teacher Ask students to predict the first question on prediction sheet.

Students share with one or two partners their prediction and make a common prediction.	Students share with one or two partners their prediction and make a common prediction.
Show the two vectors and their sum in a window from Visualizer. The triangle rule for the addition of the two vectors is shown using "ghost vectors".	After discussion ask the students to run the program on their cellphones vector1 and write password on the blackboard for students to use it and access the program on your cellphone. Students control the animation that shows how to make the sum of the vectors of the triangle method.

The application is shown on the pictures below these lines.

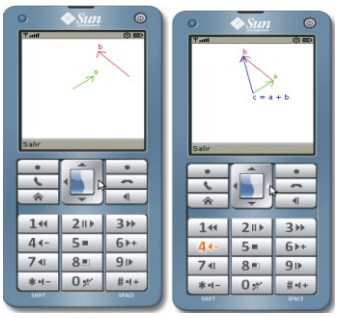

FIGURE 1. Two screens of the cell phone application.

Programs, request a different password each one and if this is not entered properly, the program ends its execution, this in order that the student does not see the answer before starting the activity.

A class before the session was given four CDs with the experimental group programs. And have them installed in their mobile phones.On the day that used the activity with students, the 8 steps were performed according to the methodology proposed by Sokoloff and Thornton [1] The following describes each of the steps:

Step 1.

Students were anxious that they wanted to provide the code to observe the application in cellular phones, and proceeded to describe the activity without the demonstration, which had in their cell protected by the code above.

Step 2.

They were asked to make teams of 4 students, ensuring that their team they had at least one cell with the applications installed, after that, they handed out sheets and income predictions, by explaining the sheet of is predictions they have to work and the results should make their annotations of the corresponding results of the demonstration.

Step 3.

In the teams formed in the previous step students discuss their predictions to agree on which of the predictions is the one that responds to the activity, or to find a common prediction and then share it with the group. When working in teams, there were only two teams who discussed over the answer most quickly come to an agreement, which may be because the students had similar predictions.

Step 4.

A representative from each team went to the blackboard to draw the prediction of his team, sharing a brief explanation with the whole group. In this step Sokoloff *et al.* [1] indicate that common predictions are obtained for the entire class. But what happened was that most students did not change their opinion to reach consensus, they maintained their prediction of equipment and not moving. Only 4 or 5 students in the group changed their minds, but very rarely.

Step 5.

After observing the different predictions can record your final prediction predictions on the sheet, and asked if they had performed the operation. When the whole class said that if they were ready to step 6.

Step 6.

The teacher tells them what application to open his cell phone in turn for the show, and since everyone was running the application and the phone will prompt for the password to access the animation display with an explanation of the problem, the professor wrote in the blackboard, the students could see how drawing development problem at hand, step by step, each time they press a key on the phone, the animation is moved one position at a time, then they control the animation, up to solve the question asked, automatically.

Step 7.

The teacher asked some students selected at random, they describe and discuss the results is when they record their observations and the result on your answer sheet. And followed the instructions for the teacher Sokoloff and Thornton [1] are on page 83

Step 8.

The teacher asked if you can reach the result by another method, or why the results and discuss it in another field, such vectors are handled, and ask if they could be displacement or speed.

V. ANALYSIS OF DATA OBTAINED IN THE TEST

To analyze if the methodology proposed in this study provides significant benefits to teaching and learning process, students was applied a test developed by Nguyen and Meltzer [8] This test consists of seven problems vector in graphic form, "and evaluate whether students can identify vectors with identical magnitudes and directions, and if it can bring this concept to the sum of vectors in one and two dimensions", said Test is applied before and after studying the issue.

Of the seven questions in the test, only 3 and 7 issues are multiple choice, and the remaining five, students can freely draw your response, and questions 4, 6 and 7 have a space to explain their response

The results presented in this document reflect the results of the experimental group and control group. The pre-test was applied September 9, 2009 before they see the issue of addition and subtraction of vectors in the physics course I CECYT 11, and the posttest was applied on 30 October the same year. To analyze how significant is the proposed methodology, we applied the Student t test results of the experimental and the following results were obtained.

TABLE II. Student t Analysis for Experimental performance of the Group.

Prueba de muestras relacionadas

	Diferencias relacionadas					t	gl	Sig. (bilateral)
	Media	Desviación típ.	Error típ. de la media	95% Intervalo de confianza para la diferencia Inferior	Superior			
Par 1 PosTesTExp - PreTestExp	12.85556	15.72236	3.02577	6.63600	19.07511	4.249	26	.000

It was found that application of the ILD improved with cell phone use experimental group (mean: M = 12.86 standard deviation: SD = 15.72). This improvement is statistically significant, with t (26) = 4.249, $p<0.05$, two-tailed done. The distribution chart for this problem is shown in the next figure.

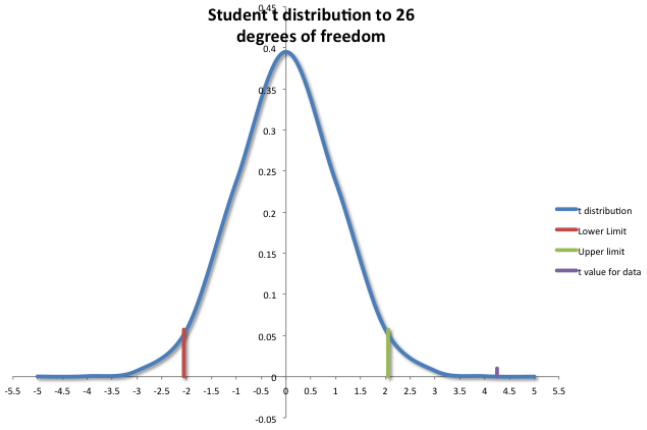

FIGURE 2. Student t curve in the Experimental Group of average grades.

The null hypothesis in our case is that "No significant difference between the average pre-test and the post-test". This graph clearly shows that the value of t is outside the acceptance of the null hypothesis, so this is rejected, demonstrating that the implementation of the proposed methodology is significant.

Averages were calculated for the pretest and posttest for each group obtained the following data:

TABLE III. Average scores for both groups.

Experimental Group		Control Group	
pos-test	pre-test	pos-test	pre-test
38.4	25.6	27.3	16.5

With averages of each group we calculate the Hake gain for both groups:

TABLE IV. Calculation of the Hake gain for both groups.

Experimental Group	Control Group
$\mathbf{g = \frac{38.4 - 26.6}{100 - 26.6} = 0.173}$	$g = \frac{27.3 - 16.5}{100 - 16.5} = 0.129$

In this case we obtain a gain *g* for the experimental group in 0.173 and a gain of 0.129 for the control group, these values of *g* are at a low level. These data are best appreciated in the following figure.

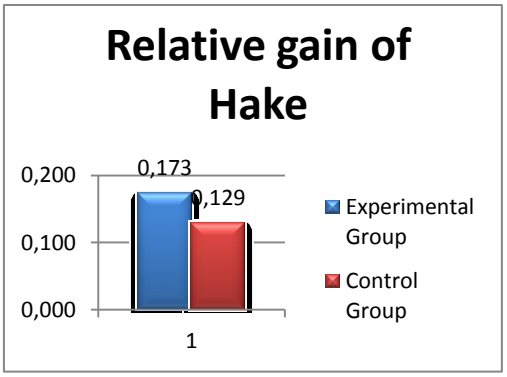

FIGURE 3. Average gain Hake scores for Both groups.

VI. CONCLUSIONS

Based on the Hake gain calculated for the entire test in both groups, we can see that the use of cell phones as a teaching resource in the classroom, does not diminish the learning of students, and even the profit for the Group Hake experimental is greater than the Control Group, with this setting a precedent in the use of cell phones in the classroom for physics class.And we found with this if you use the cell phone with a carefully planned activity can be utilized in the classroom.

The conclusions must notice the new and remarkable contributions of the paper. Also thesuggestions and shortcomings of the manuscript must be pointed out.

Based on this research, could develop similar activities for other subjects in the curriculum of Physics CECYTA 11, instead of using cell phones use calculators Texas instruments, or the new tablets as the Iphone and similar system Android in fact found in the Apple online store,

there are applications for motion analysis and capture data using Bluetooth PASCO sensor, or accelerometer devices with iPod Touch, Iphone and the Iphone, so it can analyze the motion from videos taken with these devices using the application developed by Vernier, and then send the data via email and can be analyzed more extensively on the PC. Applications already exist, so from our point of view is needed is the teaching strategy for the teaching-learning process using new trends in the teaching of physics which are effective.

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