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On the contextualization of mathematical problems

C. Dr. Amín Bahena S., Dr. Crisólogo Dolores F., Dr. José María Sigarreta A., Dr. Ismael G. Yero

Associate Professor, Mathematics, Technological Institute of Acapulco, National Technological of Mexico, México

amin.bahena@gmail.com

Full Professor, Mathematics, Faculty of Mathematics,UAG, México

cdolores2@gmail.com

Full Professor, Mathematics, Faculty of Mathematics,UAG, México

josemariasigarretaalmira@yahoo.es

Universidad de Cádiz, Av. Ramón Puyol, s/n, 11202 Algeciras, Spain.

ismael.gonzalez@uca.es

ABSTRACT:- In this work the treatment of the cognitive interests of students is revealed, it is a way that allows the stratification of the group students according to their tastes and aspirations, and from that position by contextualizing problems pay tribute to the work of problem solving.

Indexing terms/Keywords:-Problem solving,activity theory, methodological proposal

Academic Discipline And Sub-Disciplines:-Matemátcas; Metodología de las matemáticas

Provide examples of relevant academic disciplines for this journal: E.g., History; Education; Sociology; Psychology; Cultural Studies;

SUBJECT CLASSIFICATION:-Mathematics, Mathematics Education

TYPE (METHOD/APPROACH):-Methodology

INTRODUCTION

The analysis of the relevant literature in relation to major deficiencies in learning, we find that there is significant research in this direction; as an example we can mention the work of Mitjáns (1995), González (1995) and Silvestre (1997), who point out that one of the fundamental difficulties in student learning is decreased interest and motivation for learning.

One of the approaches for addressing this difficulty is to study and understand the cognitive interests of students, based on the ideas presented by Shúkina (1978) in stating that they "... can be characterized as a complex man's attitude toward the objects and phenomena of reality around him, an attitude that reflects their tendency to study multilaterally and deeply, and know their essential properties. "(Shúkina, G. 1978, p. 9).

Among the elements that have allowed us to reach that conclusion was, as a guide, the study of cognitive interests of students had been addressed, in most cases, the result or purpose of the teaching-learning, assumed position to understand as a base what spurs the inclinations of students to different activities that encourage creativity and cognitive development; although not advancing in the analysis of such interest as required for students to participate actively in the process, to meet their cognitive needs.

Another element is related to analyzing the study of cognitive interests as a basis for the general organization of all activities of the school developed for teaching mathematics in particular, element concatenated directly with the teaching principle that emphasizes the link between affective and cognitive teaching methods. In support of this position González (1983) states:

> *"It is in the interests that man reflects most strongly, in the first level of systemic organization, the unity of the affective - cognitive. Even the orientation of personality could be found through the special interests, being symptomatic more stable, strong and dominant interests. "(González, F. 1983, p. 76).*

Investigations concerning the teaching and learning of mathematical problem solving and the incidence of them in the formation of personality in the students of pre-university education (Sigarreta, J., Dolores, C., Bahena, A. (2014)), demonstrate the importance of understanding and studying the cognitive interests of students as a vital link in the process of teaching and learning of mathematical problem solving. Many teachers, specialists and researchers have argued a priori that the presentation of a problem linked with practice, exemplifying the application of Mathematics character, etc.; can motivate students for the subject and trigger a problem situation in them, however, these ideas are based on general theoretical assumptions, which does not take into account particular, specific aspects of major importance, such as cognitive interests students.

In working with teachers they were oriented to present a problem with a relevant and interesting text for students in all classes as one of the steps of the proposed strategy for the treatment of mathematical problems, and all of the teachers, without exception asked: which of the problems that you have given will prove to be interesting for students. It is unquestionable that the adolescents, the center of educational activity, show a keen interest in everything that is new, a characteristic that is used to direct their focus on content and problems from a new angle, making some things, phenomena, and especially the process troubleshooting, which had not given it a real attention before, interesting.

Inexorably, what is studied or presented to the student will have value to him to the extent that the content covered is meaningful, ie, tell the student what he wants to know, to the satisfaction of their cognitive interests and can relate it to what he already knows. Interests depend on multiple factors such as physical and mental development, expertise in the area of analysis, the way that the student views himself, individual capabilities, and so on. Therefore, interests are not permanent positions, but rather there is a real possibility of acting on these factors to change them in accordance with the stated objectives.

In this way the teacher should try to identify trends and characteristics of students' cognitive needs to stratify them, in such a way problems that have been made out and given to the students for the development of personalities and that have a link to areas of the culture in general to the aspiring students. The variety of problems can, in principle, meet these trends, which the students or subset of them would be emotionally involved in the process of resolving.

Creating an output for each of the cognitive interests of students through math problems is theoretically possible for the number of situations that may be concatenated into the text of a given problem. But it is clear that this process can not produce the diversity and complexity of all these in the school setting, for known reasons. However, knowledge should lead to regularities that allow planning of activities and tasks that really appeal to most students.

For the use of the instruments it was necessary to start from the study of previous work in this direction, both domestically and internationally; for example in the United States, so-called Annastasi interest inventories(1970) have been used. In general, the most common techniques used for diagnosis and study of psychological formations of the personality are named products of the activity developed by Mitjáns (1995). This method studies, its products, rather than the direct development of the activity in order to infer them indirectly from the psychological peculiarities and activity of the active subject.

The study of the products of the activity of man allows their abilities and habits, attitude towards work and in many cases, the very process of compliance and on the psychological functions related to him, to be judged. In this sense, the author's positions coincide with the so-called classical school of psychology, considering that any activity is not really useful to really study the personality of the student in depth, as it is only expressed directly in the activities that have real significance for him.

One of the elements of forced presence in the pedagogical activity of teachers in organizing the educational teaching process, is that cognitive interests measure up, for the most part, to the experience gained by the individual in the course of his life, which after becoming set, become mental properties. It is clear from the previous positions that a student who rejects mathematics and expresses, in first place, that experience which he has with respect to mathematics (school mathematics) is negative.

At work the cognitive interests are analyzed, fundamentally, as a complex attitude of man towards the essence of objects and phenomena of reality. The words of Ponce (2011), permit us to understand that attitudes are not immutable and therefore, that a work organized and planned in that direction will positively affect its transformation and development. In this sense: "The attitude is the expression of the personality to the reality. Therefore, the attitude is different in each person, since they are in perpetual transformation, as well as the external environment"(Ponce, j. r. 2011, p. 41).

Understanding that the attitudes of the subject are based on his personal history, changes in the experience regarding the object of (mathematical) attitude will involve an alteration in it. The study of cognitive interests, which can be braught to classes, will as far as possible, improve the teaching-learning process and the attitude of students toward mathematics in general, and the resolution of problems in particular. Resources used for the study of the cognitive interests of the students, are based on ideas that are handled by the research Group on the teaching-learning of mathematical problems in the schools of the Autonomous University of Guerrero. For this study, it was necessary to use problems related to various activities of the sciences, especially with mathematics and the humanities, and an inventory of interests.

In pre-university level in Mexico, the diversity of interests and vocations is numerous and sometimes becomes complex; Therefore, it is necessary not to forget these realities just when presenting mathematical problems to students, since a given problem is not the same for a student who aspires to study the arts as it is for one who wishes to be an engineer. Contextualizing problems not only satisfies the students' interests and potential vocational occupations, but also brings problems to the experiences of the students and the socio-cultural framework in which develops during a determined historically-concrete moment.

Problem solving as a proper way for the integral formation of young people, at the height of its era is conceived from the declared positions. This it is conducive to students with moderate attitudes toward mathematics to develop them and even those who do not will be able to cultivate them during passage through the different levels of education, and that fewer students refuse classrooms because of mathematics. For the achievement of that goal it should be fully reaffirmed that pre-university education should prepare the students with a general culture to face life and not to develop, at least at that time, as a science specialist in particular.

Despite this utility of mathematics, which is recognized in general, the majority of students are left wondering what the mathematics that is learned in school is useful for. This is motivated, in its genesis, because after the teaching of different levels tend to establish an almost total divorce between school mathematics and its application in practice. It is equally true that teachers must respond and meet a set of requirements of programs that must be developed, but also teachers, the vast majority, do not possess the necessary elements to allow them to establish the link between the content taught in school and life for their student to develop the social context.

The possible applications of mathematics to life must corespond to the needs of the world in which the student lives and to cognitive interests; they must in turn allow the activation of their relationship with the activities of economic, laboral, cultural, scientific, environmental, sports, etc, in such a way that favor the formation of personality from these positions. Obviously, this does not negate the possibility of including problems for entertainment purposes within the classes, but they must have correct pedagogical justification of the reason for their use.

Among the advantages of contextualising a problem are:

- It increases the interest of students to see the immediate practical application of what they study.
- The student ceases to be a receiver of the unique ideas of the teacher and becomes a protagonist of the activity, with a sustained participation.
- The contents are not forgotten easily because most of the problems, mainly those that have text, associate the mathematical content with the interests of the community and student in particular.
- It facilitates the formulation of new questions about the proposal or situation resolved, questions as important as the resolution of the problem itself.
- It helps to develop oral expression and therefore facilitates the power of communication, which extends, enriches and perfects the mother tongue.
- It cooperates in response to the interests and concerns of students, if it arises in correspondence with these.
- It enables to correlation of the text of the problem with a conflict situation or specific moral dilemma.
- It helps eliminate negative beliefs about the ability of the student to solve mathematical problems.

Basically, the contextualization lies in the problems with a "meaningful" text, which harmoniously combines the considerations described above, its relationship to the interests of students and, finally, the presentation - as already explained – the cognitive that corresponds to social activities of various magnitude and with the psychology of the adolescent and youth. In this way there is a great contribution to the formation of personality, to promote their cognitive-ideological component, for example: features 1. And 2, previously mentioned, present the possibility that the student participates in an active way in the process, expressing their points of view with respect to the reality that surrounds it and develop their emotional sphere because of the problems' being associated with cognitive interests.

Similarly, you can establish a direct relationship between each of the above features and indicators of the personality that has been employed. The presentation of these problems does not eliminate in any way, exercises that do not comply with the said conditions, for it is known that certain functions are met in the teaching of Mathematics.

An example where the text is not linked with practice, but does meet the required conditions, is as follows: when shown the factorizing of algebraic expressions, it is natural that exercises are presented so that students will develop skills for recognizing the different types of expressions and how to break them down, but is not more than an exercise like this: Use the result of: $x^2-9=(x+3)(x-3)$, breaking down the number 9991 into two factors other than 1 and 9991. The decomposition of the binomial with security that is no longer a problem for the majority of the students, but the breakdown of the number 9991 under given conditions is a problem, since the student needs to have previously searched relations that allow him to discover the links between the given elements.

Another important element, allowing the contextualization of the problems for the formation of personality, is the realization of a set of questions related to the text, which not only covers possible mathematical relations, but that take advantage of the text of the problem with a view to the development of the affective sphere and its impact on the socio-cultural environment. In today's society the ability to discover problems, i.e., find possible questions and recognize situations unknown to man is considered to be one of the essential features to be developed in all its members. One of the ways to cooperate in this direction is by means of the questions the teacher can present along with mathematical problems.

Asking questions is recommended for any subject and level of education, whether through the daily teaching, to check the level of assimilation of concepts and their definitions, procedures and properties that have been transmitted in the classes, or in periodic assessments and final exams, as a way to check if the class or course objectives are being, or have been met. These questions may take different forms depending on the typical situation of the subject being taught or evaluated. Thus, in mathematics, questions are formulated about concepts and their definitions, procedures, theorems and mainly envelope problems.

It's not about the type of questions that normally appear in the mathematical literature used in teaching, in which the considerations are addressed, but to a series of questions or comments which can be derived from the classics and which depend mainly on the experience, skills and culture of the teacher, which contribute to fixing and correctly applying the knowledge acquired. In addition, with these questions additional objectives can be achieved from those established in the contextualization and output are given to numerous events of educational character, such as:

- Ensure that students adequately understand the situation that is being presented.
- Develop their power of communication, allowing them to freely express their ideas, experiences and points of view.
- Make it the Center of activity, contributing ideas that give strength to the studied subject.
- Ensure that the student will discover new relationships (math or social) that are beyond their current means.
- Contribute to the formation of personality, to exploit, to the maximum, the educational potential of the problems.

Consider using examples how the preceding considerations are manifested in certain mathematical problems, moreover, other items that can not be ignored in the question-problem relationship are content to be considered and intonation with which the teacher asks the question. With examples of contextualized problems, an idea of how the different questions or comments that encourage discussion provide outputs in a natural way to situations that a teacher of today can not escape or marginalize, such is the formation of personality. The first example shows with the same problem its possible contextualization, under the prism of the cognitive interests of students to which it is addressed.

Contextualized Problems

Example 1.

There is a square of side l and we will ask questions in accordance with the interests of the students and the characteristics of the class. If we are teaching a class whose content permits the establishment of a link with certain manual skills, it can state the following situation: "you want to build a wheelbarrow, to facilitate agricultural activity, and the wheels will be made from the wooden square given. There are two options, make it with four wheels or a single one, as shown in figures A and B. Which uses more wood?

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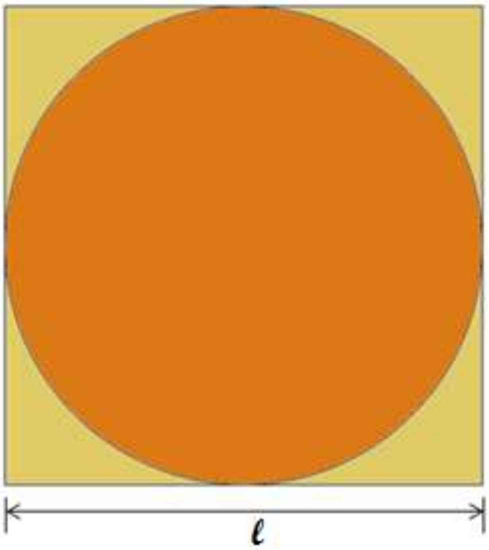

Figure A

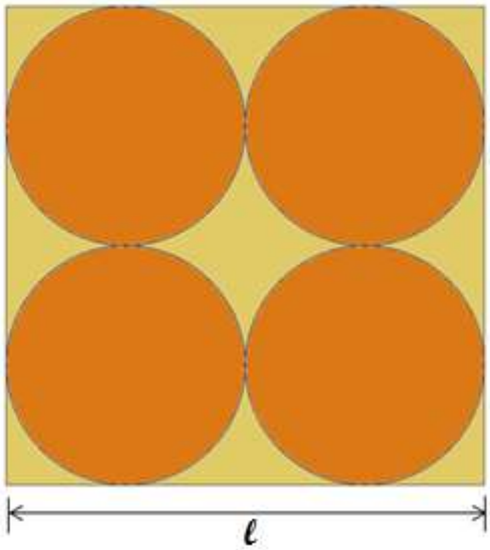

Figure B

There are opportunities, in this case, to direct any questions or comments related to the social importance of the agricultural activity they perform, with the policy of savings that our country develops in all orders. In addition, the text can be used to contribute elements related to hard laobor.

If in the investigations carried out in the class it has been detected that there are students with multiple inclinations, one of them is the arts, in particular for painting, it is possible to work on the same structure as the previous problem only that in this case we will have to modify its text and squares of C and D diagrams will be proposed so that the student selects the scenery he likes most and say where is more paint needed, considering that equal areas have the same amount of paint.

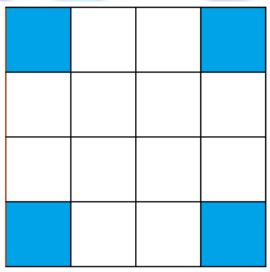

Figure C

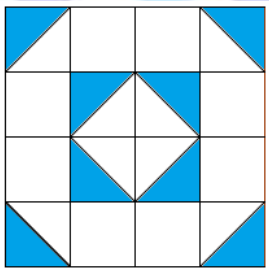

Figure D

Although the text of the problem encourages the flow of questions or comments in the analyzed order, the professor should promote discussion of solutions and appreciate the students' criteria. Bearing in mind that questions are not always so explicit, they, along with the valuations of the entire solution, are irreplaceable items for contributing to the development of the critical and self-critical spirit of students.

Example 2.

a) A chemist sells medicine in cylindrical containers with radius of 3 cm and a height of 7 cm. (See Figure E and F)

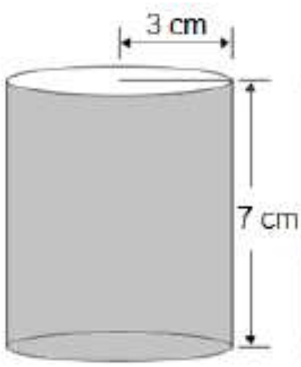

Figure E

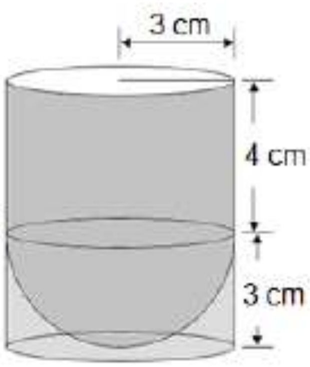

Figure F

i) Calculate, to three significant figures, the volume of medication in the container when full.

ii) Calculate the area of a label covering the entire side surface thereof.

b) The chemist decides to use chemical containers in which the bottom is a hemisphere, as shown in diagram F. The midpoint of the hemisphere is in the center of the cylinder. The container radius and height remain the same.

I. Calculate, to three significant digits, the volume of ointment contained in this new container.

II. The cost of the drug that in the container depicted in the diagram E was $80 and the that in the new container, $70. Which of the two containers is cheaper for the user? Explain why.

In this problem, in addition to the mathematical relations required to solve it, through questions and comments the Professor can project into different situations, for example, of a political nature, compareing the cost of drugs in rich countries with the price offered in Mexico; or in connection with trade policy exhibited by some companies, the price of the second container is apparently better, but it's really high, from which it can be inferred that the striking appearance of the second container is only an excuse to increase the price of the item.

Example 3.

The star of David, also called shield of David or Solomon's seal, is one of the symbols of Judaism. The shape consists of two superimposed equilateral triangles, forming a star. With the establishment of the State of Israel, the star of David on the blue and white flag became the symbol of the State.

a) Given a regular hexagon how can the star of David be constructed using symmetry? (See figure 1)

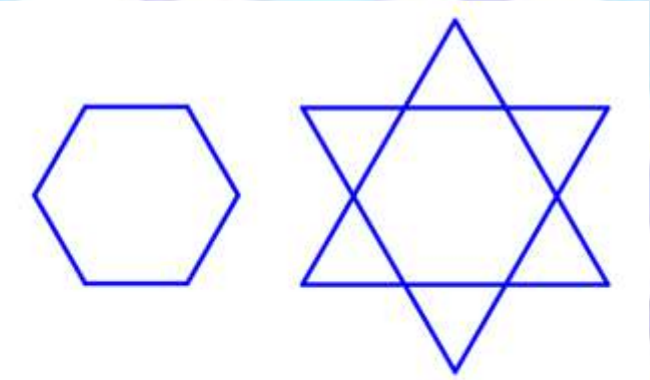

Figure 1. Construction of the star of David from a regular hexagon

b) Analyze the figure known as a star of David and respond as follows:

i. If the perimeter of the hexagon is 10 what is the perimeter of the star of David?

ii. Propose a formula to calculate the perimeter of the star of David, with respect to the inside hexagon.

iii. Propose a formula to calculate the perimeter of the star of David, with respect to any of the triangles that make up the tips.

iv. Is the relationship found between the perimeter of the star of David and the inside perimeter of the hexagon layout met if you draw a star from a Pentagon, a heptagon, an Octagon, ect?

c) Analyze the figure known as a star of David and answer the following:

i. If the area of the hexagon is 10 what is the area of the star of David?

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ii. Propose a formula for calculating the area of the star of David with respect to the hexagon drawn inside.

iii. Propose a formula to calculate the area of the star of David, with respect to any of the triangles that make up its tips.

iv. Is the relationship between the area of the star of David and the area of the hexagon on the inside met if you draw a star from a Pentagon, a heptagon, an Octagon, ect?

Example 4

A wall clock fell, and the glass broke. I took one piece of the glass to the glass shop so they could cut me another to replace it. The glazier asked for the rest of the pieces in order to know the diameter, but I told him that I took only a part (from the edge) because the rest was shattered. The next day, the glazier handed me the circular glass and when I put it in the clock it fit perfectly.

Figure 2. Wall clock

a) How would the problem be resolved if all pieces of glass were brought together?

b) The glazier traced the arc of circumference of the piece of broken glass on a piece of paper and taking three points from it, formed a triangle. What purpose could that serve?

c) What marks did the glazier have to make in order to solve the problem?

Being conceived the problem for students of Acapulco and associated to their socio-cultural environment, the particular historical moment in which they live and the elements of their social practice, gives the students an overview of the possible answers of the problem and moves them directly toward its solution.

Example 5

In Acapulco, since the year 2000 the new year was brought in with a show of Fireworks which can be seen from the beaches of the Bay. A bunch of rocket launchers are strategically distributed along the beach, as well as a platform that floats in the sea so that the show can be seen better from the beach.

The location of the floating platform creates a better view from some places than others:

a) If you want to the lights look the same distance from the three different points of the beach (red dots) marked on the map where should you place the floating platform (See image 1).

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Image1. Acapulco bay with three observation sites

b) If two places are to be given preference (marked with red dots) where should the floating platform be placed?

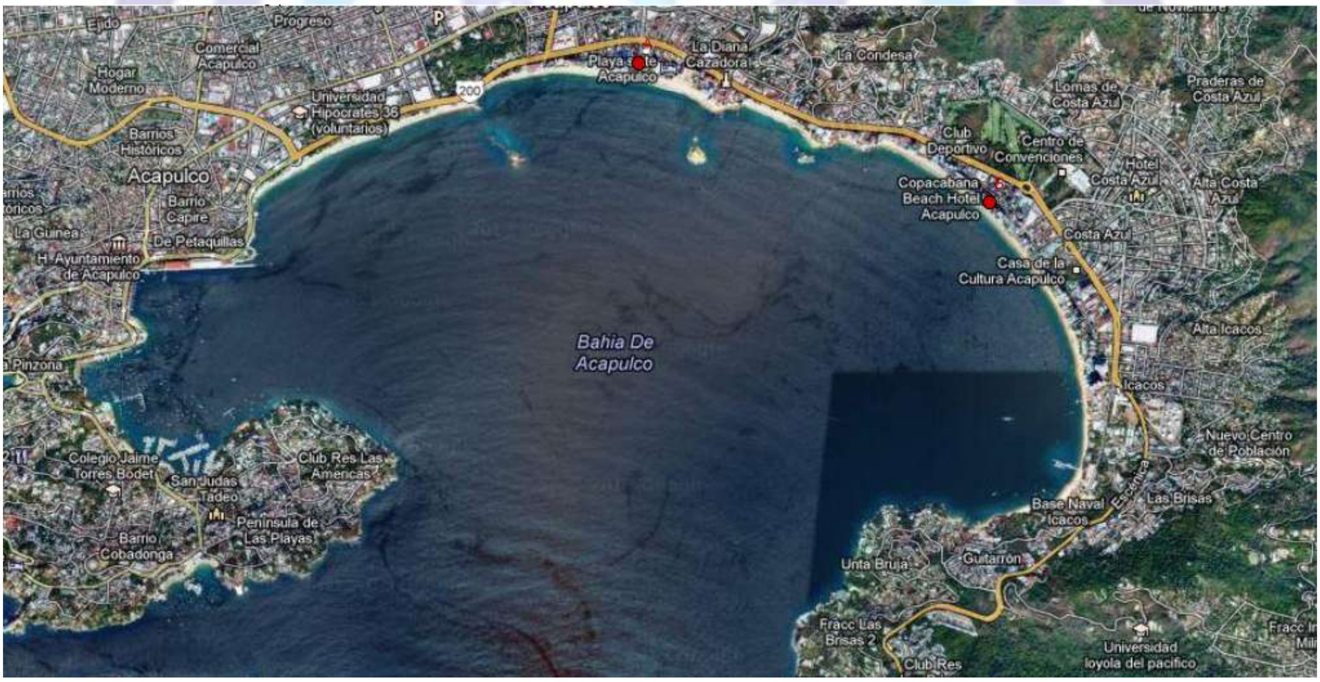


Image2. Acapulco bay with two observation sites

c) If the places chosen to watch the spectacle are the three marked with red dots, where would the floating platform be placed? (See image 3)

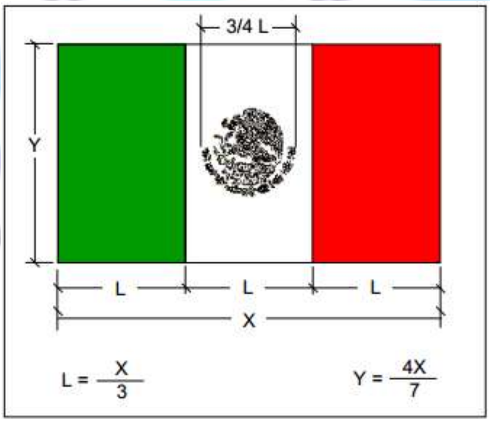
Image3. Acapulco bay with three observation sites

d) Four points are being considered as the preferred viewing points from the beach. Is it possible to use the same procedure? What conditions must the four points meet for the procedure to work?

Example 5

The flag of the United States of Mexico is one of the symbols of this nation; its day is celebrated on February 24. The Ministry of National Defense, in its standards for the national flag the following is mentioned:

1. THE PAVILION WILL BE A RECTANGLE OF SIZE PROPORTIONAL TO THE BUILDING IN WHICH IT IS RAISED, DIVIDED INTO THREE VERTICAL STRIPES OF MEASURES IDENTICAL, WITH THE COLORS IN THE FOLLOWING ORDER FROM THE FLAGPOLE: GREEN, WHITE AND RED. IN THE WHITE STRIP AND THE CENTRE WILL HAVE THE COAT OF ARMS, WITH A DIAMETER OF THREE-QUARTERS OF THE WIDTH OF SAID STRIP. THE RATIO BETWEEN WIDTH AND LENGTH OF THE FLAG IS 4 TO 7, AS SHOWN IN THE FOLLOWING FIGURE.



2. DIMENSIONS OF THE FLAGS ARE NOT SPECIFIED IN THE CURRENT MILITARY DOCTRINE BUT FOR PURPOSES OF BEAUTY AND COMMON BANNER WITH INSTALLATION ARE DEEMED TO LONG TO BE EQUAL TO HALF THE LENGTH OF FLAGPOLE WHERE HOISTED, ...

The coat of arms of Mexico is located in the Centre of the white band and consists of a Mexican Eagle devouring a snake which it is also holding with his beak, with the foot on his right leg, the Eagle is found standing on a cactus located on an area of the Texcoco Lake represented by a nahuatl glyph. The coat of arms of Mexico is based on the Aztec legend that tells how his people wandered for hundreds of years in Mexican territory searching for the signal indicated by their gods to found the city of Tenochtitlan (the current city of Mexico), where they saw an Eagle devouring a snake.



a) You want to construct a flag which is one meter wide

What dimensions the pieces of fabric will have?

What is the diameter of the coat of arms on the flag?

b) Monumental flags have been made in different cities in Mexico. In the Port of Acapulco, the flag measures 14.286 m in height.

What are the dimensions of the pieces of fabric (for each color)?

What is the length of the flagpole?

If the top of the flag is a quarter of the length of the flag what is the height from the flagpole to the bottom of the flag?

What is the radius of the coat of arms?

In this problem, the solution is not immediate. Analyze the data provided in the text to split the problem into subproblems that will help the resolver to reach the solution. In another sense the contextualization, as in the previous problem, allows the work to be permeated with educational interests pursued by society, the school and the teacher - including civic education-, through its own text or the set of questions or comments that can be derived from it.

The relationship between problem solving, contextualization, the cognitive interests, is analyzed by understanding that contextualization is directed to the output of cognitive interests, which in turn favors the process of problem solving and enhances the emotional elements that make up a relationship between the student, their experiences and points of view with respect to the environment in which it operates.

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Amín Bahena Salgado is a professor of mathematics at the Technological Institute of Acapulco (Mexico); holds a Master in Science in mathematics education from the Autonomous University of Guerrero, Mexico . He has conducted research on mathematics education.

Crisólogo Dolores Flores is a full professor of mathematics at the Autonomous University of Guerrero (Mexico); holds a Ph.D. in mathematics education from Pedagogical University of Habana (Cuba). He has conducted research on Methodology of Math and its impacts to mathematics education.

José M. Sigarreta is a full professor of mathematics at the Autonomous University of Guerrero (Mexico); holds a Ph.D. in mathematics education from Pedagogical University of Holguin (Cuba) and a Ph.D. in mathematics from University Carlos III of Madrid (Spain) . He has conducted research on Geometry, Graphs Theory and on Methodology of Math and its impacts to mathematics education.

Ismael González Yero is an assistant professor doctor at the Superior Polytechnic School of Algeciras (Spain). He has conducted research on Discrete Geometry, Graphs Theory and on Methodology of Math and its impacts to mathematics education.