Article **Journal of Technology and Innovation**
December 2019 Vol.6 No.19 22-30

PSeInt Technological tool to develop logical-mathematical intelligence in structured computer programming

PSeInt herramienta tecnológica para desarrollar la inteligencia lógica-matemática en programación estructurada de computadoras

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Received: September 09, 2019; Accepted: November 04, 2019

Abstract

Information and Communication Technologies (ICT) have an increasing influence on the way of communicating, learning and life; and that the challenge is to use these technologies effectively so that they serve the interests of the students as a whole and of the entire educational community as didactic strategies to support the students, in their arduous task of learning topics related to the development of the logic of computer programming, since for them it is a factor that makes it difficult to solve problems in algorithmic form, independently of any programming language. In the search to improve the teaching-learning process in the fundamentals of the logic of computer programming, the present work aims to describe the experience where the first semester students of the Computer Systems Engineering of the Technological of Advanced Studies of the East of the State of Mexico (TESOEM) learned to develop their skills to understand such logic, necessary to solve problems in algorithmic form using a psedolanguage as a pseudocode, where the PseInt program was used as an educational support tool significantly influencing the understanding of this logic.

PseInt, Programming, Logic-Mathematics

Resumen

Las Tecnologías de la Información y la Comunicación (ICT) tienen una influencia cada vez mayor en la forma de comunicarse, el aprendizaje y la vida; y que el desafío consiste en utilizar eficazmente estas tecnologías para que estén al servicio de los intereses del conjunto de los estudiantes y de toda la comunidad educativa como estrategias didácticas de apoyo a los estudiantes, en su ardua tarea de aprender temas relacionados con el desarrollo de la lógica de programación de computadoras, ya que para ellos es un factor que dificulta para solucionar problemas en forma algorítmica, independientemente de algún lenguaje de programación. En la búsqueda de mejorar el proceso de enseñanza-aprendizaje en los fundamentos de la lógica programación de computadoras, el presente trabajo tiene por objetivo describir la experiencia donde los estudiantes de primer semestre de Ingeniería de Sistemas Computacionales del Tecnológico de Estudios Superiores del Oriente del Estado de México (TESOEM) aprendieron a desarrollar sus habilidades para entender dicha lógica, necesaria para solucionar problemas en forma algorítmica usando un psedolenguaje como pseudocódigo, donde el programa PseInt se utilizó como herramienta de apoyo educativo influyendo significativamente en el mejoramiento del entendimiento de esta lógica.

PseInt, Programación, Lógica-Matemática

Citation: CRUZ-BARRAGÁN, Aidee, SOBERANES-MARTÍN, Anabelem and LULE PERALTA, Armando. PSeInt Technological tool to develop logical-mathematical intelligence in structured computer programming. Journal of Technology and Innovation. 2019, 6-19: 22.30

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Introduction

The incorporation of Information and Communication Technologies (ICT) in society and, especially, in the field of education, has become increasingly important and evolving in recent years. However, what gives a true potential within the classroom is the pedagogical sense of the teacher, so that incorporation must be the product of a constant reflection of the teacher on several aspects, including the didactic strategy to be used, the skills to be developed, the theme and the problem that must be solved. ICTs in the classroom provide both the educator and the student with useful tools and position the student as the protagonist of their own learning (Cruz and Barragán, 2014).

At present there are various educational technological tools, such as didactic strategies to support students, in their arduous task of learning topics related to computer science, such as the logic of computer programming, the latter as mentioned by Novara (2014) that learning to program algorithms is very difficult for most students, since programming logic is required, fortunately the tendency of the last ten years is more frequent to use technological tools at university level to facilitate teaching learning based on representations of pseudocode or flow charts, among these stand out Pseint and FreeDfd.

Recalling that programming algorithms is very difficult, López (2006) points out that one of the problems found in computer programming students is to understand the logic and how a program really works, because most of the time they simply memorize the code syntax, taught in a specific programming language and that causes a lot of confusion, because at the moment that the student advances in the different semesters how to implement Object Oriented Programming, it is where the teacher realizes that “something” is needed. So that "something" that lacks is the basic logic of programming.

Similarly, López (2006) mentions that students are not being taught to think; that is, they are not developing the logic of programming and that is a factor that makes it difficult for most students and for the teacher it is a challenge that must be faced, because programming is an intellectual activity that requires a lot of creativity, ability to abstraction, analysis and synthesis and that these skills can be developed in an appropriate way.

Howard Gardner has proposed his theory of Multiple Intelligences since 1983. Through it, Gadner concluded that intelligence is not something innate and fixed that dominates all the skills and problem-solving skills that the human being possesses as often thought, but that education can develop it. Within their theory of intelligences is Logical-Mathematical Intelligence, people with this intelligence have among their abilities logical thinking, high numerical reasoning, the ability to resolve, understand and approach arithmetic elements, in general in resolution of problems.

Gardner (1983) recognizes that every human being is born with potentialities that are the product of genetics, however, he considers that they are developing in one way or another, in what influences the environment, experiences, education received, culture, among other aspects not less important.

The experience obtained through the subject of Computer Programming Fundamentals is presented during the 2018/2 school year (September-January) in which the first semester students of Computer Systems Engineering of the Technological of Higher Studies of the East of The State of Mexico (TESOEM), learned to understand the logic needed to solve problems in an algorithmic way, regardless of some programming language, that is, to learn algorithms using a psedolanguage as a pseudo-code and not directly with a programming language.

The foregoing, in order for the student to understand how a computer program really works through the PSeInt tool as support for constructive, collaborative learning and discovery through ICT, in the sense that pseudocode exercises are not understood for some of the students in an abstract way, which led to simulate the execution of the process with true data in that tool.

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Commonly the verification of the exercises is by the blackboard and paper, so it is tedious in simple basic exercises.

ICT in educational processes

UNESCO (2013) indicates that Information and Communication Technologies (ICT) have an increasing influence on the way of communicating, learning and life; and that the challenge is to use these technologies effectively so that they are at the service of the interests of all students and the entire educational community. Likewise, it considers that ICTs help to achieve universal access to education and improve the equality and quality of education; they also contribute to the professional development of teachers and to the improvement of the management, governance and administration of education, provided that appropriate policies, technologies and capacities are applied.

Tobón et al. (2010) refers that the incorporation of ICT in educational processes offers ample possibilities to offer alternative educational models in which technologies can become support or complement of face-to-face education.

Delgado and Venesio (2013) mention that Salvador Llopis, in his article «The innovative and creative teacher. Typology of the ICT teacher », invites us to think about the creative teaching figure, who has the capacity to transform and generate new ideas / concepts or new associations; uses ICT as a useful means to achieve an end, adapting old and new methods to create a new teaching.

The same author mentions that David Sánchez Barbudo Miranda, says “The creative teacher knows the student, is not individualistic, never leads the closed class, promotes participation, is collaborative and is generous with his materials because he does not consider them his own, but an evolution than others created for him”. Referring to the innovation processes regarding the use of ICT in university teaching Salinas (2009) mentions that they usually start, most of the time, of the available technological solutions and availability and consider innovation as a creative way of selection, organization and use of human and material resources by the teacher.

According to Fullan and Stiegelbauer (2000), with the innovation processes in terms of improvements in the teaching-learning processes is the incorporation of new materials, new teaching behaviors and practices and new beliefs, as well as new conceptions to achieve significant learning.

From the perspective of Ausubel et al. (1997: 42): “The conceptualization of meaningful learning is achieved when the student can relate new knowledge to their individual experience (with what they already know), with everyday situations, with real situations, etc. so, Leon (s / f): makes mention that the human being has the willingness to really learn only what he finds meaning or logic. Tends to reject that which does not make sense. The only real learning is meaningful learning, meaningful learning. Any other learning will be purely mechanical, memorial, conjunctural: learning to pass an exam, to pass the subject, etc.

Pelayo (2007) states that the teacher becomes only the mediator between knowledge and students, it is no longer he who simply imparts them, but that students participate in what they learn, but to achieve student participation they must create strategies that allow the student to be willing and motivated to learn. Thanks to the motivation that the teacher can achieve, the student will store the knowledge imparted and find it meaningful or important and relevant in his daily life.

Mathematical Logic Intelligence

In 1983, Dr. Howard Gardner, Project Zero director and professor of psychology and educational sciences at Harvard University proposed his theory that there are seven intelligences. These are: linguistic-verbal, logical-mathematical, physical-kinesthetic, spatial, musical, interpersonal and intrapersonal. Then, based on the most recent studies, it establishes that there are more intelligences: the naturalist, the spiritualist, the existential, the digital and others.

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Through this theory Gardner (1983) concluded that intelligence is not something innate and fixed that dominates all the skills and problem solving skills that human beings possess, has established that intelligence is located in different areas of the brain, interconnected with each other and that can also work individually, having the property of developing widely if they find an environment that offers the necessary conditions for it.

Logical-Mathematical Intelligence reaches the way to identify models, make calculations, formulate and verify hypotheses or assumptions, using the scientific method and inductive and deductive reasoning. It uses the sensitization of the schemes and the logical relations, the affirmations and the proportions, cause and effect, makes connections, uses the numerical thinking to classify, categorize, sequence and plan, in general in problem solving.

Gardner also mentions that this intelligence has a very important function, but above all it is considered and recognized as social science, because it is considered complete and influential as science in general, with all its applications, it goes from the theoretical to the practical.

Gonzales (1987) "Considers that if the student learns mathematical logic, he will not have problems to learn exact sciences and will be able to program computers, since a computer program is nothing more than a sequence of logical steps that the person establishes to solve a determined problem".

How to stimulate mathematical logical thinking according to Gardner:

1. Use various interrogation strategies.
2. Pose problems with an open end for students to solve.
3. Build models for key concepts.
4. Encourage students to construct meanings from their object of study.
5. Link mathematical concepts or processes with other content areas and aspects of everyday life.

Technological Tools for Algorithms

In general, it is a fact accepted by the academic community that learning to program algorithms is very difficult for most students Bennedsen and Caspersen (2007). Fortunately, the ten-year trend to date is to use software tools as didactic support to facilitate teaching algorithm learning. For this, there are different tools, among which are Alice (Cooper et al, 2003) and JKarelRobot (Buck and Stucki, 2001) used mainly in basic and upper secondary education. At the university level, the use of tools based on representations of pseudocode or flowcharts is more frequent, among them is PSEINT (Novara, 2012), Raptor (Wilson, Carlisle, Humphries, & Moore, 2004) and DFD (Cárdenas, 1998). Next, each one of them is briefly described:

RAPTOR

RAPTOR (acronym for English Rapid Algorithmic Prototyping Tool for Ordered Reasoning) is defined as: "a programming environment based on flowcharts, specifically designed to help students visualize their algorithms and avoid syntactic baggage," is software for the Microsoft, Windows platform, very efficient and easy to handle (Wilson, Carlisle, Humphries, & Moore, 2004).

DFD

DFD, which stands for Data Flow Diagram "is a useful flowchart editor. It helps us to graphically numerous algorithms. It is redefined as "an editor, interpreter and debugger of algorithms represented in flowcharts." During the execution of a diagram, syntax and subprogramming errors are detected (Nieva and Arellano, 2009).

PSeInt

Novara (2014) the creator of this software mentions that PSeInt comes from PSEudoINTérprete, where PSE refers to PSEudocode and INT Interpreter. Therefore, the PSeInt is a program that interprets an algorithm written in pseudocode, N-S chart or flowchart. This program is free and free, distributed under the GPL (General Public License).

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PSeInt is designed to assist the student who begins in the development of computer programs or algorithms. The pseudocode is usually used as the first contact to introduce basic concepts such as the use of control structures, expressions, variables, etc., without having to deal with the particularities of the syntax of a real programming language, which will undoubtedly facilitate learning. This software aims to make it easier for the beginner to write algorithms in pseudolanguage by presenting a set of aids and assists, and some additional tools that help him find errors and understand the logic of the algorithms.

Main functionalities

Compared to other programs, PSeInt offers various tools for creating algorithms with pseudocode in Spanish. It has auto completed, command sheets, syntax coloring, etc. It also allows the simultaneous creation of multiple algorithms. It determines and marks errors and has numerous attributes, among which its free and free use should be noted. whose use is intuitive and nothing complex. It also provides a work environment with numerous aids and teaching resources and is approved tested on Microsoft Windows, GNU / Linux and Mac OS X. (Novara 2014).

Also, Pseudocode, PSeInt Algorithms is a mobile application for learning algorithms with pseudocode, this app uses the same pseudolanguage as the PSeInt tool.

PSeInt implementation

With the previous analysis, the reasons why the implementation of the PSEINT tool is preferred, beyond the existence of other tools, is because the interpreter is designed to assist the student who begins in the development of programs or computational algorithms, since which is a friendly and visual application as didactic support for the better understanding of the programming logic in students and for students to more easily understand the fundamentals of programming logic through pseudo codes, since the capabilities of this logic were limited.

Experience

Practice lived in one of the activities that was carried out in the subject of computer programming fundamentals, during the 2018/2 school year (September-January) with two groups one of 22 students and the other of 15. Sampling is not probabilistic; The selected sample is intentional, that is, all students from both groups were considered for this experience. The techniques were observation, explanation, application, and verification.

First, the theoretical classes were developed with exposition and foundation of theoretical contents as an algorithm: characteristics and foundation, forms of representation of an algorithm; control structures: concept and types; program: concept, types and basic elements of the same and practical activities through the analysis and solution of problems under the focus of the structured paradigm that were developed entirely in the classroom.

Subsequently, the practical classes were developed using the following sequence: Problem analysis, algorithm design, algorithm specification using one of the representation tools that is pseudocode, pseudocode verification, display of the proposed pseudocode, verification and debug operation.
Another technique applied was that of observation as mentioned by Schmuck, 1997, quoted in Kawulich (2005: 4) that observation methods are useful to researchers in a variety of ways. They provide researchers with methods to review nonverbal expressions of feelings, determine who interacts with who, allow them to understand how participants communicate with each other, and verify how much time is being spent on certain activities.

Likewise, (Cuevas, 2009, cited in Hernández Sampieri, Fernández Collado et al. (2010): 418) mentions that observation is very useful: to collect data about phenomena, issues or delicate situations or that are difficult to discuss or describe ; also when the participants are not very eloquent, articulate or descriptive; when working with a phenomenon or in a group with which the researcher is not very familiar; and when it is necessary to confirm what was collected in the interviews with first order data.

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One of the issues that could be observed at the beginning of the teaching of the subject, were the most common mistakes made by students at the start of computer programming, such as: syntactic errors, misuse of input-output, errors in control structures, errors in troubleshooting. Another question was that the student could not understand or imagine what he was programming for, that is, he did not find meaning or logic at the exit of the program, as well as the importance of the syntax of the variables, the order, etc.). Consequently, these errors affected the first-grade failing grades of most students.

Even clarifying the students' doubts and making corrections to paper, the tendency will be to reject what they did not find meaning, since as mentioned above the only real learning is meaningful learning, meaningful learning. Any other learning will be purely mechanical, memorial, conjunctural: learning to pass an exam, to pass the subject, etc.

There are several questions that may arise trying to find the answers to the difficulties that most students present in the teaching-learning process at the beginning of computer programming, so this work provides a didactic strategy to exercise the logic-mathematical intelligence through a technological tool like PSeInt where the student began to understand more easily and to experience the fundamentals of programming logic through pseudocodes.

As Gutiérrez and Vargas (2000) mentioned, one of the main problems faced by people who want to learn to program is to create logical sequences of instructions that allow solving a given problem. Next, in order to implement this didactic strategy, students were asked to download the PSeInt program from http://pseint.sourceforge.net/index.php?page=portada.php in a computer room assigned to the subject, a Once the application was downloaded, the installation proceeded, which takes no more than a few minutes. The next step was for each student to enter the first pseudocode elaborated on paper, explained and reviewed in class. Then it was passed to the verification tests where the instructions of the pseudocode were the correct ones to be able to visualize the proposed pseudocode, by means of the flow chart and the desk test checking that the requested outputs were consistent.

If when performing such tests, the program will mark syntax errors in writing or at runtime, the student will be supported to solve these errors. One of the objectives of this activity was a first attempt for students to develop one of the skills of logical-mathematical intelligence, such as the understanding of programming logic for problem solving. Considering the most common and important needs that students with little or no programming experience had and providing them with a technological tool that would facilitate learning and be meaningful.

Below are some results of the practices that were developed in the course.

In Figure 1, the main PSeInt environment is shown.

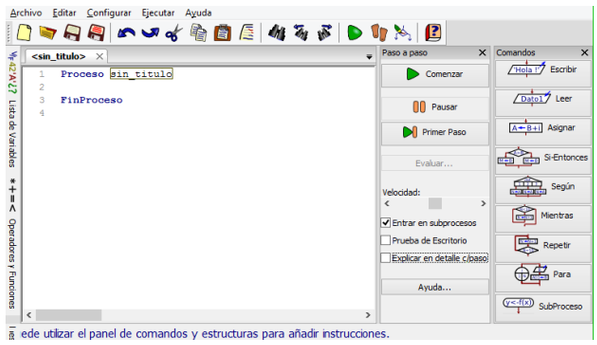

Figure 1 PSeINT Main Screen

Example of writing a pseudocode with sequential structure, see figure 2.

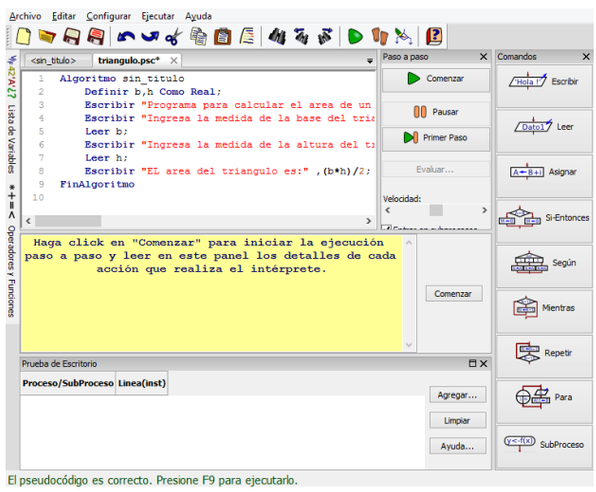

Figure 2 Correct writing of a Pseudocode

Figure 3 shows the execution of the pseudocode step by step controlling the speed and inspecting variables and expressions.

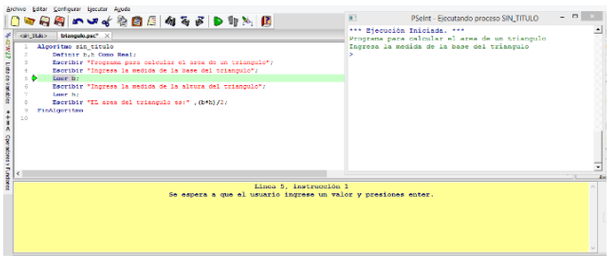

Figure 3 Pseudocode execution step by step

Figure 4 shows the complete execution of the program.

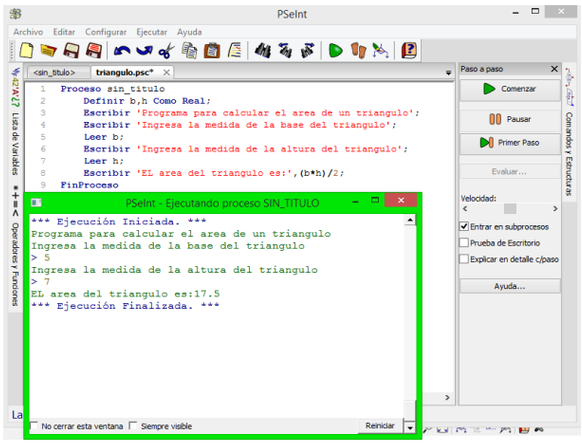

Figure 4 Complete execution of the pseudocode

Flowchart Generation from the pseudocode of figure 4, see figure 5.

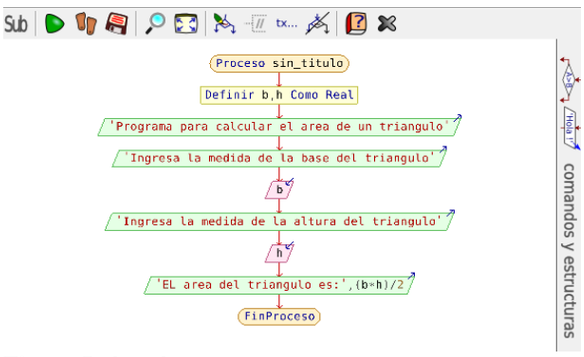

Figure 5 Flowchart

Results

Next, the results obtained from the survey applied to the first semester students of Computer Systems Engineering of the Technological of Higher Studies of the Eastern State of Mexico (TESOEM) are presented, the results are presented through figures and are accompanied by a brief analysis.

The percentage of gender that answered the survey is shown in Figure 6, where 65% are men and 35% are women, this is because the enrollment of the Computer Systems career is mostly made up of men.

Figure 6 Participation of men and women
Source: Own elaboration 2019

Another question was to know the percentage of students who had knowledge of the existence of technological tools as pseudo code interpreters, so in Figure 7 it is shown that the majority of students (represented by 86%) did not know any interpreter of pseudocodes, while 14% did know some; This allowed us to identify that the integration of PSEINT as a technological tool was a good support strategy for teaching learning.

Figure 7 Students who had knowledge of pseudocode interpreters

Likewise, it was discovered that of 14% of the students who had knowledge of a technological tool such as Pseudocode Interpreter, 8% did know PSEINT, while 92% did not know as shown in Figure 8; This allowed us to know that the integration of PSEINT as a technological tool was a good support strategy for teaching learning.

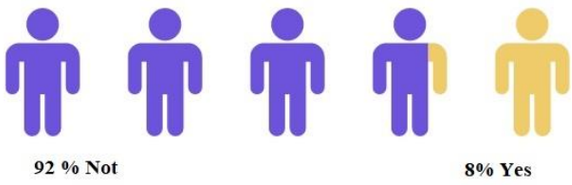

Figure 8 Students who knew PSEINT

Regarding the learning process there are several variables to consider, and among them it was when asking the students, if the learning of pseudocodes and flowcharts was facilitated with the implementation and use of a Pseudocode Interpreter.

For this the majority, 76%, declare that much, while 24% declare that enough, see figure 9.

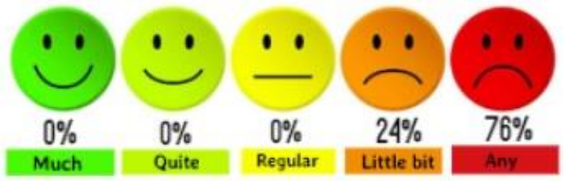

Figure 9 Students who were facilitated learning pseudocodes and flowcharts with PSEINT

In addition to knowing, if the PSEINT tool was provided in their learning, it is also useful to know the percentage of difficulty the student had with the development of pseudocodes and flowcharts, as can be seen in Figure 5. A Through this question that question could be analyzed. Of all the students, 76% did not find it difficult and only 24% the difficulty level was low. Therefore, it can be recognized that, through the response, students will be able to use this tool during their career without major problem.

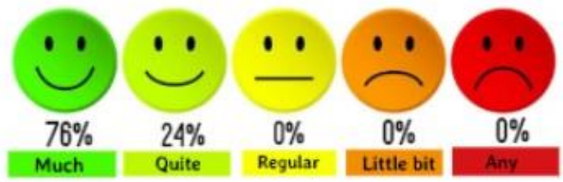

Figure 10 Difficulty percentage with PSEINT

At the same time, it was important to know if the tool is friendly, and as shown in Figure 11, it was found that the most chosen option has been "a lot" with 59%, followed by "Enough" with 41%. In no case were the other options chosen, Therefore, we see that it was a good strategy to introduce student's friendly technology and where them could generate knowledge from this tool.

Figure 11 PSEINT as a friendly tool

The technological resources offered in the classroom are considered to be very important in the education processes, which is why the students were asked, if the technological resources favor the acquisition of learning, thanks to the simulated environments, and the the most chosen was a lot, with 81%, followed by the option enough, with 11%, followed by the least voted option that was regular with 8% (see figure 12). For this, it was observed that these resources facilitate teaching and constitute an auxiliary element in the learning process by functioning as a mediator in the education of students.

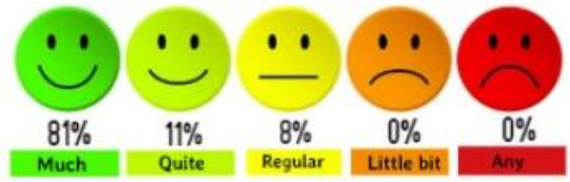

Figure 12 Perception of technological resources in the learning process

As you can see PSeInt is a friendly and visual application that as a didactic support significantly influenced the improvement of the understanding of the programming logic in the students, it was a good didactic strategy to develop the logic-mathematical intelligence and so that the students more easily understood the fundamentals of programming logic through pseudocodes, the capabilities of this logic were limited.

As López (2006) mentions, using a pseudolanguage allows to develop the mental abilities that a student must have to program a good structure, understand the logic and how a program really works by solving problems, since Problem Based Learning (PBL, for its acronym in English), it is a strategy "focused on the student, in which he learns through the experience of problem solving" (Branda, 2001).

The results were very satisfactory, since most of the practices of the subject could be carried out, so that with the use of this application the learning teaching objectives were achieved, but mainly it was observed that the student learned to understand the logic needed to solve problems algorithmically and this began to reflect in the improvement of their qualifications.

ISSN 2410-3993

It is important to mention that there are numerous technological tools that offer multiple advantages and possibilities to develop the capabilities of computer programming logic, where the teacher can and should take advantage, having with this a better opportunity for teaching-learning, because the Computer science is not only about programming, but a whole way of thinking (Ioannidou et al., 2011).

Finally, what is expressed by Salinas (2004) is resumed, at the university the activities related to ICT and teaching have been usually carried out by enthusiastic professors, who have managed to equip themselves with the necessary resources to experiment. Also, Rosewthar (1998) indicates in the Psychology dictionary that "The teacher's expectations are decisive for making predictions about what a student can get to learn".

Conclusions

In this experience it was interesting to observe that the students had openness, interactivity and participation in the activity. While it is true the success or failure of applications of educational innovations in the classroom depends, in large part, on the way in which the teacher implemented them. Also, as a conclusion, mathematical logical intelligence is not only intelligence with numbers, and mathematical problems, as previously reviewed, it is also problem solving through logic.

It is important to mention that this Technological tool is a didactic resource in the teaching-learning of algorithms, so it does not replace any other means of traditional learning, since these are considered an additional resource of support and enrichment of the teaching processes -learning, in which the student is the main builder of his knowledge.

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