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Statistic Analysis About Flipped Classrooms Didactic Strategy´S Incidence In Modern Physics Teaching With Highschool Students

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Abstract

The teaching of modern physics at the school level has been a challenge that has not yet been overcome. Among some of the difficulties are: lack of teacher preparation to address these issues; little or no transfer of conceptual change; difficulty in making an efficient didactic transposition; low motivation for learning. Thus, in the present work, we report the evaluation process on the incidence of didactic sequences based on the inverted classroom (Flipped Classroom), in the learning of basic concepts of special relativity in eleventh grade students (ages between 14 and 17 years old). The theoretical approach is based on the postulates of cognitivist and constructivist psychological theories of learning. The methodology used was complementary, with a quasi-experimental design with a control group, complemented with an analysis of emerging narratives on the educational experience. Among the results found, the following stand out: it was evidenced that, through the implementation of didactic sequences based on the gradual transfer of learning, the students demonstrated the development of competences related to the learning of Modern Physics; which gives way to demonstrate the need and the possibility of incorporating these topics in the national curricular designs.

Keywords: Flipped Classroom, Didactic Strategy, Modern Physics, Special Relativity.

1. Introduction

Research on the teaching of Natural Sciences at school has been generating enormous knowledge in the last three decades, gaining strength in relation to the didactic transformations necessary to promote meaningful learning and the development of scientific competencies in students (Gutiérrez, 2012). However, there still exist and persist problems that underlie the teaching and learning of Physics. In this way, it is highlighted that in different studies, a scarcely encouraging perspective is shown, regarding the acquisition of competences for the level of understanding and application of scientific knowledge in students, which empowers them to: identify situations or phenomena to be questioned; gather relevant and pertinent information about what is observed; explain such phenomena and draw conclusions based on evidence; acquire and socialize new knowledge (Hinijosa and Sanmarti, 2013; Elizondo, 2013). The educational practices carried out, in a not minor number of cases, blur the learning of science, understood as a need of human beings to conceive and understand their world.

Therefore, it is necessary to continue researching on dissimilar ways to achieve the task of effective learning.

2. Development

The Inverted Classroom, as a didactic strategy, is a new way of carrying out the pedagogical practice, in which students outside the regular class time, read, analyze, study, observe, deepen, on certain content provided by the teacher, allocating the time of the meeting to promote other processes that allow higher levels of deepening, such as: discussion and implementation of the knowledge acquired for problem solving; clarification of doubts; debates; among other activities, which stimulate the exchange of ideas and constant feedback in an intersubjective manner among the different actors participating in the process (García, Porto and Hernández, 2019; Cedeño-Escobar and Vigueras- Moreno, 2020). In the present work, the implementation of this didactic strategy in the teaching of Modern Physics was analyzed, especially what refers to special relativity. Among the fundamental topics studied were: Galilean principle of relativity; Galileo's transformations; Michelson-Morle experiment; postulates of special relativity; and Lorentz transformations.

2.1 Theoretical framework

The following section contains the propositions and arguments that support the proposal; it includes the vision of authors who support the initiative and the development of the conceptual axes involved.

In this sense, the notion of didactic strategies is understood as useful tools that help the teacher to communicate the contents and make them more accessible to the student's understanding. A didactic strategy is not valuable in itself; its value lies in facilitating student learning and in generating more pleasant and conducive environments for training (Flores et al, 2017). It should not be ignored that didactic strategies affect student motivation. If a learner is apathetic to the strategy used by the teacher, he/she will not be able to develop the competencies that are intended to be formed (Benavides et al, 2020).

On the other hand, the term "Flipped Classroom", or in free translation "Inverted Classroom", is commonly associated with the work of American teachers Jonathan Bergmann and Aaron Sams (2012), who published a book in which they disclose a way of inverting the classroom, where the traditional oral presentations of the teacher are replaced by videos to be assisted by students asynchronously. The authors, through the experience accumulated in years of illustrating chemistry in high schools, seek to encourage and help in the transformation of teaching practice. Despite being a reference in relation to the inverted classroom methodology, the authors themselves emphasize that the term does not belong to any specific teacher or researcher, and that several existing methods could be characterized as forms of classroom inversion.

Thus, the Inverted Classroom is an alternative that seeks to take advantage of the learning process from other perspectives. Thus, the student is given more space and time to build and deconstruct their knowledge, especially when it is delivered in a common language: "technology". Therefore, by having the classes in a digital format in their hands, students can adapt to their own pace and learning style. For his part, the teacher, in addition to contributing effectively to learning outside the classroom, has more time to respond to the educational needs of students inside the classroom, where he is no longer an essential protagonist, but a guide and a designer of environments conducive to meaningful learning (Ibáñez and Muñoz, 2019).

2.2 Problem statement

In different national and international studies, there is a scarcely encouraging perspective in Latin American countries, especially in Colombia, regarding competencies for the level of understanding and application of scholarship to identify questions, acquire new knowledge, explain phenomena and draw conclusions based on the observation of scientific evidence. However, in international tests, such as PISA (Programme for International Student Assessment), which is a study carried out by the OECD worldwide, and which among its components evaluates these competencies, scores have been obtained below the average. This indicates the weak development of scientific competencies by the population, a fundamental factor to improve the quality of life in general.

On the other hand, for more than a hundred years there have been advances in the field of physics, called modern physics. However, school curricula in Colombia, for the most part, focus their interest on the theories that were developed in

physics until the end of the 19th century. Thus, it is necessary to emphasize that, with few exceptions, the contents of modern physics are not usually the object of interest for teachers, directors and members of the academic community of educational institutions, responsible for establishing the themes and curricula in the different grades of elementary and middle school in Colombia. Regarding this particular aspect Grajales (2017) states that "... after a century of the emergence of these theories, their incorporation into school curricula and research around their teaching remain marginal in the Latin American context and, in particular, in Colombia" (p. 9). At the same time, in various contexts, some scientific terms are used arbitrarily in order to capture and captivate a naïve public of the advances in science (Vicario and Venier, 2010).

3. Method

The study was fundamentally of an interventional type, with a quasi-experimental design and a control group. In the first part, a diagnostic test was carried out to determine the state of development of knowledge and skills related to the basic concepts of special relativity. Then, didactic interventions mediated by the flipped class, as main units, were carried out. At the end of the intervention, a post- test was performed for both the experimental and control groups.

The target population was the eleventh grade students (142). An intentional sample (non-probabilistic) was drawn from them, by means of a focus group of 16 students, taking into account criteria of interest and motivation towards the learning of these concepts, as well as connectivity and technological device to carry out the synchronous meetings and their asynchronous activities. The data collection techniques used were the following: Test 1: Initial Evaluation; Test 2: Final Evaluation; the test that was executed was elaborated taking into account the SABER 11 test booklets of the last 6 years. This was validated by experts and by means of a pilot test, in which Cronbach's alpha test resulted in 0.718.

The intervention program was carried out taking into account the complexity of the topics and seeking to analyze the degree of knowledge that the students had in basic topics for learning special relativity, this intervention was given through three main phases, in which the classes and topics programmed for each of them were developed. The phases carried out are described as follows: Phase 1: in this phase there was a temporal disposition of three weeks, in which the students were oriented on basic concepts for the learning of relativity; Phase 2: This phase lasted four weeks. In this phase the following topics were worked on: Galilean principle of relativity; Galileo's transformations; Michelson- Morle experiment; postulates of special relativity; Lorentz transformations. Finally, in Phase 3, which lasted three weeks, group work was based on understanding, analysis and problem solving, as well as the implementation of virtual laboratories. In this aspect, the process carried out during the intervention time (10 weeks, 3 hours per week) was basically inspired by the philosophy of gradual transfer of learning control (Iriarte and Flórez, 2019).

4. Results

In the first instance, a Shapiro-Wilk test was applied to determine if the students' grades are normally distributed in the two evaluations applied. The hypothesis system is as follows: Ho: The grades are normally distributed; Hi: The grades are not normally distributed.

Table 1. Shapiro-Wilk test, normality check of the data.

		Normality test		
			Shapiro-Wilk	
Grade and group		Statistician	gl	Sig.
Pretest	Experimental Group	,968	16	,811
	Control Group	,931	16	,735
a. Lilliefors significance correction.				

Source: Own elaboration using SPSS 21 software

The analysis of the results shown in the table1 establishes that the grades in the two groups are normally distributed, since the p-value is greater than 0.05, accepting the null hypothesis. Therefore, it is necessary to apply a parametric test to determine if there is any dependency relationship between the grades obtained by the students and the didactic strategy applied.

Similarly, the groups are equivalent in age, for which the Kruskal-Wallis test was performed, corroborating that age does not present statistically significant differences (X^2= 1.745, p=0.781). The sex distribution (male and female) did not present statistically significant differences in the different groups (X^2= 0.745, p=0.873). In addition, the environmental conditions of the groups remain constant, considering that the study was conducted in the same institution and on the same day, these characteristics remain unchanged. The classrooms are equipped with chairs, fans, acrylic boards, televisions, among others.

After the application of the intervention program carried out in the experimental group, the analysis of the results obtained in the post-test, compared to those obtained in the pre-test, are shown. The purpose of this was to evaluate the effects of the treatment. Thus, a Wilcoxon test was applied for the intra-group analysis, which allows establishing whether there were statistically significant differences in each course over time, after having developed the intervention. The results obtained by applying this test are shown in the following table.

Table 2. Wilcoxon test, intra-group posttest contrast.

Contrast statistic			
		Sign test	
	Z	Sig. asymptotic (bilateral)	
Experimental Group	-4,395	,000	Experimental Group
Control Group	-0,385	,700	Control Group

Source: Own elaboration using SPSS 21 software.

According to Table 2, the p-value obtained when applying the Wilcoxon test to the performances shown by the students belonging to the control group is 0.700 (p-value > 0.05), which corroborates that they did not present statistically significant differences between the application of the diagnostic test and the posttest. The analysis of the results obtained indicates that the students of the control group did not advance in the development of the learning of the basic concepts of special relativity. The opposite of the experimental group.

However, in order to establish whether there are significant differences between the results obtained in each of the groups, the Mann-Whitney U test was performed. This test contrasts whether two sampled populations are equivalent in their position, to evaluate whether or not there were effects on the dependent variable. The results obtained are shown in Table 3.

Table 3. Mann-Whitney U test, posttest contrast between experimental and control groups.

Contrast statistic				
		Mann-Whitney U		
Grade and group		Statistician	Z	Sig. asymptotic (bilateral)
Posttest	Experimental vs. control group	219,000	-4,897	,000

Source: Own elaboration using SPSS 21 software

According to the above, there is a statistically significant difference between the results obtained in the final test. This corroborates the efficiency of using the Inverted Classroom didactic strategy in student learning.

5. Discussion

The work carried out corroborates the stipulations of constructivist theorists, who state that the implementation of group activities in meaningful contexts better develops students' learning processes (Piaget, 2000; Vygotsky, 1995; Alcántara, 2009). Therefore, the use of an intervention program based on the gradual transference of control over learning, makes students move from a heterostructural to a self-structuring educational process (Pozo, 1998). In this way, it was possible to promote cognitive, procedural, metacognitive and self-regulatory learning processes, from scenarios mediated by ICT, specifically using the Inverted Classroom (Arístizabal et al. 2016). In turn, it confirms the stipulations of Rivera et al. (2009), who state that the linking of learning, through various modalities, manages to develop dissimilar competencies of a scientific nature, which lead to the construction of solid and meaningful knowledge, by the learners.

Similarly, we agree with Espinosa-Ríos et al (2016), who state that through the implementation of different forms of representation of the phenomenon, it is possible to develop and strengthen dissimilar scientific skills in students, such as: the appropriate management of the variables studied; the comparison between theoretical and practical data; the construction and correct formulation of hypotheses; problem solving; and the establishment of conclusions based on the scientific concepts being studied. In this way, beyond solving exercises or receiving distributive classes, they compare the phenomenon from different perspectives, enabling a better understanding of it.

6. Conclusions

According to the objectives of the research, it is concluded that the implementation of didactic strategies based on the Inverted Classroom has a significant impact on the understanding and learning of the basic concepts of special relativity. Likewise, the didactic strategy used is efficient for the teaching of this subject, taking into account that it links technological tools with a process of gradual transfer of learning control (Mateos, 2001). This transfer occurs according to the ideal that the learner moves from a heterostructuring learning process to a self-structuring one, without neglecting co-structuring learning. In this way, the realization of the phases carried out, allow to achieve in a plausible way, the development of the ability to learn to learn, on the part of the student. It is recommended that teachers who guide the subject of physics in the different institutions include modern physics in their classes, enlightening students on a different and little known subject, thus motivating them to the study of science and the search for new knowledge.

7. References

[1] Alcántara, M. D. (2009). Importancia de las TIC para la educación. Innovación y Experiencias Educativas, 15, 1-20.

[2] Aristizabal, J. H., Colorado, H. y Gutiérrez, H. (2016). El juego como una estrategia didáctica para desarrollar el pensamiento numérico en las cuatro operaciones básicas. Sophia, 12 (1), 117-125.

[3] Benavides, C., Mahecha, J. y Conejo, F. (2020). Estrategias didácticas que inciden en la motivación de los estudiantes inscritos en el curso de Práctica en Responsabilidad Social de la sede de Uniminuto Virtual y a Distancia. Brazilian Journal of Development, 7 (3), 30880 - 30898. https://www.brazilianjournals.com/index.php/BRJD/article/view/27092/21415

[4] Bergmann, J. y Sams, A. (2012). Flip Your Classroom: Reach Every Student in Every Class Every Day. Printed in the United States of America.

[5] Cedeño-Escobar, M. y Vigueras-Moreno, J. (2020). Aula invertida una estrategia motivadora de enseñanza para estudiantes de educación general básica. Dominio de las Ciencias, 6 (3), 878-897. https://dominiodelasciencias.com/ojs/index.php/es/article/view/1323/2282

[6] Clavijo, C., Conejo, F. y Mahecha, J. (2021). Estrategias didácticas que inciden en la motivación de los estudiantes inscritos en el curso de Práctica en Responsabilidad Social de la sede de UNIMINUTO Virtual y a Distancia. Brazilian Journal of Development, 7(3), 30880 – 30898. https://www.brazilianjournals.com/index.php/BRJD/article/view/27092/21415

[7] Elizondo, M. (2013). Dificultades en el proceso enseñanza aprendizaje de la Física. Presencia Universitaria, 3(5), 70-77.

[8] Espinosa-Ríos, E., González-López, K. y Hernández-Ramírez, L (2016). Las prácticas de laboratorio: una estrategia didáctica en la construcción de conocimiento científico escolar. Entramado, 12(1), 266-281. https://revistas.unilibre.edu.co/index.php/entramado/article/view/477

[9] Flores, J., Ávila, J., Rojas, C., Sáez, F., Acosta, R. y Díaz, C. (2017). Estrategias didácticas para el aprendizaje significativo en contextos universitarios. Unidad de Investigación y Desarrollo Docente Dirección de Docencia Universidad de Concepción. http://docencia.udec.cl/unidd/images/stories/contenido/material_apoyo/ESTRATEGIAS%20DIDACTICAS.pdf

[10] García, M., Porto, M., y Hernández, F. (2019). El aula invertida con alumnos de primero de magisterio: fortalezas y debilidades. REDU. Revista de Docencia Universitaria, 17(2), 89-106. https://polipapers.upv.es/index.php/REDU/article/view/11076/12228

[11] Grajales, H. (2017). La enseñanza de la física moderna en la educación básica: una aproximación desde el principio de incertidumbre. Trabajo de grado (no publicado). Licenciatura en Física. Universidad Pedagógica Nacional. Bogotá, Colombia

[12] Gutiérrez, G. (2012). La enseñanza de las ciencias naturales y la educación ambiental en la escuela: realidades y desafíos. Praxis & Saber, 3(5), 9-14.

[13] Hinijosa, J. y Sanmarti, N. (2013). Dificultades en la transferencia del modelo de mecánica newtoniana. IX congreso internacional sobre

investigación en didáctica de las ciencias. 1748-1753.

[14] Ibáñez, C. y Muñoz, W. (2019). Primera experiencia de aula invertida en la Universidad de La Salle: principio de Cavalieri. En Valbuena (Ed.), 3 Encuentro de Ciencias Básicas - Retos frente al abandono, educación en Ciencias Básicas y formación docente universitaria (Vol. 3, 93 – 102). Editorial Universidad Católica de Colombia. https://publicaciones.ucatolica.edu.co/pub/media/hipertexto/pdf/encuentro-ciencias-basicas.pdf

[15] Iriarte. A y Flórez, A. (2019). La lúdica como escenario pedagógico para el desarrollo del pensamiento matemático a través de aprendizajes basados en situaciones problemas (tesis de maestría no publicada Sociedad de Universidades Estatales del Caribe – SUECARIBE, Sede Universidad de Sucre).

[16] Mateos, M. (2001). Metacognición y educación. Serie Psicología Cognitiva y Educación. Aique Grupo Editor.

[17] Piaget, J. (2000). Psicología del niño. Barcelona. Ediciones Morata.

[18] Pozo, J. I. (1989). Teorías cognitivas del aprendizaje. Ed. Morata.

[19] Rivera, L., Aroman, M., Moncayo, J.P., y Ordoñez, D. (2009). Laboratorio virtual de física. Revista de la información educativa y medios audiovisuales, 6(12), 8-12.

[20] Vicario, J. y Venier, F. (2010). La enseñanza de la física moderna, en debate en Latinoamérica. Revista Argentina de Enseñanza de la Ingeniería, 11 (20), 49-57

[21] Vygotsky, L. (1995). Pensamiento y lenguaje. Ed. Paidós.