

Gnosciedra: Learning Instrument for Mathematics

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This project presents a learning tool for mathematics which can not only be applied to learning algebra at the high school level in the IPN, but is also helpful for other school subjects because it involves the students in its design, using their creativity, synthesis capacity, and judgment to include relevant information. This instrument has its origin in origami, and was adopted to appropriate algebra knowledge, whose tradition has marked it as boring, difficult and only for the privileged.

The study methods and techniques encourage good practices and promote consistency in work of people who want to acquire knowledge and rely on learning tools. That's why the general goal of this project is to help students to acquire a study technique to learn math.

Specific goals of the project range from expanding the cognitive capacity of the students to have a repertoire of the algebraic elements and expressions in the algebra learning unit and generate an instrument that improves the processes of the instruction for logic mathematical reasoning.

Keywords: study skills, school performance, motivation, gnosciedra, learning

ALTERNATIVE METHODOLOGIES IN UPPER SECONDARY EDUCATION

Introduction

The present work is a sample of what is done in the area of mathematics, particularly in the algebra learning unit, which has been worked on since the previous level, but where most of the students bring deficiencies, both in learning and the execution for the solution of problems. In addition, algebra is essential in the Upper Secondary Level (U.S.L.) of Instituto Politécnico Nacional (I.P.N.), because it is the basis of knowledge of mathematics (geometry and trigonometry, analytical geometry, differential and integral calculus and, finally, probability and statistics) that the student must take throughout high school to consolidate their knowledge.

The idea of creating a study instrument arises from knowing that between 50% and 60% of students (although this percentage varies from group to group) are kinesthetic, due to the strong impact of technology

coupled with this fact that, even before the pandemic, many of them no longer use a notebook and pencil to make notes (except when it comes to solving exercises in the classroom) and that they prefer to use their cell phones to take a picture of the blackboard rather than copying the information. These and other factors influence the teaching environment and make the classroom an experimentation center, and change the perspective of mathematics from the teacher to the student.

This work began with observation, diagnosis (to get to know the students), analysis and the key question: how to ignite the interest of young people in the study of mathematics? Although there is also the paradigm shift of the teacher.

Justification

The upper secondary education (U.S.E) student lacks study techniques and methods not only for the acquisition of knowledge in mathematics, but also for most of the learning units. This is largely due to the fact that the student only plays the role of receiver and this limits criticism and reflection. To change this perspective, the student must be a creator, that is, that "the young person is the craftsman of his learning" (Pansza, 1991).

However, there are some students who do not require methods or techniques to complement their training because they have already developed their own method, usually they are self-taught. Although, the highest percentage of the student community requires strengthening their study habits, (such as, programming of activities, organization of time, and planning, etc.) because they don't know them or they have ignored them. These study techniques and methods promote good practices and optimal organization of time and work, which will lead to better academic achievement, if they're carried out effectively. The instruments strengthen study techniques and methods.

Objectives

- *General:* Foster in students study techniques for the learning process of mathematics.
- *Particular:* Expand the cognitive ability of students to have a repertoire of algebraic elements and expressions in the algebra learning unit. Generate an instrument that improves the instructional processes for mathematical logical reasoning.

METHODOLOGY

Concern or dissatisfaction with the results obtained in evaluations motivates the teacher to search for alternative methods to obtain better learning in the students and involve them in their own learning. For this reason, it was a priority to know the number of students who already had or knew a study technique or method and for how many of them their learning techniques worked, because generally, the student and the parents think and act based on the grade; but rarely is knowledge related to a grade, since the latter derives from the former.

Besides, there is a poor overview of what knowledge implies, since it is not only carried out within the classroom or seen as a result on a paper; knowledge, in general, must be applied inside and outside the classroom, it must be reflected in everyday life for the solution of simple and complex problems.

With these ideas in mind, the search for an instrument that would be of interest to the student, but, at the same time, would allow them to manipulate the object and also serve as an information gathering mechanism, led to the exploration of origami (whose antecedents can be traced back to the 2nd century in China), since it offered the possibility of creating a useful tool as a didactic material due to the fact that it registers elements and algebraic expressions, which are used for the teaching (pedagogy) and learning (didactics) of the content of the learning unit (subject), it also lays the foundations for playful learning, in this case for algebra.

Of the five groups that were given class in algebra, most of the students did not participate very much, were withdrawn and vulnerable, which led to putting into practice the gnoscedra. The name of the instrument has its origin in the Greek words "γνώσις", -εως,(gnosis, eos), knowledge and ἔδρα, -ας (hedra, as) "base or support point", whose etymological definition is "face of knowledge". At first it was useful as

an icebreaker, because when showing the material they expressed (see annex) incredulity about its elaboration and were surprised when they made their instrument following the instructions virtually.

The elaboration of the instrument resorts to minimal origami skills, because a strip of cardboard has to be measured, then, on top of it, folds have to be made to form the isosceles triangles and, at the end, the leftovers must be cut out, gluing only one side. Once the skeleton has been elaborated, the student is responsible for giving it a design and, through their creativity, making it pleasing to the eye, but above all, make sure that it includes the necessary information to learn the subject that is being developed, because in mathematics, in general, every time a subject is worked on, there are elements and algebraic expressions, for example, the percentage, the area, the perimeters.

When elaborating the instrument, the students, creatively, make it presentable for their own motivation, which is vital to reach a goal; because motivation "refers to an internal state that activates us and allows us to maintain a behavior closely related to the interests and goals that we set for ourselves throughout our lives" (Contreras Gutiérrez & Del Bosque Fuentes, 2004, p. 47).

An Instrument for the Appropriation of the Knowledge of Algebra

Algebra is the set of basic operations that uses numbers, letters or symbols to solve problems in the academic field; however, it is also very useful in everyday life. It is located in the first semester of the Upper Secondary Level (N.M.S.) of the National Polytechnic Institute (I.P.N.). It requires, for its execution, to make use of algebraic expressions and elements, which the student may find boring or tedious and, in this century, with so much "availability of information, it will be necessary to have tools to organize such information and, above all, give it a special meaning, that is, it is about what experts call building personal meanings" (Pimienta Prieto, 2008, p. vii).

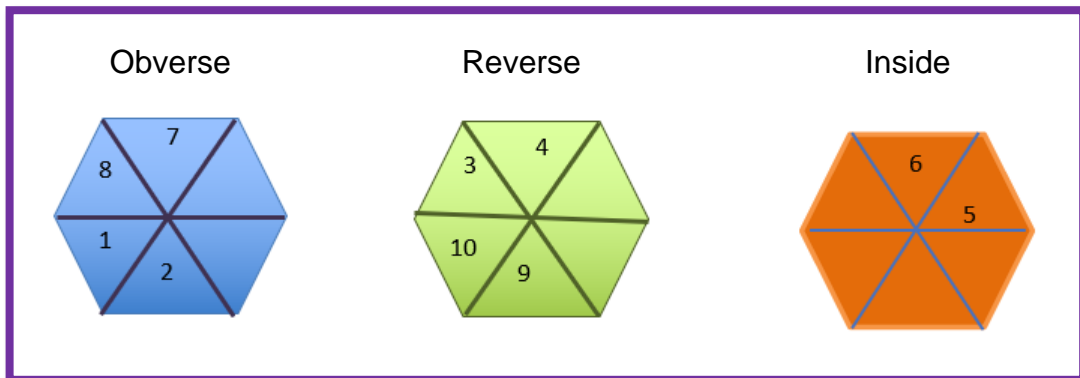
But young people have to be accompanied; because the thesis of the paradigm defended by Vygotsky must be fulfilled, namely: "higher psychological functions can only be understood through the study of mediated instrumental activity (use of instruments) and [said functions] have their origin and are developed in the context of socioculturally organized relationships" (Hernández Rojas, 2017) (The highlighting is by the author).

In order to carry this out, the modern form or the classic cheat paper was designed, an instrument that a large number of students of the current century are unaware of, because they have gotten used to making a copy and reducing it, until the document fits in the palm of their hand. This modern way of working by the students is not very useful, because reading is shallow and momentary, which results in laziness for writing, the latter action being a necessary condition to reinforce learning. Thus, the elaboration of the gnoscedra began.

The gnoscedra, as previously mentioned, is an instrument that comes from origami; it is a useful tool as didactic material, because it can be used to record information of all kinds and whose purpose will serve for teaching (pedagogy) and learning (didactics) the content of the learning unit (subject) of algebra, in this case. The didactic resource has three faces in a structured way, two visible and one hidden; in each one of them the elements and algebraic expressions that will be used in each one of the ordinary periods are registered (according to the course planning for the Study Center) and, at the end of the semester, it will have the general content.

The geometric figure that shapes the gnoscedra is a hexagon. It is as follows:

FIGURE 1
PARTS OF THE GNOSCIEDRA



The didactic material, in addition to being original to record the elements and algebraic expressions, is elaborated according to the taste of each one of the students, which awakens the approach and empathy, towards an area that has been a source of aversion, to promote change of perception with respect to mathematics. It is very useful and supports learning, since it provides better retention, which allows the understanding, analysis and reflection of algebraic expressions when using them to solve problems, in a concrete, easy, fast and simple way.

By recording the elements and algebraic expressions for problem solving and being assembled in one place, it is easy to identify the one that will be useful for solving an academic exercise. If the students learn to use it, they will handle their didactic material properly and improve their mathematical skills. For a clearer explanation check the following: <https://bit.ly/3AD8WII> (activate automatic translation on the video platform), or scan the following QR code.



Among the advantages that have been attributed to the Gnoscedra by students is that it facilitates the use of algebraic elements and expressions as they are gathered in one place. From the teacher's point of view, it provides security to the student and helps them improve their skills in the area of STEAM (Science, Technology, Engineering, Arts and Mathematics) when they learn to use them properly.

The elaboration of the gnoscedra is carried out individually and brings out the creativity of each student; that is, they use different colors and geometric shapes to give it a unique presentation. Besides, according to Dansereau, cited by Campos Arenas, teachers "provide an effective way to identify the fundamental ideas and relationships between concepts of different levels of complexity; they lead to the

formation of mental images that can later be used to guide the memory of mental propositions” (2014, p. 10) and mathematical logical reasoning.

On the other hand, it serves as a didactic sequence (it is the result of establishing a series of learning activities that have an internal order among themselves), since it organizes learning situations. For this reason, it is important to emphasize that it cannot be reduced to a form to fill spaces, it is an instrument that demands the knowledge of the subject, the understanding of the study program, the experience and the pedagogical vision of the teacher.

Regarding the various learning styles, it can be affirmed that it is suitable for all students, in this regard the proposal of Neurolinguistic Programming is considered, in other words, it is evident that for the kinesthetic style there is an instrument in the hands (which has mobility); regarding the visual, it involves the colors and shapes that were chosen by the individual for the design itself; and for the auditory, the elements and algebraic expressions that are in their material can be read aloud inside and outside the classroom.

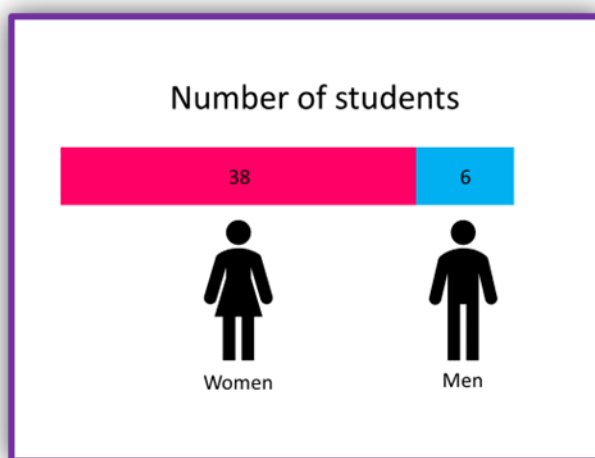
With regard to putting motor skills into play and involving kinesthetic students, the material rotates, and different information can be glimpsed on each of its three faces.

RESULTS

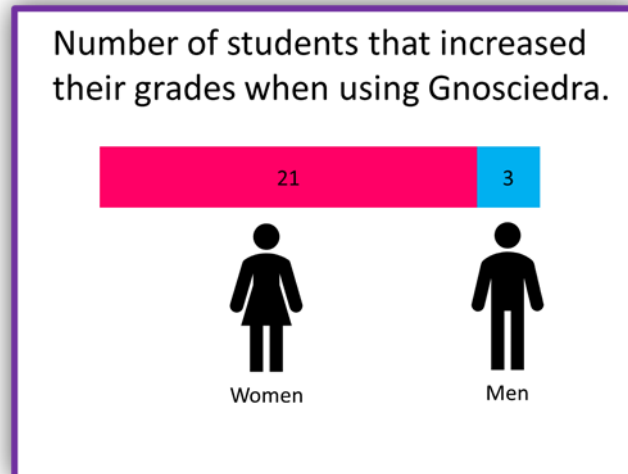
The study technique began with the instrument called gnoscedra. Despite the fact that it was applied to all of the five groups, only one group in the first semester that was studying the algebra learning unit was considered; this course was initially face-to-face; but from the second evaluation and until the end of the semester it was carried out virtually. This work shows the result of the usefulness of the instrument to study and learn Algebra.

Group A was initially made up of 53 students, but for various reasons only 44 remained constant. Out of these, 38 used the instrument to study, that is, 86%. The group was made up as follows:

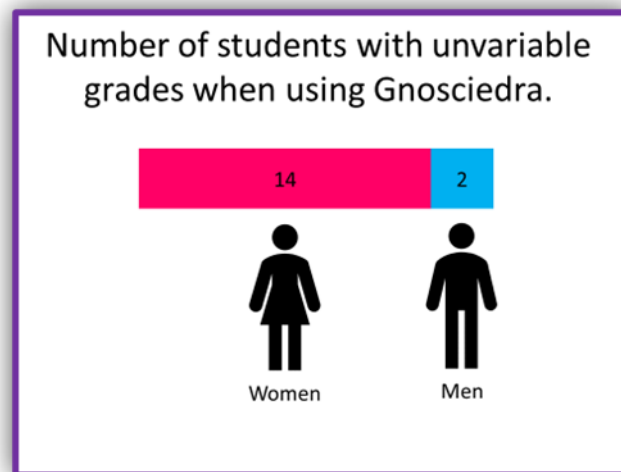
**FIGURE 2
GRAPHS**



Graph 1



Graph 2



Graph 3

21 students increased their grade from the first evaluation to the second, this represents 56%; while fourteen students maintained the same average, that is, 37%. 3 students lowered their evaluation, which represents 7%.

CONCLUSIONS AND/OR FINAL REFLECTION

The gnoscedra is creative according to the perception of the students, easy to use, and supports them in remembering the expressions and algebraic elements at the moment an academic exercise or daily life is presented. In addition, it gives them confidence, not only because they can visualize it, but also because by elaborating it and writing on it they reinforce their knowledge.

With regard to pedagogy, the teacher feels motivated to innovate and get involved not only in the design of the teaching material, but is also impressed with the creativity of the students. Regarding the various learning styles, it can be affirmed that it is suitable for all students, because as a study technique they have in their hands an instrument that was elaborated chronologically step by step and in it the information of a

full course is synthesized. It has the ease of being able to be carried everywhere, because it does not require much space. It doesn't cause excessive expense either. With respect to learning, it is useful because in addition to involving the students in its elaboration, it makes them participants in the recording of information, which encourages them to exercise mathematical writing.

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APPENDIX

