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Learning about particle dynamics through Interactive Physics software in engineering students

Aprendizaje de la dinámica de una partícula a través del software Interactive Physics en estudiantes de ingeniería

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ORIGINAL ARTICLE

KEYWORDS

learning, dynamics, physics, laws, software.

Summary: The research aimed to determine the effects of the Interactive Physics software on the dynamic learning of a particle in engineering students from the National University of Juliaca (Peru-2017), in order to optimize the academic performance of the students of the Professional School Textile and Clothing Engineering. The research design was quasi-experimental for the application of the Interactive Physics software. Seeking that the student interact in their learning process related to the application of Newton's laws in solving problems of particle dynamics. For the collection of information, the written test of knowledge of the dynamics of a particle has been used. The population was made up of students from the second semester of Textile and Apparel Engineering. The results indicate that 8% of the students in the experimental group are in the very good category in relation to the students in the 4% control group who are in the very good category.

PALABRAS CLAVE
aprendizaje, dinámica, física, leyes, software.

Resumen: La investigación tuvo como objetivo determinar los efectos del software Interactive Physics en el aprendizaje dinámica de una partícula en estudiantes de ingeniería de la Universidad Nacional de Juliaca (Perú-2017), con la finalidad de optimizar el rendimiento académico de los estudiantes de la Escuela Profesional de Ingeniería Textil y de Confecciones. El diseño de investigación fue cuasi experimental

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para la aplicación del software Interactive Physics. Buscando que el alumno interactúe en su proceso de aprendizaje relacionado a la aplicación de las leyes de Newton en la solución de problemas de dinámica de una partícula. Para la recolección de información se ha utilizado la prueba escrita de conocimiento de dinámica de una partícula. La población estuvo compuesta por estudiantes del segundo semestre de Ingeniería Textil y de Confección. Los resultados indican que el 8% de los estudiantes en el grupo experimental están en la categoría muy buena en relación con los estudiantes en el grupo de control del 4% que están en la categoría muy buena.

1. INTRODUCTION

One of the most important factors in a country, to guarantee economic, political, and social development, is higher education (Malagón, 2006). In Peru, one of the problems that university higher education is going through is related to the didactic strategies used by university teachers (González & Triviño, 2018), since these should allow the student to be more reflective, critical and creative, in order to pose and to provide alternative solutions to different problems, either in their academic or personal life, in a more competent way (Laiton, 2010; Rodríguez, 2010).

Science education at the university level is a fundamental factor in the training of students (Figueroa, 2012; Gil, Beléndez, Martínez, & Martín, 1991; González & Triviño, 2018), its development favors responsible and informed actions. Within the university study plan, physics is a general basic training subject (Ortigoza, Llovera, & Odetti, 2011), oriented to the knowledge of concepts, methods and procedures for solving everyday problems and rational understanding of the physical environment. According to Campanario (1999), students have various difficulties in the science learning processes. And it has been found that among the main obstacles to learning science, there is the logical structure of the conceptual contents (Ortigoza et al., 2011), previous knowledge and the lack of ability to solve problems (Buteller, Gangoso, Brincones, & González, 2001). Furthermore, the difficulty of learning physics is one of the main problems addressed by research in physics teaching (E. Aguilar, 2006; Elizondo, 2013; Guridi & Salinas, 2001; Llancaqueo, Caballero, & Moreira, 2003).

Currently, information and communication technologies (TIC) have made rapid inroads into education(M. Aguilar, 2012; Berrío & Rojas, 2014), but these are not used properly (Barrio, 2018; Romero & Araujo, 2012), since teachers use didactic strategies that do not allow the student to develop thinking skills every time they manipulate TIC (Hernández, Acevedo, Martínez, & Cruz, 2014; Vence, 2014).

Interactive Physics simulation software is one of the most widely used tools in simulating physics problems (Dünser, Walker, Horner, & Bentall, 2012; Jimoyiannis & Komis, 2001; Wolff,

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1995). Padilla (2017) applies virtual laboratories through the Interactive Physics simulator to learn kinematics, making it a didactic tool used by the teacher and used by students. Guambo (2017) applies the Virtual Laboratory with the support of the Interactive Physics simulator in the laws of movement block to overcome the academic performance of students, concluding that the guide allows students to capture attention throughout the learning process and become an active methodological strategy in the teaching of Physics, through the development of virtual practices and problems; managing to promote skills and abilities in problem solving. Villacis (2017) determines how the virtual notebook has a significant relationship with the learning of Physics for Newton's laws curricular block, concludes that the use of the virtual notebook of Physics presents a friendly and easy to manipulate environment. Velasco (2016) seeks to publicize the incidence of Interactive Physics educational software on the academic performance of first semester students, concluding that the use of this methodology contributes to improving the academic achievement of students. Cando and Cayambe (2016) use the Interactive Physics software to learn uniformly varied rectilinear motion, achieving an increase in knowledge after the use of software.

The proposal that was put into practice consisted of the application of the Interactive Physics software in learning physics. This allowed the interaction of the student with a physical phenomenon through the software environment and in this way the student visualizes in real time the variables that intervene in the phenomenon, looking for the motivation to solve problems of particle dynamics.

2. METHOD AND MATERIALS

The research was carried out at the National University of Juliaca, it is located in the Juliaca district, San Román province of the Puno department, it has five professional schools of which four are from the engineering area.

The research method consisted in the application of the deductive hypothetical method, experimental and quasi-experimental design (Rojas, 2015), in which two homogeneous groups of control and experimental are considered, in the latter is where the use of the interactive software Physics is applied. with the intention of subjecting the dependent variable to manipulation, whose scheme is as follows.

Table 1. Research design

	Proof of Entry	Treatment	Exit Test
Experimental Group	O_1	X	O_2
Control group	O_3		O_4

Where:

O_1 y O_3: Entry test result

X: It is the experimental variable

O_2 y O_4: Output test result

The experimental material used was the Interactive Physics software in which extension files ".ip" of simulations of physical phenomena related to the topic of particle dynamics were developed, which were presented in the learning sessions of the experimental group and also be I provided a manual for the use of the Interactive Physics software in which the functions of the menus and the simulation process were indicated, as well as examples to interact with the software, simulating problems related to the dynamics of a particle.

The population was made up of the students of the second semester of the Professional School of Textile and Clothing Engineering (ITyC) of the National University of Juliaca, who were enrolled in the academic semester 2017-II, in the course of Physics I. They form a total of 50 students. The sample size is made up of the entire population because it is very small.

The entry and exit test instrument consisted of ten multiple-choice questions corresponding to the dimensions of information compression, inquiry and experimentation, and critical judgment. The reliability of these instruments was calculated using the correlation coefficient between two scoring series, using the Test-Retest method, which consists of calculating the correlation coefficient between the total scores obtained by each student in the application of the test and those of the second (Gemmp, 2006; Pere & Anguiano, 2010), for the entrance exam, 32 students from the fourth semester of ITyC were considered, obtaining a value of 0.90 of linear correlation and for the exit exam 29 students from the third semester to Those who obtained a correlation coefficient of 0.92, to calculate the validity of the instruments, was performed by calculating the correlation coefficient between the test and an external criterion (Carretero & Pérez, 2005; Cruz & Martínez, 2012). Therefore, 40 ITyC students are considered, obtaining a correlation coefficient of 0.97, this result guarantees a validity of 97% of the results.

3. RESULTS AND DISCUSSIONS

Analysis of the results of computer knowledge

The results shown below are obtained from the application of the computer knowledge survey prepared by (Quispe and Chipana, 2010) to the research sample that is made up of the 50 students enrolled in the Physics I course in the academic semester 2017-II of the ITyC.

Regarding the question "do you have a personal computer, a desktop computer or do you not have one", the following results were obtained.

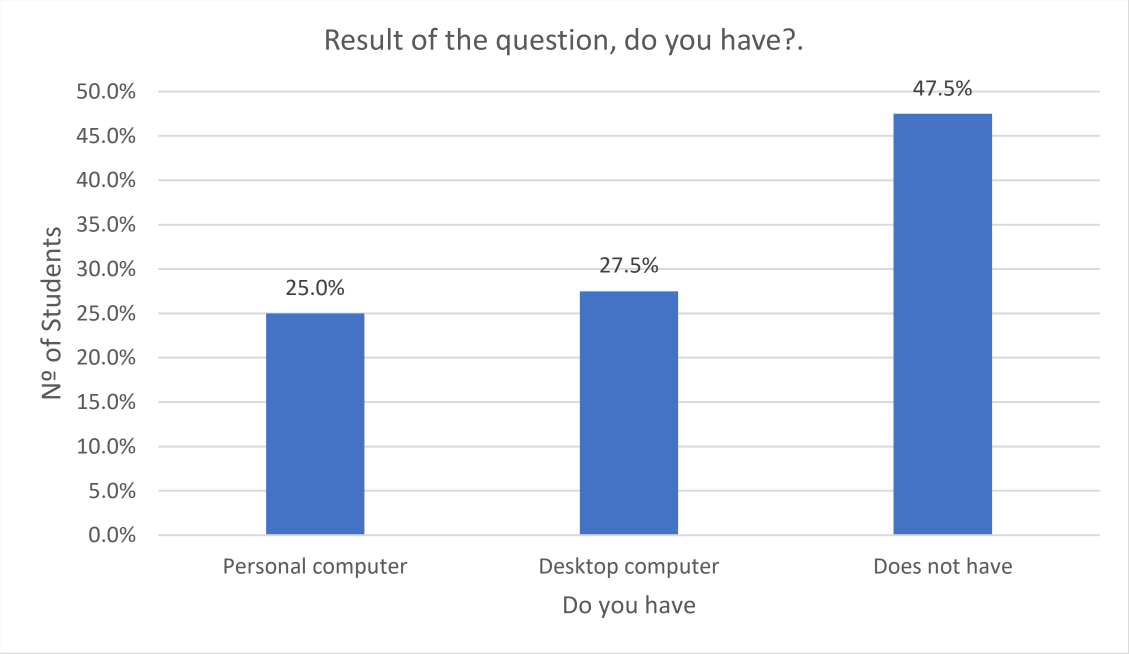

Figure 1. Result of the question, do you have? From the students of the 2017-II semester

In figure 1, the results are shown to the question, if you have a computer, the results show that 47.5% of the students do not have a computer, this being the highest percentage of students of the total, this in the words of Quispe and Chipana (2010) y Ortigoza (2011) would make the management of computer knowledge somewhat difficult.

Table 2 shows the number of commonly used computer applications(Quispe & Chipana, 2010; Valiño, Silvera, Perdigones, & García, 2008), related to the levels of learning regarding the use of the programs, the same as they are in categories; (1) does not drive, (2) basic level, (3) intermediate level and (4) advanced level.

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Table 2. Results of the question Do you drive? at a basic, intermediate or advanced level

you use, at a basic, intermediate or advanced level	Do not use	% Do not use	Basic level	% Basic level	Intermediate level	% Intermediate level	Advanced level	% Advanced level
Word processor	7	14%	36	72%	6	12%	1	2%
Spreadsheet	15	30%	26	52%	8	16%	1	2%
Teaching software	15	30%	24	48%	9	18%	2	4%
Email	10	20%	26	52%	12	24%	2	4%
Web pages	2	4%	27	54%	16	32%	5	10%
Programming language	27	54%	18	36%	3	6%	2	4%
Specific use programs	20	40%	26	52%	4	8%	0	0%

Source: Own elaboration based on the results of the survey prepared by Quispe & chipana (2010) applied to the second semester of ITyC, academic semester 2017-II.

In the question, do you use a word processor, we observe in Table 2 that 72% of the total students are at the basic level, this being the largest number of students. This indicates that students have a basic knowledge of word processor.

Regarding the question, use a spreadsheet, it is observed that 52% of the total students are at the basic level, which concludes that the students have a basic level of use of spreadsheets.

In the question, Teaching software, 48% of the total students are at the basic level, this being the largest number of students, therefore it is concluded that with respect to the use of didactic programs, the students are at the basic level, with a low tendency at the intermediate level.

Regarding the use of email, 52% of the total students are at the basic level with a low tendency to the intermediate level.

Web pages, 54% of the total students are at the basic level and 32% at the intermediate level of the total, concluding that the students have a basic level of use of the web pages that would facilitate the feedback of information on use of the software.

Regarding the question, you use programming languages, it is observed that 54% of students do not use programming languages, concluding that students do not use programming languages which would make it difficult to deepen the application of the Interactive Physics software in obtaining data and processing of these by external software.

In the question, specific use program, 52% of the total students are at the basic level with a low tendency to 8% at the intermediate level, concluding that students use specific programs at a basic level, with the Interactive Physics software a program of specific use in the simulation of physical phenomena.

Concluding with respect to the use of computer tools, students manage at a basic level and this in the words of Quispe & Chipana (2010) will hinder the development of simulations with the Interactive Physics software.

Table 3. Results of the question. According to their criteria, computing represents

According to their criteria, computing represents:	fi	%
A novelty	9	18%
An advance in science	18	36%
A working instrument	23	46%

Source: own elaboration based on the results of the survey prepared by Quispe and Chipana (2010) applied to students of the second semester of ITyC, academic semester 2017-II.

According to Table 3, it is observed that 46% of the total of students think that computing is a working instrument, this results differs from the results of Quispe & Chipana (2010) which obtained that the majority of the students think that computing is an advance of science. These results favor our research, since the opinion is that computing is a working tool.

Table 4. Results of the question. The use of the computer in physics classes is:

The use of the computer in physics classes is:	fi	%
Interesting	20	40%
Very important	16	32%
Suitable	15	30%
Boring	0	0%

Source: Own elaboration based on the results of the survey prepared by Quispe and Chipana (2010) applied to students of the second semester of ITyC, academic semester 2017-II.

According to Table 4, it is observed that no student considers that the use of the computer in physics classes is boring, this result leads us to conclude that the students consider it interesting, very important, and adequate. These results in the words of Quispe & Chipana (2010) y Ortigoza (2011) mean that the use of the computer in the development of learning sessions has a positive impact on the learning of Physics.

Table 5. Results of the question. The use of software in the physics laboratory is:

The use of software in the physics laboratory is:	fi	%
Interesting	15	30%

Very important	12	24%
Suitable	18	36%
Boring	5	10%

Source: Own elaboration based on the results of the survey prepared by Quispe and Chipana (2010) applied to students of the second semester of ITyC, academic semester 2017-II.

According to Table 5, it is observed that 10% of students think that the use of computers in physics classes is boring, this being the least amount, so the rest of the students, equivalent to 90% of the total, think that the use of software in the laboratory is interesting, very important and adequate, this in the words of Quispe & Chipana (2010), Serrano & Prendes (2012) means that the use of software in the development of physics laboratories has a positive impact on learning of Physics.

Analysis of the results in the entrance test of the control and experimental group students

The results of the entrance test applied to the research sample are shown below, which is made up of the 50 students enrolled in the Physics I course in the 2017-II academic semester of ITyC.

Table 2. Results of the application of the income test, before treatment in the control group

SCALE	NOTES	fi	Fi	hi	Hi	%
Deficient	[00-10]	10	10	0.4	0.40	40%
Regular	[11-13]	8	18	0.32	0.72	32%
Good	[14-17]	7	25	0.28	1.00	28%
Very good	[18-20]	0	25	0	1.00	0%
		25		1		

Source: Own elaboration based on the results of the application of the entrance test to the control group, in the academic semester 2017-II.

In Table 6, the notes obtained in the entrance test of the control group are observed. It is seen that 10 students obtained grades less than or equal to 10, which encompasses 40% of the total and are located on the scale, deficient; this being the largest number. The results show that the highest number of students are on the deficient scale with a low tendency to the regular scale, this agrees with the results ofQuispe & Chipana (2010), Padilla (2017) y Guambo (2017).

Table 3. Results of the application of the income test, before treatment in the experimental group

SCALE	NOTES	fi	Fi	hi	Hi	%
Deficient	[00-10]	9	9	0.36	0.36	36%
Regular	[11-13]	11	20	0.44	0.80	44%
Good	[14-17]	5	25	0.2	1.00	20%
Very good	[18-20]	0	25	0	1.00	0%
		25		1		

Source: Own elaboration based on the results of the application of the entrance test to the experimental group, in the academic semester 2017-II.

In Table 7, the notes obtained in the entrance test of the experimental group are observed, it is appreciated that 11 students obtained grades from 11 to 13, which represents 44% of the students who are on the regular scale. The results indicate that the largest number of students is on the regular scale with a low tendency to the poor scale, therefore, it is in agreement with the results of Quispe & Chipana (2010), Padilla (2017) y Guambo (2017).

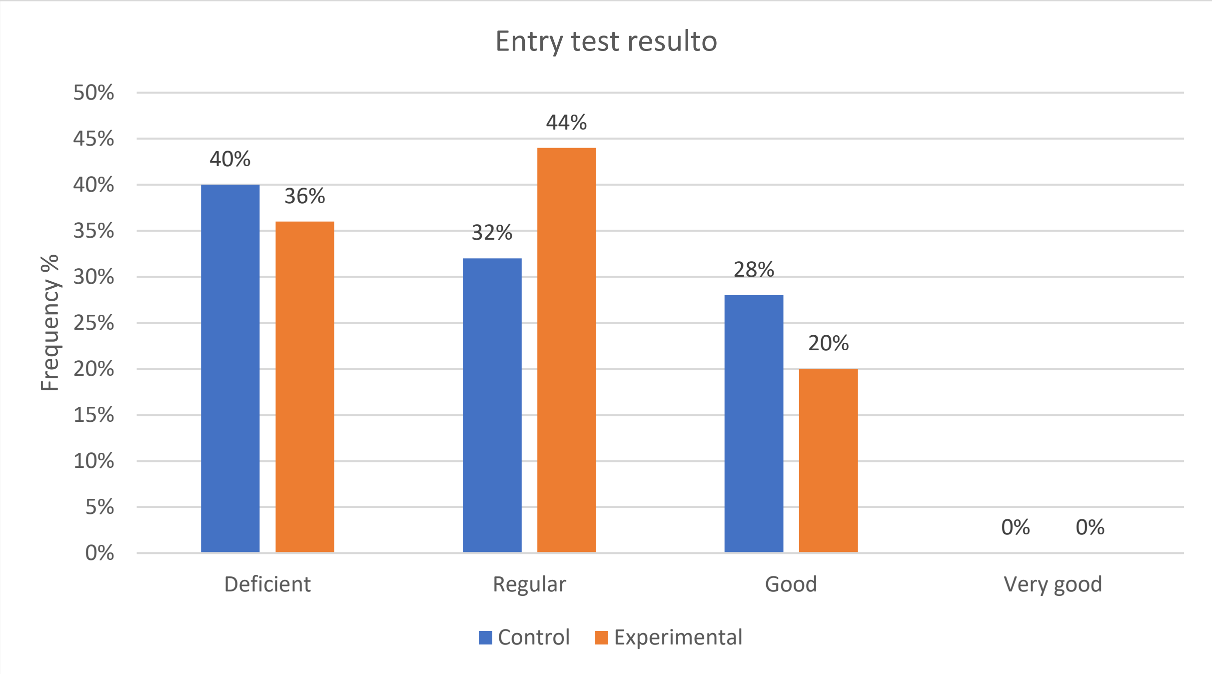

Figure 2. Comparison of the results of the admission test before treatment in the control and experimental group, physical course I, of the academic semester 2017-II

From figure 2, it is observed that the control group has 40% of students on the Deficient scale, this being the largest number, compared to 36% of students in the control group, with respect to the other scales, the control group did not it has a significant difference with respect to the experimental group, concluding that the majority of students in the control and experimental group are in the deficient and regular scales. Therefore, we affirm that the students of both groups mentioned have similar characteristics in terms of learning Newton's laws before applying the software in physics class sessions.

Analysis of results of the exit test of the control and experimental group students

The results of the exit test applied to the research sample are shown below, which consists of the 50 students enrolled in the Physics I course in the 2017-II academic semester of the ITyC professional school.

Table 4. Results of the application of the exit test after treatment in the control group

SCALE	NOTES	fi	Fi	hi	Hi	%
Deficient	[00-10]	5	5	0.2	0.20	20%
Regular	[11-13]	11	16	0.44	0.64	44%
Good	[14-17]	8	24	0.32	0.96	32%
Very good	[18-20]	1	25	0.04	1.00	4%
		25		1		

Source: Own elaboration based on the results of the exit test applied to the control group, in academic semester 2017-II.

In Table 8, the notes obtained in the exit test of the control group are observed, it is appreciated that 11 students obtained grades from 11 to 13, which represents 44% of the students who are on the regular scale; 8 student obtained the note from 14 to 17 is in 32% and is located on the good scale; and finally we observe that it was possible for a student to obtain a grade from 18 to 20 on the very good scale which represents 4% of the total and taking the results of the research work Quispe & Chipana (2010), Padilla (2017) and Guambo (2017) we conclude that students are on the regular scale with a tendency to the good scale.

Table 5. Results of the application of the exit test after treatment in the experimental group

SCALE	NOTES	fi	Fi	hi	Hi	%
Deficient	[00-10]	5	5	0.2	0.20	20%
Regular	[11-13]	6	11	0.24	0.44	24%
Good	[14-17]	12	23	0.48	0.92	48%
Very good	[18-20]	2	25	0.08	1.00	8%
		25		1		

Source: Own elaboration based on the results of the exit test applied to the experimental group. in the academic semester 2017-II.

In Table 9, the notes obtained in the test out of the experimental group are observed. It is appreciated that 12 students obtained the note from 14 to 17, this represents 48% and is located on the good scale; and we observe that the student with very good scale achievement is at 8%, it means that 2 students obtained the grade from 18 to 20. Concluding that the highest number of students are on the good scale with a tendency to very good scale. These results show us that the Interactive Physics simulator produces positive effects in terms of learning Newton's laws, supported by the work of Quispe & Chipana (2010), Padilla (2017) y Guambo (2017), they conclude that the Interactive Physics software contributes to learning physics.

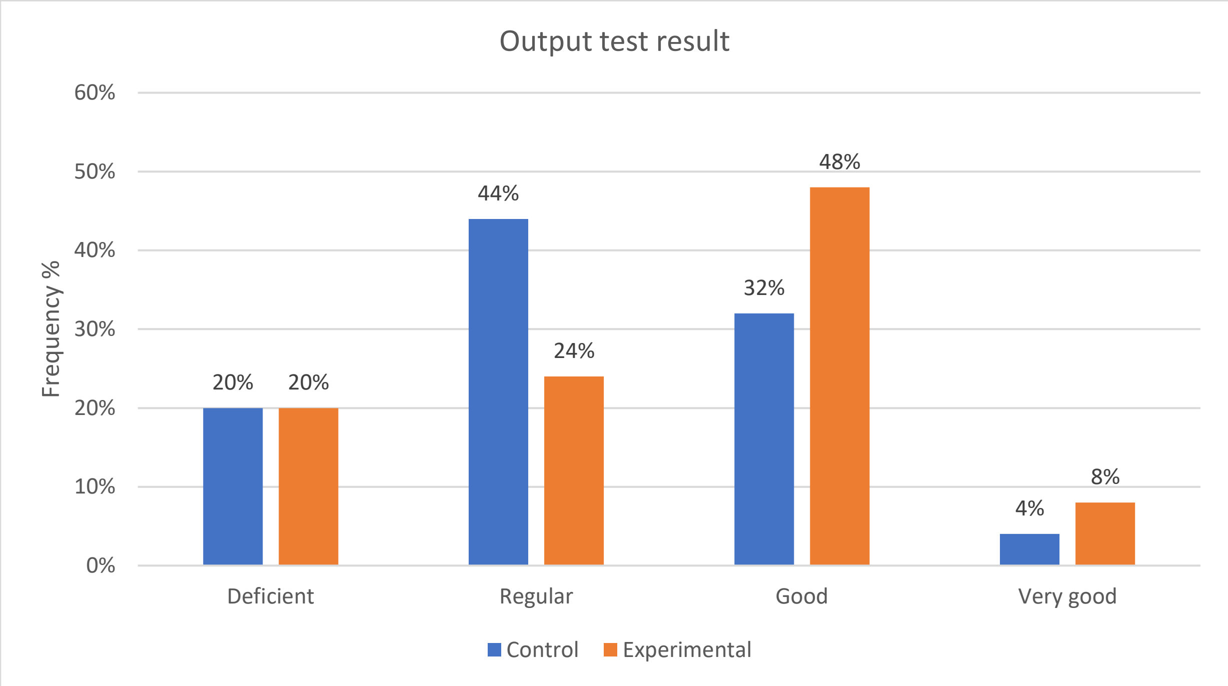

Figure 3. Comparison of the results of the exit test after treatment in the control and experimental group, physical course I, for the 2017-II semester

In figure 3, it is observed that 44% of the students in the control group have qualifications corresponding to the regular category, while in the experimental group the largest number of students, that is, 48% have qualifications corresponding to the good category. From these results, it should be noted that the results of the exit test allow us to determine the importance of the application of the Interactive Physics educational software in learning physics in higher education students. These results confirm the conclusions of the works carried out by (Cando & Cayambe, 2016; Guambo, 2017; Padilla, 2017; Quispe & Chipana, 2010; Villacis, 2017).

The results of this investigation verify the hypotheses raised. Therefore, in relation to the use of the Interactive Physics software, it is stated that it has an effect on the learning of the dynamics of a particle in the students of the second semester of the Professional School of Textile and Clothing Engineering of the National University of Juliaca during the semester. academic 2017-II.

Quispe & Chipana (2010) states that the influence of the Interactive Physics educational software can be observed in the performance of the students (of the experimental group) who in the pre-test 70% were at the regular level, 18% at a level good and 1% at a very good level; going to 26% at the regular level, 52% at the good level and 11% at a very good level in the post test. In our research, the pre-test results were obtained in the experimental group, which 36% of the students were on the deficient scale; 44% of students ranked on the regular scale; 20% on the good scale and 0% on the very good scale. Obtaining after the application of the software the results that 20% of the students are located on the deficient scale; 24% are on the regular scale; 48% are on the good scale and 8% on the very good scale, which affirms that the software contributes to learning the dynamics of a particle.

Padilla (2017) indicates that the application of the laboratory, with the virtual kinematic guide through the Interactive Physics simulator, became a didactic tool used by the teacher and used by the first-year high school students at Colegio Chambo Cha. In our research, the students' interest in the application of Interactive Physics software was observed, in the solution of Newton's law problems and thus verify their theoretical calculations.

Guambo (2017) affirms that the guide allowed students to capture attention throughout the learning process and become an active methodological strategy in Physics teaching, through the development of virtual practices and problems; managing to promote skills and abilities in problem solving. In our work the students solved problems using the Interactive Physics software, showing an interest in the advantages that the software has in the visualization of physical phenomena.

4. CONCLUSIONS

When applying the entrance test to the students of the second semester of the Professional School of Textile and Garment Engineering, it is appreciated that the average of marks of the evaluation in dynamics of a particle is deficient, since the majority is in the category of deficient (40% in the control group, table 6 and 36% in the experimental group, table 7). In other words, the low qualifications obtained in the entrance test explain the lack of commitment between the elements that participate in the learning process, a student with little knowledge of differential calculus and teachers with few teaching strategies.

At the conclusion of the learning process using the Interactive Physics software, it was found in the exit test that there are significant differences between the experimental group and the control group in the level of learning of dynamics of a particle, according to this result the experimental group has a higher academic performance on dynamics since its highest percentage is in the good category (48%) and a percentage in the very good category (8%) table 9, while in the control group its highest percentage is in the Regular category (44%) and a very good percentage on the scale of 4%, Table 18, for a confidence level of 95%.

The effect produced by the application of the Interactive Physics software in the learning of the dynamics of a particle has been determined in the students of the National University of

Juliaca, as shown in figure 3, where the students significantly improve their learning in the dynamic unity. call of a particle after treatment, applying the Interactive Physics software.

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