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AUTHOR Zuluaga, Fabio Eliecer Gomez

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ABSTRACT

The main goal of this practicum was to increase general science achievement and improve acquisition of Spanish as a second language in a group of 21 sixth-grade Spanish immersion students. The students were having some difficulty with Spanish learning due to lack of Spanish science vocabulary, lack of appropriate science materials accommodating the differing levels of Spanish proficiency, and complexity of grammatical structures used in some Spanish science textbooks. Based on these needs, the researcher developed a concept-based science workbook in Spanish to address the academic, cultural, and linguistic variation in the students. The workbook contains six units, each divided into three sections corresponding to stages in the learning cycle theory: vocabulary; main ideas; and concept application. The report describes the practicum's context, problem, anticipated outcomes and evaluation instruments, solution strategy, and results and recommendations. The results indicate that the students increased their science vocabulary to a level at which they could understand important general science concepts, facilitated by meaningful and well-coordinated science experiences and projects. Appended materials include data on student achievement, data on science concept instruction difficulties, and a natural science test in Spanish. The workbook itself is not included. Contains 34 references. (MSE)

Increasing General Science Achievement for Spanish Immersion Students Through an Integrated Educational Approach

By

Fabio Eliécer Zuluaga Gómez

Cluster 59

A Practicum I Report Presented to the Ed. D. Program in Child and Youth Studies in Partial Fulfillment of the Requirements for the Degree of Doctor of Education

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PRACTICUM APPROVAL SHEET

This practicum took place as described.

Verifier: Dr. M. A. Harrison, Jr.

Mark Harrison Jr. , Ph. D.

Principal, Central Middle Magnet School

Title

3611 Linwood Blvd. Kansas City, Missouri

Address

June 3, 1994

Date

This practicum report was submitted by Fabio E. Zuluaga under the direction of the adviser listed below. It was submitted to the Ed. D. Program in Child and Youth Studies and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Nova Southeastern University.

Approved:

July 13, 1994

Date of Final Approval of Report

Georgianna Lowen

Georgianna Lowen, Ed.D.

Adviser

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The writer would especially like to express an enormous gratitude to Dr. Georgianna Lowen, practicum advisor for Nova Southeastern University. Dr. Lowen's authority and profound knowledge base in this matter made it possible to undertake this adventure.

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. . . in loving memory of my brother Aldemar!

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ABSTRACT

Increasing General Science Achievement for Spanish Immersion Students Through an Integrated Educational Approach. Zuluaga Gómez, Fabio E., 1994: Practicum Report, Nova Southeastern University, Ed. D. Program in Child and Youth Studies. Immersion Education/Bilingual Science/Spanish Immersion/Science Achievement/Middle School.

The main goal for this practicum was to increase general science achievement and improve acquisition of Spanish as a second language, in sixth grade students, enrolled in a Spanisn immersion program. The Spanish immersion students were facing some problems with their second language: first, the lack of science in their Spanish vocabulary; second, the lack of bilingual science books that accommodates the linguistic variability of these immersion students; and third, the complexity of the grammatical structures used in some Spanish science textbooks.

The writer developed and implemented a concept-based science workbook in Spanish in order to accommodate the academic, cultural and linguistic variability of the students in this specific immersion program. The workbook presented six basic units. Each unit was divided into three basic sections, following the learning cycle theory: Vocabulario/vocabulary, Ideas fundamentales/main ideas, and Taller/concept application.

Practicum results indicated that Spanish immersion students increased their science vocabulary to be able to understand important concepts in a general science class. It was clear that meaningful and well coordinated science experiences and projects facilitated children's learning in this particular science class.

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CHAPTER I

INTRODUCTION

Description of Work Setting and Community

A new foreign language immersion program at the middle school level was the setting for this practicum. The court-mandated desegregation effort of the middle 80's in the school district of this community provided the basis for the development of a foreign language program from kindergarten through twelfth grade.

In 1987, the foreign language immersion magnet middle school was established. This magnet school is committed to the study of a second language as an integral part of each student's educational experience. The vision of this new type of school is to achieve desegregative attractiveness by providing the public with quality schools, which combine a strong academic curriculum with a unique foreign language thematic emphasis.

This specific foreign language program is new in the U.S. when considering its size and the scope of its offering, particularly in what refers to immersion education programs. "Immersion is a form of bilingual education in which students who speak the language of the majority of the population receive part of the instruction through the medium of a second language and part through their first language." (Genesee, 1987. p. 1). Both the second language and the first language, are used to teach regular school subjects such as mathematics, science, or physical education, in addition to language arts. The same subjects are not taught using both languages concurrently or during the same academic year.

One of the most important considerations for this foreign language program is the immersion methodology. Coupling it with the planning of the immersion strand and its relationship with the non-immersion component of the program is considered of capital importance for the overall success of the program. Three teaching dimensions have thus emerged that are shaping the curricular and methodological thinking: Immersion, Target Language, and Infusion. Immersion refers to the teaching of a discipline in the second language. Target language refers to the teaching of French, German, or Spanish, as such. Infusion refers to the ancillary, yet very important, contribution that teachers of non-immersion disciplines make to the general thrust of the program by strengthening historical, geographical, and cultural elements pertaining to the three second languages.

Target native language teachers are selected from Belgium, Germany, Nigeria, Cameron, Canada, Spain, Argentina, Colombia, Perú, Mexico, Honduras, and Puerto Rico to implement the three languages (German, French, and Spanish). The aim is to attract a white student population through a quality program and simultaneously integrate and balance the student population racially to: African-American; 60%, and Caucasian; 40%.

The incorporation of the methodologies which foreign language teachers bring with them, have enriched the learning styles of these children. Foreign Language teachers come with a different experience and style, thereby offering a broader approach to education and different expectations of students' performance.

Their cultural background, their perception and understanding of education, actually enhances the individual student's perceptions of the world he/she lives in and continues to expand the student's awareness of the value of an education he/she needs to pursue beyond elementary and middle school.

The population selected for this study consisted of twenty-one Spanish immersion students enrolled in a general science class. Fifteen students were African-American, five were Caucasians, and one student was Latino. Thirteen students were enrolled in the free lunch program. Five students lived in middle class suburban areas approximately one hour from where the school is located. Ten students came from a single family home, and five were living with their grandparents.

The Spanish immersion students received one hour of science, math, social studies, and the target language, Spanish, per day. These children had the opportunity to learn Spanish through immersion in the language for a portion of the school day. When they walked through the science classroom door, they left English behind. All available resources were then utilized to help the children felt they were no longer eleven, twelve, or thirteen year old

Americans living in this community, but observers of and participants in a foreign culture.

Writer's Work Setting and Role

As a bilingual (English-Spanish) science resource teacher, the writer's main role is to function at the school site as a part of the team for planning and implementing the Middle Magnet Foreign Language theme. The main task is to work cooperatively with all persons and all levels of instruction and technology for developing, implementing and evaluating content area curriculum materials for science, math, and social studies.

The writer has a bachelor's degree in science in education with a major in chemistry, and a master's degree in education with a curriculum area of emphasis in science. He is also certified in science k-12, and in elementary education k-8. The writer's native language is Spanish. At the present time, the writer is teaching the advanced immersion science classes. The classes are conducted in Spanish.

CHAPTER II

STUDY OF THE PROBLEM

Problem Description

Achievement in science is a crucial aspect for any middle school student whether the class is conducted in English, Spanish or any other language. It was found that this specific student population lacked the ability to explain general science concepts. In other words, these twenty-one Spanish immersion students were not able to explain basic scientific phenomena, nor to relate it with the real world.

One of the very important skills that the students did not have was the ability to understand basic scientific vocabulary in Spanish.

Even though the students were able to understand eighty percent of the Spanish language, they did not comprehend scientific terminology. It was also found that the students lacked the ability to recognize the main instruments (scale, meter, microscope, etc.) used in any type of science class.

Students were also having difficulties when reading from books that originally were written for native Spanish speakers. Even though scientific terminology was very similar whether the book was from Argentina, Spain, or Mexico, there were still many expressions that were used to explain scientific terms, and these expressions were "different" from one country to another.

In order to avoid these problems, some teachers wrote their own worksheets. These informal activities did not have a strong sequence over several years making it difficult to evaluate their effectiveness. New teachers, for example, had to start from scratch. Foreign teachers did not have the time to write enough bilingual materials using the students' Spanish background.

The immersion students were not taught the necessary science vocabulary in Spanish, at the elementary level, in order to be able to succeed in a general science class at the sixth grade level. Briefly stated, twenty-one sixth grade students enrolled in a Spanish immersion program were experiencing low achievement in general science class.

Problem Documentation

Spanish immersion students did not have enough science vocabulary to be able to understand the main concepts in a science class at the sixth grade level. The results of a teacher prepared test showed that the students were not able to list the processes used to solve a problem scientifically. The same test showed that this specific population did not identify the units of distance, volume, and mass using the International System of Units (SI). Only two students out of twenty-one were able to find the area and/or volume of a cube and express the results in cm2/cm3 respectively.

This immersion student population did not complete the minimum requirements to be able to understand how living things relate to each other in order to survive. The same teacher prepared questionnaire indicated that the students were not able to define relationships between organisms in a community. One student out of twenty-one was able to recognize the terms: producers, consumers, and decomposers, and the order in which they related in the food chain.

This low achievement was confirmed when standardized tests were compared between these specific Spanish immersion students and a bigger population . The Missouri Mastery and Achievement Test, (MMAT), clearly showed that requirements for life skills were achieved only by thirty-four percent of the total student body at this foreign language magnet middle public school (see appendix A)

Students were also having difficulties understanding physical science (energy, atoms, etc.), and earth/space concepts. This specific student population had a very low achievement level of these concepts. Three students out of twenty-one were able to differentiate between kinetic energy and potential energy, and only one student was able to recognize the structure of the atom.

A formative evaluation of the third year elementary foreign language schools (Clay, 1990) revealed that eighty to ninety percent of the elementary teachers reported non-instruction whatsoever of some science skills. Thus, students were showing a great amount of difficulty when those science concepts were introduced to them.

This evaluation included the immersion students and the non-immersion ones.

Informal interviews with the immersion students revealed that most of them lacked exposure to science experiments during their elementary years. They also stated that they had very little experience with experiments, science fairs, or any other related event. The writer observed that the Spanish immersion students did not know how to behave, or 'what to do' when a science experiment takes place, even when clear directions were explained and reviewed. Most of the Spanish immersion students showed nervousness when they handled glass instruments, or simple tools, such as an alcohol burner.

Grade report cards indicated that thirty to forty percent of similar Spanish student populations received D's and F's during the first year at this school (See appendix B). This pattern did not change during the present academic year. Eight students, out of twenty-one, received D's and five students received F's for their first quarter science immersion class.

Parents expressed their concern about their children's poor science achievement. Even though, during the first parent teacher conference, they were very pleased with their children in this immersion bilingual program, most of the parents felt that the students were experiencing some lag in academic achievement as a result of being taught through the medium of a second language. Nevertheless, they were very positive and very supportive in wanting to find the adequate solution.

Causative Analysis

The Spanish immersion students were facing some problems with their second language. It was clear that many of them did not understand basic scientific terminology to be able to succeed in a general immersion science class at the middle school level.

The fact that the children lacked previous school experience in science, was indeed a contributing factor (See appendixes C and D). It was found, for example, that the bilingual immersion program had a complete absence of a science curriculum in Spanish (k-8), with the content paralleling what is taught in the regular science program taught in English (Clay, 1990).

Although there were books available from other countries for review, instruction and translation, teachers were extremely busy developing other skills such as speaking, reading, and writing in the foreign language, in this case, Spanish. Simply stated, there was not enough time to teach science at the elementary foreign language schools. This insufficient bilingual science instruction, at the elementary level, created a gap between what the children were supposed to be able to understand, and what, in fact, they did, when their science class was conducted completely in Spanish.

Another important consideration was the fact that the students did not possess enough science vocabulary in Spanish to be able to understand science concepts, and this was creating too many misconceptions. The frustrating aspect was overcoming those misunderstandings. The Spanish science teacher used very limited science in Spanish terminology to avoid even more confusion.

Students who received their science instruction in their native language, English, were experiencing similar problems. In this type of instruction, to bridge the science gap, was less complicated. When using their native language to explain science phenomena, teacher and students were able to use a greater amount of expressions, words, examples, synonyms, etc. Thus, the students, in fact, were understanding the main concepts.

The possibility of misconceptions and misunderstandings also existed when the students read books that were written originally for native Spanish speakers (Bamford & Mizokawa, 1992). These particular immersion students were using one book from Spain for their math class, and one book from Colombia "El Ingéniate" for their science class. Follow up research on these Spanish immersion students indicated that most of their elementary teachers were from Argentina. This important variable was taken into consideration. A clear example of this situation was when the science teacher asked his/her students 'to deposit the blue liquid into the dishwasher'. A teacher from Argentina said 'deposita el líquido en la pileta'. The teacher from Spain usually used the expression 'pozeta' instead of 'pileta'. The students during the immersion science class were told 'deposita el líquido en el lavamanos'. As we have seen in this particular example there were four different science-related terms used just to give a simple command.

To summarize, there were several causes that may explain why these Spanish immersion students were experiencing low achievement in general science class. For the purpose of this study, the following causes were taken into consideration: first, the lack of science in their Spanish vocabulary; second, the lack of bilingual science books that accommodates the linguistic variability of these immersion students; and third, the complexity of the grammatical structures used in some Spanish science textbooks.

Relationship of the Problem to the Literature

Achievement in immersion education programs have been studied in Canada, United States, and many other countries. Swain (1978) found that one-year late French immersion students in Ontario, scored significantly lower with respect to achievement in science when scores were compared with an English control group. This study suggested that students without enough exposure to the foreign language, in this case French, may have some lack of achievement during content-based instruction. The students did not have sufficient command of the foreign language to be able to receive academic instruction using French as a vehicle of communication.

Mackey (1988) suggests the improbability of immersion education without some special effects. He studied the case from the Philippines (1960-64) were English was implemented as a second language. In this particular case, it was found that one year in achievement was completely lost when English was used as a vehicle of communication.

Mackey (1988) also analyzes a similar study in immersion education where this type of backwardness was not present in subjects like math. The evidence also suggested that even though there were some differences in scores between the English control group and the immersion one, those differences were not significantly higher as to make a conclusion about mathematics.

Lambert (1980) found that immersion students encounter more problems when they are asked to recognize some words or expressions other than the unilingual. It is important not to generalize from these studies since science immersion education varies strongly from context to context.

Several causes need to be analyzed when low academic achievement is present in immersion programs. For example, most of the Spanish immersion programs in the United States have been characterized as using text books and many other printed materials from Spanish speaking countries (Spain, Mexico, Argentina, etc.). Lapkin (1982) found that text books from other countries may have grammatical structures that are extremely complex. This variable interferes when the immersion students need to understand the main concepts. The same study also suggested that materials translated directly from English lacked the cultural authenticity of the context where immersion programs are been implemented.

Some studies on immersion education show how some programs have developed proficiency in the foreign language at the expense of other skills (Kolesinski & Lereoux, 1992). This phenomenon is not unique to immersion programs. For example, it is found that low science achievement in the United States is related to the amount of time and the type of instruction students receive. Newport (1990) found that elementary teachers are extremely busy working with writing, reading, and math with no time to develop other skills.

The elementary teacher is faced with the unique challenge of trying to integrate the goals and ideas of science education researchers and other groups with the often conflicting realities of the classroom. Rising 'standards' in science have resulted in textbook series that emphasize topic coverage and memorization, leaving no room for experimentation and concept application (Fisher & Lipson, 1985). Increased testing and accountability puts pressure on teachers to promote facts and memorization and to concentrate on those students that learn quickly and well.

Immersion teachers are also receiving pressure in a different area. The main goal of some groups is to produce bilingual students, yet many others are more concerned with math and science skills. The reality is that, regardless of the type of program, all students must be able to understand the complex world and apply scientific inquiry methods to changing conditions (Hazen, 1991).

Even when teachers in immersion programs define their goals and determine priorities, they are faced with inadequate preparation and support. Research findings on immersion education are difficult to understand and apply. Even highly motivated science immersion teachers have limited time and energy (Miller, 1987). As a result, there continues to be a widening gap between the researched or perceived goals of classroom immersion science and the actual classroom science immersion teaching.

There are several studies that view immersion education from a broader view. A view that takes the learner beyond the classroom. For example, Taylor & Bassili (1973) suggest that acquisition of a second language may have positive effects on the individual through the process of cognitive restructuring. Later on, Lamy (1979) found that when a student learns a foreign language, it may influence his/her perception of other cultures. The individual internalizes two systems of world views. This was the case of some Spanish immersion students who were found to have positive attitudes toward Mexican-American cultures (Brittain, 1991).

Research on immersion education has indicated some of the potential and some of the limits of using a foreign language as a vehicle of communication to teach regular school subjects such as science, in this particular case. The Spanish immersion students will be able to understand the main science concepts only if he/she has enough science vocabulary in Spanish. Solutions will work only if causes for poor science achievement in bilingual settings like this one are established. The next point will be the creation of a pedagogical strategy that relates specifically to this particular situation.

CHAPTER III

ANTICIPATED OUTCOMES AND EVALUATION INSTRUMENTS

Goals and Expectations

The following goals and outcomes were projected for this practicum: the main goal was to increase general science achievement in sixth grade students enrolled in a Spanish immersion program. The second goal was to improve acquisition of Spanish as a second language so students can comprehend the main topic in this particular science class.

Expected Outcomes

At the end of the implementation period, twelve weeks, it was expected to improve science achievement and enhance the twenty-one Spanish immersion student's comprehension at the sixth grade level.

Eighteen students, out of twenty-one, were expected to demonstrate successful comprehension in Spanish of eighty percent of the following objectives, as measured by teacher prepared pretest and posttest:

1. The learners will be able to use the processes used to solve a problem scientifically; analyzing problem solving through controlled experimentation.
2. The learners will be able to identify, classify, and define at least ten common laboratory instruments.
3. The learners will be able to identify and define the SI (International System), units of distance, volume, mass, and temperature.
4. The learners will be able to recognize the parts of a cell and summarize the function of each organelle.
5. The learners will be able to define the relationships between organisms in a community (producers, consumers, and decomposers.)

6. The learners will be able to define the following terms: matter, mass, energy, compound, and work.
7. The learners will infer how work is related to energy and how to distinguish between potential energy and kinetic energy.
8. The learners will be able to define and recognize vocabulary related to earth science, earth structure and the solar system.

Measurement of Outcomes

A teacher prepared pretest and posttest was created to evaluate student outcomes (see appendix E). The test was developed to access both science achievement and Spanish comprehension.

The writer designed a pretest and posttest to access achievement in general science. This instrument was written in Spanish. Thus, the students were to be able to understand the main expressions used in this test. The "Exámen de Ciencias Naturales" [Natural Science Test] was made up of thirty-five multiple choice questions which were intended to measure the goals presented in chapter III.

-Questions 1-10 were designed to measure the student's skills in: -laboratory instrument recognition, -problem solving through controlled experimentation, and -the ability to use the SI (International System).

-Questions 11-14 were designed to measure the student's knowledge of: parts of a cell and the functions of a cell's organelles.

-Questions 15-18 were designed to measure the student's knowledge of how organisms in a community relate to each other and the name of those organisms.

-Questions 19 and 20 were designed to measure the students knowledge of the structure of the atom.

-Questions 21-26 were designed to measure the student's knowledge of: energy, potential energy, and kinetic energy.

-Questions 27-30 were designed to measure the student's knowledge of the human body.

-Questions 30-35 were designed to measure the student's knowledge of the solar system and the structure of the earth.

All items on this test were reviewed to eliminate those whose content were biased because of the lack of students' comprehension in the Spanish language. The questions were written using "transparent words", words whose roots are in Latin, so the students were able to have a schema of this particular word either in English or Spanish. Examples of these words were: microscopio, termómetro, metro, cubo, área, volúmen, célula, membrana celular, átomo, oxígeno, etc. Thus, making it possible that even the slowest child in Spanish did not experience a high degree of frustration. It is important to clarify that Clay (1990) found that this particular immersion population was able to understand up to eighty percent of the Spanish written language.

The Exámen de Ciencias Naturales was constructed considering the concepts of validity and reliability. The consistency of this measurement tool was analyzed under the following circumstances (Popham, 1993) :

1. Since Test-Retest procedure was used, changes in the examinee, such as maturation, further learning or forgetting, were considered. To minimize fluctuations in the true score, the following aspects were taken into consideration: a) no feedback was provided to students regarding correct answers after the first administration; b) examinees were not forewarned that the test was going to be administered a second time; c) the test itself contained sufficient items so that students did not remember them.

2. The emotional or physical state of the examinees, such as fatigue, sickness, emotional disturbance, etc., may have affected the results of the test and provisions to avoid their influence were taken.

3. Inconsistencies in the administrative process may have caused an inconsistency in the measurement. The following factors were considered : the clarity of instructions; the time of test administration; the prevention of cheating; and the physical environment (factors such as lighting, temperature, noise and interruptions).

4. Sometimes the nature of the test itself may effect its reliability (Borg & Gall, 1989). Reliability is influenced by the number of items in the test. This natural science test contained thirty-five items. This aspect increased the range of scores possible and it allowed for the observance of consistency in each student's performance throughout the two administrations of the test.

Considering the appropriateness of this science assessment tool, in order to determine if the test really measured what it was supposed to measure -validity- , some factors were taken into consideration (Walker, 1985):

1. This Exámen the Ciencias Naturales [Natural Science Test] matched its objectives and the audience for which it was intended.

2. This Exámen de Ciencias Naturales [Natural Science Test] reflected the appropriate grade level. It did not include items that were not taught. Some of the items were removed from the test, since they were not considered appropriate.

3. If the students' responses do not reflect their true ability, the test lacks response validity (Grant, 1987). Therefore, clear instructions and a familiar test format were provided to the students before the final test.

For this Natural Science Test, all the items were selected to strictly measure the expected outcomes for this specific practicum. Thus, a student's score on a test reflected primarily his/her ability of/on those specific outcomes.

CHAPTER IV

SOLUTION STRATEGY

Discussion and Evaluation of Solutions

A great amount of techniques have been developed in order to increase academic achievement when a foreign language is used to teach regular school subjects. Several strategies were borrowed, adapted, and transformed from many other contexts to fit the particular needs of this project. Thus, based on what researchers have done, and, on personal convictions on how immersion education should be approached, this practicum was implemented in order to increase general science achievements in twenty-one Spanish immersion students at the sixth grade level.

Immersion programs in Canada, United States, and some countries in South America suggested several options when low academic achievement was present. The French immersion program in Canada adjusted books and many other teaching materials from Quebec and France (Genesse, 1987). In this particular program, an interdisciplinary approach was used. Contents and concepts were aligned from one subject discipline with the content and concepts of another, while at the same time, clear boundaries between disciplines were maintained.

In the Spanish immersion program in California, teachers simply observed and borrowed techniques from the conventional English classes, adjusting or translating those activities according to the student's level of proficiency (Genesse 1987). It was found to have a strong positive impact on teachers who gained many new ideas from their peers. But the grammatical structures from the books in English were extremely difficult to translate and adjust according to the student's language proficiency in Spanish.

The Culver City Spanish immersion program sponsored the creation of bilingual materials in Spanish for content-based classes such as math and science (Rubenstein & Rothman, 1989). This program was found to have its roots in the Biological Science Curriculum Study (BSCS), which encouraged interaction between students and their environment. In this model, students explained, elaborated, and evaluated information through a variety of hands-on activities. The BSCS 's design built upon the theory that all of us construct knowledge to fit our own experience. The main explanations provided by the students were done in English or in Spanish, but the teacher used the second language, in this case Spanish, as much as possible.

Rubenstein & Rothman (1989) found some type of successful degree with the Culver City Spanish immersion program. Even though the scores did not increase that much in math and science in comparison with the English control group, teachers and students were more relaxed with the foreign language.

An important component of the Culver City Spanish immersion program was taken into consideration for the purpose of this practicum. There was a clear articulated cognitive method of language teaching. Students attained a minimal control over the rules of the target language because grammar was explained and discussed. The instructor moved from the known to the unknown in terms of grammatical structures. In order for the foreign languages to be meaningful, new material was organized so that it related to the student's existent cognitive structure. Blanc (1987) stated that, in order for learning to be effective and permanent, it must be meaningful and relatable to the existing knowledge that the learner already possesses.

The primary goal of this cognitive approach was the encouragement or self-expression. In pairs or small groups, students first practiced a new language skill through controlled exercises. Later on, they moved onto an application activity that incorporated the new skill, but allowed for responses that were more personalized and unconstrained than the precedent exercises (Grittner, 1990).

Several studies indicated that this type of cognitive approach was effective, and that positive cognitive changes thus occur when a student was exposed to a second language. A study released by the National Center for Education Statistics (1990) showed that seniors with no foreign language experience had a mean score of 366 for the verbal part of the SALT test, and 409 for the math part. The same study showed that seniors with five years of foreign language studies had a 504 verbal score and 535 math score respectively.

A well known English immersion program in Bogotá D.C. Colombia, South America, used the learning cycle theory (Gallegos, 1985). This approach was a direct attempt on the part of science immersion teachers to apply Piagetian theory to classroom instruction. An example of a lesson involving the learning cycle was taken from Lawson (1975), and then adjusted into the immersion classroom. The example was the "communities". In this unit, students are introduced to no more than ten new terms related to the structure of the plant. Students examined seeds and plants, then they observed plant growth in the controlled environment of a terrarium. The unit then introduced plant eaters (mealworm), and later animal eaters (frogs or chameleons), with no more than five new terms from now on. Finally, they observed feeding relationships at the various stages. This first part of the unit was called <u>exploration activities</u>.

During the second phase of the unit, <u>concept introduction</u>, the teacher introduced the concept of a biological community as a way for students to organize their observations into a conceptual unit. At this point, students had a clear understanding of fifteen to twenty new words in the foreign language related to this specific unit. Some students were able to develop a working understanding of the concept while others needed additional background experiences.

The third phase of the unit, concept application, provided opportunities for students to examine new communities, e.g., a forest community, a desert community, a prairie community. Students constructed an aquarium community. Once the students grasped the meaning of a biological community, they were able to discover applications to other biological settings e.g., a pond, seashore, a river, or a lawn. The notion of concept application was to have an idea and to discover various situations in which it applies.

This project has been very successful. Gallegos (1985) found that eighty-five percent of the high school students that graduated from English immersion schools, in Bogotá D.C., Colombia (South America), have been accepted by North American Universities. Even though the student population and the one in this particular work setting are completely different, the main concept remains the same.

The learning cycle theory was borrowed for this particular project. It was important to follow a similar format in order to achieve the main goal. As the students work directly with science materials, their proficiency in Spanish and their current conceptions in science maybe challenged. As they are provided with science terminology in Spanish, with time, an opportunity to explore and experiment, the knowledge about science, either in Spanish, in English, or in both languages, maybe reconstructed.

Blanc (1981) outlines several conditions in order to construct new knowledge and develop language skills:

1. "Languaging should be taught, not language.
2. If dialectical thinking is taught, it will foster growth in other learning behavior.
3. Dialogue can be taught in any subject because any intellectual discipline is a microcosm of the structure of knowledge and language.
4. All methods should promote independence and emotional maturity.
5. The best methods attack social and psychological inhibitions.

6. Information should be taught as it was discovered.
7. Students are not just acquiring more information, but they are creating new knowledge" (1981, p. 44).

Description of Selected Solution

The main strategy was to write, use, and implement a concept-based science workbook in Spanish that accommodates the academic, cultural and linguistic variability of the twenty-one students in this specific immersion program. It is important to point out that the workbook was written in Spanish for students whose first language was not Spanish.

The workbook was an introduction to some concepts related to the general sciences, emphasizing the skills that the students did not have at that time (see appendix C). The workbook presented six basic units that were implemented over a period of twelve weeks. It started with a study of the scientific method and the concept of measurement. From there, it introduced the students to the life science study. In this workbook, the students had the opportunity to understand how the physical world relates. Finally, this workbook studied our planet earth, deriving additional considerations about the earth's structure.

Each of the basic units were divided into basic sections. The units were developed following the learning cycle theory. During the first part of the unit, which was called vocabulario/ vocabulary, the students were introduced to no more than ten new words in Spanish. The main purpose of this section was to create schema for each of these words. Each word was defined and explained. According to the learning cycle theory, this part is called concept labeling (Lawson, 1975).

The second part of each unit, ideas fundamentales/main ideas, organized the new words the student just had learned into a conceptual unit. Very few ideas were explained to the student. The student was the one who had to create his/her explanations through the exploration process. These explorations processes included, but were not limited to: observing, describing, classifying, measuring, communicating, predicting, interpreting, hypothesizing, identifying, controlling variables, experimenting, drawing conclusions, defining operationally, and constructing instruments such as simple devices and physical models.

The third part of each unit, taller/concept application, evaluated if the transfer of learning took place. This section of the unit included activities such as: true/false questions, multiple choice questions, labeling, completion, and open-ended questions.

To summarize, the basic intent of the vocabulary section was to introduce words, provide definitions of new terms, and concepts that relate to the main topic of the unit. The main ideas provided an experience background for the new topic in consideration, and the concept application section permitted further extension and evaluation.

Immersion settings, especially when science concepts are introduced, demand the following aspects (Blanc, 1981. p. 38):

1. "The learner be permitted to become thoroughly acquainted with the object, event, or situation being studied. (This is exploration.)

2. A concept, which allows the learner to think about what his explorations have produced, be provided either by the learner himself or by the teacher. (This is concept introduction.)

3. The learner be given the time to find out how the newly-invented concept can be used, and when and where it is valid. (This is concept application.)"

Report of Action Taken

This practicum was developed to increase skills during a period of twelve weeks. The writer named each day of the week with a specific sequence, first day, second day, third day, etc. Most of the time, Monday was the first day of the week during our implementation period.

The first and second days of the week were used to develop vocabulario/vocabulary. Students were introduced to no more than ten new scientific terms in Spanish during the first day and second day of each week. Many posters, graphics, pictures, magazines, newspapers, slides, and transparencies were used to ensure the creation of new schemes. Students were allowed to guess about the names of unknown instruments, to write about them, and to talk about their main purpose. At this point, there were no right or wrong answers. Active participation and cooperative learning tasks were key elements during this stage of the process. After this, the workbook introduced the students to the 'adequate scientific term.' Graphics were presented and labeled in Spanish. These graphics were organized and classified by categories; for example one category included all the instruments used to make indirect observations -microscope, telescope, magnify glasses- among others. The writer must point out that in many instances it was extremely difficult to find the adequate graphic or picture to be used in the workbook. The author decided to create his own graphics, and to adjust many of them from computer clip art collections. Adequate copyright permissions were granted.

The third day of the week was used to introduce the students to ideas fundamentales/main ideas. The students had the opportunity to organize those new words into a conceptual unit. This third day was also used to design an experiment that related with the main topic of each unit. Students were extremely involved at this point. Many of the children brought their own books from home. The books were written in English, but it did not matter, since the writer was able to translate the major topics into Spanish. The following format was used: -objective, -materials/equipment,

-procedure, -discussion, and -conclusions. Throughout each experiment, this format included the following rules:

1. Students must help to find the experiment or help in designing one according to the unit's topic.
2. The teacher makes a small presentation on how to set up the experiment. Student's ideas were welcomed.
3. There is a general discussion about the risk of doing the experiment, if any at all, and the safeness of the laboratory.

The fourth day of the week was used to implement the experiment. This day was know as "the lab day." Students had the opportunity to create their own explanations through the exploration process. At the beginning of the class, students directed themselves to their assigned laboratory stations. Eleven laboratory stations were equipped with all the material needed for a general science laboratory class. It is important to clarify that most of the experiments were adjusted taking into consideration the availability of the equipment and supplies in general. Substances such as starch, salt, sugar, etc., flowers, insects, leaves, and fish food, among many other things, were provided by the students.

The fifth day of the week was used to test if the transfer of learning took place or not. This last part was called taller/concept application. During the 'taller' students were able to write compositions, complete activities, draw pictures related to the specific topic, write questions and answers, create projects, and make oral presentations, most of the time using the Spanish language as a vehicle of communication. It was a fascinating day. Parents were invited to attend every fifth day. Since many of the parents were not able to do so, a science fair presentation was organized during the last parent teacher conference.

Special considerations were taken for the time frame within which this practicum was implemented. It was noticed, for example, a time span of two or three days was necessary for students to become once again accustomed to speaking in Spanish after they came back from their spring break. A very intensive review was organized in order to overcome this type of regression.

It is very important to notice that this practicum was implemented during a period of twelve weeks. Every day of the week was used as a part of the implementation period. Since the practicum developed skills that were an integral part of the sixth grade science school curriculum, permission to have that many encounters with the children was granted by the principal.

In general, these twelve weeks of implementation were organized in order to cover one 'entire unit,' during a period of ten days, two weeks. The same format was followed every week: vocabulary, related terms, concept introduction and/or concept application, laboratory, science skills, and linguistic skills. The vocabulary section introduced new words, provided definitions of new terms, and created concepts for the specific unit in study. The concept introduction allowed the learner to think about his/her own explorations. Finally, concept application permitted extension and played an important role during the evaluation process.

During the practicum implementation period, the practicum leader, the science department chair, and the senior foreign language coordinator discussed observations and impressions in general. This meeting was held twice, one after the sixth week of the implementation period, and the last one after the twelfth week. Several activities were analyzed and implemented according to the students' needs as follows:

Week One

Unit 1: Introducción al Método Cientítifico.

Vocabulary: método, problema, modelo, teoría, y ley.

Related terms: guantes protectores, tijeras, gafas protectoras, extinguidor, pinzas, cepillo limpiador, estufa, embudo, y gradilla.

Concept introduction: the scientific method, steps of the scientific method; observación, medición, y clasificación.

Laboratory: students manipulated and classified laboratory equipment according to the following categories; glassware, scales, laboratory burner setup, safety equipment, equipment used in the field, and other equipment.

Science skills: observing and communicating.

Linguistic skills: oral comprehension of basic commands such as: vamos a clasificar objetos de vidrio, vamos a agrupar instrumentos para medir, vamos a organizar instrumentos de protección, etc. .

Week Two

Unit 1. Introducción al Método Científico.

Vocabulary: observación, medición, clasificación, experimentación, y conclusión.

Related Terms: probeta, vaso de precipitados, erlenmeyer, frascos, tubo de ensayo, brújula, martillo, balanza, dinamómetro, y soporte universal.

Concept application: given a set of problems students found different ways to solve them using as many instruments as they could.

Laboratory: students observed and described different objects under a microscope.

Science skills: observing, communicating, collecting data, defining operationally.

Linguistic skills: students studied, practiced, and drilled the following prepositions in Spanish: sobre, debajo, encima, y defrente.

Week Three

Unit 2. Introducción al Concepto de Medición.

Vocabulary: longitud, área, y volúmen.

Related terms: metro, centímetro, milímetro, metro cuadrado, metro cúbico, largo, ancho, y altura.

Concept introduction: the concept of measurement. Tools: metro, balanza, and termómetro.

Laboratory: students used the metric system in order to determine the area, length, and volume of several objects inside the classroom: laboratory tables, classroom door, windows, books, teacher's desk, etc. .

Science skills: observing, predicting, measuring, collecting data, and inferring.

Linguistic skills: study, practice, and drill of the following articles: el, la, los, un, una, y unos.

Week Four

Unit 2. Introducción al Concepto de Medición.

Vocabulary: masa, tiempo, y temperatura.

Related terms: gramo, kilogramo, onza, hora, minuto, segundo, grado Celcius, grado Faranheit, y grado Kelvin.

Concept application: given a set of problems on measurement, students collected, classified, and used hard data in order to describe the properties of the object in study.

Laboratory: students measured area, volume, mass, and temperature under several circumstances expressing results using the International System of Units, (SI).

Science skills: measuring, collecting data, and inferring.

Lingusitic skills: drill and review of the articles and prepositions used in the Spanish language using several paragraphs related to the unit's topic.

Week Five

Unit 3. Introducción a Las Ciencias de La Vida.

Vocabulary: célula, microscopio, tejido, órgano, sistema, y reproducción.

Related terms: ser vivo, nacer, crecer, reproducción, membrana celular, núcleo, citoplasma, mitocondria, boca, hígado, esófago, estómago, intestino grueso, e intestino delgado.

Concept introduction: the characteristics of living things and their organization were discussed; reproduction, growth, development, and response to a stimuli were analyzed. The levels of organization in an organism's body were emphasized: cells, tissue, organ, system, and body.

Laboratory: students used a compound light microscope to observe prepared slides of an insect leg and wing. They drew their observations and compared them with their classmates.

Science Skills: following directions, observing, and communicating.

Linguistic skills: use and drill of the following commands in Spanish: conecta el microscopio, coloca el objeto sobre el porta-objeto, toma el microscopio, dame el microscopio, observa esta célula, y desconecta el microscopio.

Week Six

Unit 3. Introducción a Las Ciencias de La Vida.

Vocabulary: célula, tejido, órgano, sistema, y aparato.

Related terms: estígma, pistilo, ovario, anteras, granos de

polen, estambre, pétalos, óvulo, y fecundación.
Concept application: given a set of living things, students described them as organized systems: la flor, la planta, etc. In order to study these systems and their structures, students used the technique of dissection.
Laboratory: students dissected simple flowers in order to observe, identify, and describe their internal structures.
Science skills: observing, collecting data, categorizing, labeling, and interpreting.
Linguistic skills: drill and review of the following commands: pon la flor sobre la bandeja, corta las estructuras internas de la flor, diagrama la estructura interna de la flor, and pega las estruturas obtenidas sobre una hoja de papel.

Week Seven

Unit 4. Introducción al Estudio del Medio Ambiente.
Vocabulary: ecología, recurso natural, recurso natural renovable, y recurso natural no-renovable.
Related terms: fotosíntesis, sol, energía solar, savia elaborada, savia bruta, oxígeno, glucosa, y dióxido de carbono.
Concept Introduction: the process of photosynthesis was introduced and discussed.
Laboratory: students determined if a plant contained

glucose, and the amount of sugar that was present in that particular plant.

Science skills: observing, collecting data, and inferring.

Linguistic skills: drill and review of the following commands: dibuja la cadena alimenticia, completa las siguientes oraciones, escribe falso o verdadero según corresponda.

Week Eight

Unit 4. Introducción al Estudio del Medio Ambiente.

Vocabulary: recurso natural renovable, recurso natural no-renovable, conservación, y reforestación.

Related terms: cadena alimenticia, productor, consumidor de primer orden, consumidor de segundo orden, consumidor de tercer orden, y descomponedor.

Concept application: given a set of different food chains, students described their ecosystem, and explained how photosynthesis effected each food chain.

Laboratory: students made an aquarium and a terrarium, in order to study the relationships between living things.

Science skills: observing, controlling variables, inferring, and making models.

Linguistic skills: students wrote complete sentences in Spanish describing the laboratory activities and the results.

Week Nine

Unit 5. Introducción a Las Ciencias Físicas.

Vocabulary: materia, masa, y energía.

Related terms: átomo, núcleo, electrón, protón, neutrón, compuesto químico, oxígeno, carbono, hidrógeno, agua, sal, parafina, lupa, y mechero de alcohol.

Concept introduction: the atom and its structure was introduced. Matter and states of the matter were analyzed (solid, liquid, and gas).

Laboratory: students demonstrated how the input of heat energy changed water from a solid, to a liquid, to a gas.

Science skills: observing, measuring, collecting data, inferring, and analyzing data.

Linguistic skills: students wrote complete sentences in Spanish describing the laboratory activity and the results.

Week Ten

Unit 5. Introducción a Las Ciencias Físicas.

Vocabulary: energía, compuesto, y trabajo.

Related terms: energía potencial, energía cinética, energía lumínica, energía química, energía calorífica, sonido, luz, calor y electricidad.

Concept application: given a set of different physical events, students classified them as physical events with

potential and/or kinetic energy. Students also had the opportunity to create several circuits explaining how the potential energy from a battery changes into light energy in a bulb, then into heat energy as a final transformation.
Laboratory: students created several types of circuits in order to demonstrate the following transformation of energy; potential to electric, electric to light, and light to heat.
Science skills: observing, making models, controlling variables, inferring, making conclusions.
Linguistic skills: students wrote a complete paragraph in Spanish describing how energy was transformed.

Week Eleven

Unit 6. Introducción a Las Ciencias de La Tierra
Vocabulary: tierra, sistema solar, y vía láctea.
Related terms: núcleo interno, núcleo externo, manto inferior, manto superior, astenósfera, litósfera, montaña, valle, cañón, continente, américa del norte, américa del centro, américa del sur, europa, áfrica, asia, hidrósfera, nubes, estratos, cúmulos, y cirros.
Concept introduction: the internal and external structure of the earth was introduced, analyzed, and discussed.
Laboratory: students constructed a model of the internal and external structure of the earth.

Science skills: making models, observing, measuring, inferring, presenting data, and explaining data.

Linguistic skills: students wrote a story in Spanish (minimum one page) about the formation of the earth. The story included a minimum of ten new terms related to the unit's topic.

Week Twelve

Unit 6. Introducción a Las Ciencias de La Tierra.

Vocabulary: sistema solar, sol, galaxia, vía láctea, y planeta.

Related terms: estrella, satélite, órbita imaginaria, mercurio, venus, tierra, marte, júpiter, saturno, urano, neptuno, y plutón.

Concept application: given a set of characteristics of the planets in the solar system, students compared and described their external properties.

Laboratory: students visited the city planetarium.

Science skills: observing, hypothesizing, collecting data, analyzing data, and inferring.

Linguistic skills: students participated on a panel conducted in Spanish. Each student made an oral presentation on the structure of one planet from the solar system. Questions and answers were conducted in Spanish.

Adequate facilities were required to provide an atmosphere and environment where this practicum with hands-on science activities was explored. It was necessary to include items such as sinks, water, electrical outlets, and storage space. Equipment and supplies to do experiments and demonstrations which correlate with the goals and expectations of this practicum were available in this work setting.

CHAPTER V

RESULTS, DISCUSSION AND RECOMMENDATIONS

Results

The main projected goal for this practicum was to increase general science achievement, in twenty-one sixth grade students enrolled in a Spanish immersion program, through an integrated educational approach. Another important goal was to improve acquisition of Spanish as a second language so students were able to comprehend the main topics in this particular science class.

The writer designed a pretest and posttest to access both, achievement in general science class, and Spanish comprehension. Thirty-five items were carefully selected for the purpose of this practicum (see appendix E). All items were selected to strictly measure eight specific outcomes stated in this practicum as follows:

1. The learners will be able to use the processes used to solve a problem scientifically; analyzing problem solving through controlled experimentation.
2. The learners will be able to identify, classify, and define at least ten common laboratory instruments.
3. The learners will be able to identify and define the SI (International System), units of distance, volume, mass, and temperature.
4. The learners will be able to recognize the parts of a cell and summarize the function of each organelle.
5. The learners will be able to define the relationships between organisms in a community (producers, consumers, and decomposers).
6. The learners will be able to define the following terms: matter, mass, energy, compound, and work.
7. The learners will infer how work is related to energy and how to distinguish between potential energy and kinetic

energy.

8. The learners will be able to define and recognize vocabulary related to earth science, earth structure and the solar system.

The taller/concept application was an extremely important tool during the evaluation process. This section of each unit included activities such as true/false questions, multiple choice questions, labeling, completion, definitions, and open-ended questions. Several other tools were used in order to evaluate the student's progress, activities included, but were not limited to cooperative learning tasks, active participation, laboratories, reports, student's portfolios, field trips, etc. All of them, very important indeed, were taken into consideration.

The results were as follows:

Objective one: THE LEARNERS WILL BE ABLE TO USE THE PROCESS USED TO SOLVE A PROBLEM SCIENTIFICALLY, ANALYZING PROBLEM SOLVING THROUGH CONTROLLED EXPERIMENTATION.

Questions one through three (see appendix E) were designed to evaluate the student's abilities to identify and discriminate the processes used to solve a problem scientifically. During the pretest four students were able to recognize 'observation' as the first and most important step of the scientific method. When posttested, twenty-one students were able to recognize 'observation' as the first step. Question four required the the students to be able to identify the adequate instrument to observe cells. Three students were able to identify the microscope as an adequate instrument to observe cells, when pretested, while twenty-one recognized the microscope as the adequate one to observe cells, when posttested. Question five required the students to identify the appropriate instrument to determine the temperature of certain bodies. Three students were able to recognize the thermometer as an adequate instrument to measure temperature, when pretested, while nineteen students identified this instrument when posttested (See table 1).

The taller/concept application revealed that twenty students were able to list the steps required to solve a problem scientifically. It was also found that eighteen students, out of twenty-one, were able to arrange the steps of the scientific method according to the following sequence: observation, measurement, classification, experimentation, formulation of a conclusion/theory,

Table 1

Correct Answers to Questions Assessing Skills in a General Science Class at the Sixth Grade Level

Question	Pretest	Posttest
1. In which step of the scientific method are we when using instruments such as: meter, graduate scale, and thermometer?	5	19
2. What is the first step of the scientific method?	4	21
3. Which of the following instruments are used to measure weight?	7	18
4. Which of the following instruments are used to observe cells?	3	21
5. What do we call the instrument used to measure temperature?	3	19
Use the diagram below to answer questions 6, 7, and 8.		
6. Which instrument does figure w indicate?	5	21
7 Which instrument does figure z indicate?	3	20
8. Which instrument does figure x indicate?	0	18
Use the diagram below to answer questions 9 and 10.		
9. What is the area of this cube?	2	19
10. What is the volume of this cube?	2	18
Use the diagram below to answer questions 11, 12, 13, and 14.		
11. Which structure does 1 indicate?	1	19
12. Which structure does 2 indicate?	3	21
13. Which structure does 3 indicate?	2	21
14. Which structure does 4 indicate?	0	21
Use the diagram below to answer questions 15, 16, 17, and 18.		
15. What do we call the corn plant in this food chain?	1	21
16. Which is the most likely food chain for the living things in this scene?	0	18
17 Which organism's disappearance would have the greatest effect on the food web?	0	17
18. Which is the most important living thing in this food web?	1	20
Use the diagram below to answer question 19.		
19. What structure does figure 19 indicate?	1	20
20. What is the most important chemical element for plants, animals, and human beings, in order for them to survive?	8	21
Use the diagram below to answer questions 21 and 22.		
21. Which figure clearly represents the concept of kinetic energy?	3	21
22. Which figure clearly represents the concept of potential energy?	2	21
Use the diagram below to answer questions 23, 24, and 25.		
23. In which location would the roller coaster car have more potential energy?	2	12
24. In which location would the roller coaster car have more kinetic energy?	2	16
25. In which location would the roller coaster car have less potential energy?	0	13
Use the diagrams below to answer question 26.		
26. In which arrangement would the lamp light?	8	21
Use the diagram below to answer questions 27, 28, 29, and 30.		
27 What body part does figure 1 indicate?	12	20
28. What body part does figure 5 indicate?	15	21
29. What body part does figure 3 indicate?	7	18
30. What body part does figure 4 indicate?	11	21
Use the diagram below to answer questions 31, 32, and 33.		
31. Which spatial body does figure 1 indicate?	13	21
32. Which spatial body does figure 2 indicate?	14	21
33. Which spatial body does figure 3 indicate?	2	21
34. Which of the following statements is not true?	0	18
35. Which of the following statements is true?	0	18

Note. Twenty-one was the possible total amount of correct answers. X = 18.8

and statement of a universal law.

During a unit review, as an open-ended question, the students were asked to explain why it was important to use a control group in an experiment. Eighteen students were able to express the importance of a control group in terms of comparison and measurement with the experimental group (See table 2).

Table 2

Acceptable Responses to Questions Assessing Problem Solving Through Controlled Experimentation

Question	Pretest	Posttest
1. What are the processes a scientist uses to solve a problem by a scientific method?	2	18
2. Write the name of an instrument used to measure: longitude, area, mass, and weight.	0	21
3. Write the name of five instruments used to make indirect observations.	0	20
4. Why is it important to use a control group in an experiment?	0	18

Note. Twenty-one was the possible total amount of acceptable answers. $\bar{X} = 19.2$

Objective two: THE LEARNERS WILL BE ABLE TO IDENTIFY, CLASSIFY, AND DEFINE AT LEAST TEN COMMON LABORATORY INSTRUMENTS.

Pretest questions six through eight were designed to evaluate the student's ability to identify and classify common laboratory instruments (see appendix E). Pretest results indicated that five students were able to identify a microscope, three students did recognize a graduated scale, and none of them were able to recognize a graduated cylinder. Posttest results indicated that all twenty-one students were able to identify and/or recognize a microscope, twenty students recognized a graduated scale, and eighteen students identified a graduated cylinder (See table 1).

During several science laboratories students worked with microscopes and were very comfortable using them, as measured by teacher's daily observations and personal logs. Twenty students, out of twenty-one, were able to prepare their own slides, observe them, and describe them, while using the microscope ninety percent of the time.

During the taller concept application, all twenty-one students were able to write properly the name of five instruments used to exclusively measure area, volume, mass, and weight. The same taller indicated that twenty students were able to successfully identify a minimum of five instruments used to make indirect observations in a science laboratory (See table 2).

Objective three: THE LEARNERS WILL BE ABLE TO IDENTIFY AND DEFINE THE SI (International System), UNITS OF DISTANCE, VOLUME, MASS, AND TEMPERATURE.

Questions nine and ten were designated to evaluate the student's abilities to calculate area and volume of a predetermined perfect cube. Pretest results for question nine, requiring the students to calculate the area of a perfect cube, L=5cm., indicated that only two students, out of twenty-one, were able to find the correct answer. Posttest results indicated that nineteen students were able to successfully calculate the area of a perfect cube expressing the results in cm2. As required by question ten, two students were able to perfectly calculate the volume of the same cube, L=5cm., when pretested, while eighteen students successfully completed the calculation, expressing the results in cm3 (See table 1).

During the taller/concept application, twenty-one students were able to recognize the units of measure for the following concepts: mass, time, and temperature, expressing some results in grams, seconds, and Celsius respectively (see table 3).

Table 3

Correct Answers to Questions Assessing The SI (International System) Units of Measurement

	Type of measure	Pretest	Posttest
1.	Distance	6	21
2.	Area	1	19
3.	Volume	0	18
4.	Mass	0	21
5.	Time	2	21
6	Temperature	4	21

Note: Twenty-one was the possible total amount of correct answers $\bar{X} = 20.1$

Objective four: THE LEARNERS WILL BE ABLE TO RECOGNIZE THE PARTS OF A CELL AND SUMMARIZE THE FUNCTION OF EACH ORGANELLE.

Questions eleven through fourteen were designed to evaluate the student's ability to recognize the parts of a cell. Question eleven required the students to identify the structure of the cytoplasm. When pretested, only one student was able to identify the cytoplasm, while nineteen students successfully recognized this structure when posttested. Pretest results for question twelve, requiring the students to properly identify the structure of the nuclear membrane, indicated that three students were able to do so. Posttest results revealed that twenty-one students properly recognized the structure of the nuclear membrane. As required by question thirteen, only two students, when pretested, identified the structure of the cell membrane. Twenty-one students were able to identify the structure of the cell membrane when posttested. When students were asked, on question fourteen, to identify the structure of the mitochondria, none of the students were able to do so when pretested, while twenty-one students were able to successfully recognize this cell structure when posttested (see table 1).

The taller/concept application revealed that eighteen students were able to draw the structure of an animal cell and the structure of a plant cell. Students also labeled these two types of cells writing the name of at least seven organelles.

A final unit project activity showed that twenty students, working in cooperative groups, were able to create models of cells, using materials such as clay and/or construction paper. Eighteen students were able to orally explain and summarize the function of at least five cell's organelles, as measured by teacher's daily observations, student's logs, and student's portfolios.

Objective five: THE LEARNERS WILL BE ABLE TO DEFINE THE RELATIONSHIPS BETWEEN ORGANISMS IN A COMMUNITY (Producers, Consumers, and Decomposers.)

Questions fifteen through eighteen were designed to measure the student's knowledge on: relationships of organisms in a community and the name of those organisms (See appendix E). One student, out of twenty-one, was able to identify plants as producers in a food chain, when pretested, while all the student population in this practicum, properly correlated plants and producers in a a food chain during the posttest. Question sixteen required the student to identify the most common sequence -sun, producers, herbivores, carnivores, omnivores- in a food chain. When pretested, none of the students were able to accomplish this task. During the posttest eighteen students, out of twenty-one, were able to identify the most common sequence in a food chain (See table 1).

Pretest results also indicated that none of the students were able to identify the most important organism in any food chain. Posttest results revealed that twenty students properly recognized plants and other autotrophic organisms as the most important elements in a food chain.

The taller/concept application indicated that nineteen students were able to properly classify a minimum of ten organisms under the following categories: producers, consumers, and decomposers. A final unit project 'the aquarium' revealed that all twenty-one students were able to set up an aquarium. During this project students successfully explained the importance and the task of at least three of the following organisms: goldfish, catfish, algae-eater, snails, algae, and bacteria. This achievement was measured by student's oral presentations and grade report cards.

Objective six: THE LEARNERS WILL BE ABLE TO DEFINE THE FOLLOWING TERMS: MATTER, MASS, ENERGY, COMPOUND, AND WORK.

Questions nineteen and twenty of the pretest and posttest were designed to measure the student's knowledge of the structure of the atom (see appendix E). Question nineteen required the student to propeny identify the structure of the atom. One student, out of twenty-one, was able to recognize the structure of the atom when pretested. Twenty students properly recognized the structure of the atom when posttested. The pretest also asked the students, on question twenty, to name the most important chemical element for plants to survive. Results indicated that eight students were able to name oxygen as the most important element for plants to exist, when students were pretested; while twenty-one students, in fact, did recognize oxygen, and its importance in nature, when posttested (See table 1).

During the taller/concept application the students were asked to write definitions of several unit related terms. Posttest results indicated that: seventeen students were able to define the atom, fifteen students defined the concept of compound, thirteen students wrote an 'acceptable definition for matter,' and ten students were able to properly describe the concept of energy and work (See table 4).

Objective seven: THE LEARNERS WILL INFER HOW WORK IS RELATEDTO ENERGY AND HOW TO DISTINGUISH BETWEEN POTENTIAL ENERGY AND KINETIC ENERGY.

Questions twenty-one through twenty-six were designed to measure the student's knowledge of: energy, potential energy, and kinetic energy (See appendix E). Questions twenty-one and twenty-

Table 4

Acceptable Responses to Questions Assessing Skills of Some Science Concepts Related to Matter and Energy

	Term to be defined	Pretest	Posttest
1.	Atom	1	17
2.	Compound	0	15
3.	Matter	2	13
4.	Mass	0	15
5.	Energy	0	10
6.	Work	0	10

Note: Twenty-one was the possible total amount of acceptable answers. $\bar{X} = 13.3$

two required the students to differentiate between kinetic energy and potential energy, respectively. Pretest results indicated that three students were able to recognize bodies with a great amount of kinetic energy, and only two students recognized bodies with a great amount of potential energy. At the end of the implementation period, posttest results indicated that all the student population in this practicum, twenty-one children, successfully differentiated the concept of potential and kinetic energy (See table 1). Pretest results for question twenty-three, requiring the students to know when a roller coaster car in motion had more potential energy, revealed that only two students were able to so indicate. Posttest results revealed that twelve students, out of twenty-one, properly indicated at which point a roller coaster car in motion had more potential energy. Similarly, for question twenty-five, none of the students were able to recognize at which point the same roller coaster car had less potential energy, during pretesting. Posttest results indicated that thirteen students properly recognized the point at which the roller coaster car had less potential energy.

The taller/concept application revealed that all twenty-one students were able to properly recognize the change from chemical energy to light energy and to heat energy respectively (See table 5). Posttest results also revealed that twenty students successfully explained the 'change sequence' from potential energy to kinetic energy and to heat energy, respectively, when they were asked to rub their hands together, and to ride a bike as measured by student's oral presentations and group discussions.

Objective eight: THE LEARNERS WILL BE ABLE TO DEFINE AND RECOGNIZE VOCABULARY RELATED TO EARTH SCIENCE, EARTH STRUCTURE, AND THE SOLAR SYSTEM.

Questions thirty to thirty-five were designed to measure the

Table 5
Correct Answers to Questions Assessing Types of Energy Changes

	What type of energy change takes place when you...	Pretest	Posttest
1.	Burn a piece of paper	0	20
2.	Turn on the gas stove	2	21
3.	Rub your hands together	0	21
4.	Ride a bike	1	21
5.	Light a candle	3	21
6.	Start running	2	18

Note: Twenty-one was the possible total amount of acceptable answers. $\bar{X} = 20.3$

student's knowledge of the solar system and the structure of the earth (See appendix E). When pretested, thirteen students were able to recognize the moon, fourteen students recognized the structure of the sun, and only two students, out of twenty-one, identified the 'imaginary path' called orbit (See table 1). At the end of the implementation period, posttest results indicated that eighteen students were able to identify the main characteristics of a star, a planet, and a satellite recognizing their similarities and differences, and explaining their relations within the solar system.

The taller/concept application, a creative final project, indicated that, all twenty-one students were able to successfully label several diagrams of the solar system, the earth, and the space in general. During the same taller students defined several earth science related concepts, using Spanish as a vehicle of communication (See table 6).

Table 6

Acceptable Responses to Questions Assessing Earth Science Literacy

	Term/concept to be defined	Pretest	Posttest
1.	Planet	10	20
2.	Star	13	18
3.	Orbit	2	18
4.	Satellite	3	21
5.	Galaxy	0	17
6.	Nova	0	15
7.	Solar System	2	16
8	Milky way	0	12

Note: Twenty-one was the possible total amount of acceptable responses. $\bar{X} = 17.1$

Discussion

The writer considers this practicum to be a very successful one. Results clearly indicated that eighteen students, out of twenty-one, demonstrated comprehension in Spanish of eighty percent of the objectives stated in this report as measured by teacher prepared tests (See tables 1-6). As a result, Spanish immersion students increased their science vocabulary to be able to understand important concepts in a science class at the sixth grade level.

Results evidence in this practicum showed that meaningful experiences involving science activities and projects facilitated children's learning in science. The format of this practicum encouraged learning through experience. Even though when working with some very abstract concepts -measurement, the international system of units, the structure of the atom- students were able to make the transition with no major difficulties (See table 2 and 3).

When analyzing the data on the student's abilities to define the relationships between organisms in a community, an enormous amount of evidence of the student's progress was noticed during the practicum implementation period (See table 1). This is a clear example of the effectiveness of immersion techniques using lessons that involve the learning cycle theory (Blanc, 1980). The aquarium and the terrarium projects confirmed the belief that this type of learning was effective and permanent in these twenty-one Spanish immersion children. Students were able to move into a new cognitive level where responses were more personalized and unconstrained (Grittner, 1990).

Results from table 1 and table 4 revealed some discrepancy between the student's ability to define energy and work, and the student's skills used to recognize energy changes. These discrepancies may have revealed strong implications on the way science is taught and learned. Usually, students associate energy only with objects that are moving or doing work. It is extremely difficult for students to understand the concept of stored energy, or to internalize the conservation of energy law (Hazen, 1991).

The writer strongly believes that there is an enormous amount of misconceptions about the way students explain scientific phenomena. During this practicum it was noticed, for example, that the students had difficulty distinguishing between the common definition of work and the scientific definition of work. Most of the students involved in this practicum, related the 'scientific concept of work' to the common expression of being tired. The pedagogical strategy used in this practicum provided many ways to overcome some of the enormous amounts of student's misconceptions. Indeed, the ideas fundamentales/main ideas played a key role. Through the exploration process, students were able to create their own explanations in order to explain scientific phenomena (Gallegos, 1985).

Another important part of the pedagogical strategy that provided activities for students to analyze their own misconceptions about science was the taller/concept application. This 'taller' provided students with opportunities to think critically as it was demonstrated by the student's answers (See table 5). Students engaged in complex tasks that enabled them to participate in the many processes that make intellectual accomplishments. Tasks did not have just one 'right' answer, (See table 2,5, & 6), and problems did not have just one route to a solution (Miller, 1987). At this point, the writer considers it extremely important to clarify that in terms of science misconceptions there is much more work to be done. A large list of misunderstandings exist when students have to deal with very abstract science terminology such as: volume, density, area, atom, energy, work, etc., among many others.

Finally, when analyzing data concerning the student's skills on earth science literacy (See table 6), there is strong evidence to suggest that students actively participated in activities that were understandable and with compelling purpose. This practicum experience held the students accountable for understanding, versus memorizing, for applying knowledge, versus reciting it, and for demonstrating their understanding through projects.

To summarize, the results of this practicum clearly demonstrated that the students at this level developed more understanding of some simple scientific principles. Students interpreted data from simple tables and made inferences about the out comes of experimental procedures. Students were able to evaluate the appropriateness of the design of an experiment. This specific student population also exhibited a growing understanding of the life sciences, including familiarity with the relationships between organisms in a biological community. Students were also able to apply and integrate scientific information, particularly in the physical and earth sciences, exhibiting basic knowledge, inferring relationships, and drawing conclusions of scientific phenomenon.

Recommendations

Achievement in science is a crucial aspect. Science is the process of becoming aware of and understanding ourselves, other living things, and the environment through the senses and personal exploration. For young children, this awareness and understanding comes as they become active learners in their own way and in their own time. Science immersion education, whether the second language is English, French, Spanish, German, etc., requires a very special type of educational approach.

1. There should be carefully sequenced and well-coordinated instruction in all sciences (life, earth, and physical), in all grades, as opposed to the traditional "layer cake" curriculum in which one area of science is taught all year as a discrete and compressed discipline.

2. Science should be understandable and enjoyable for all students. In order to accomplish this, students should be provided opportunities to engage in activity-based, interactive experience, both in the classroom and in the natural world, before they attempt to learn the abstract terms of science.

3. The quantity of science topics and their terminology should be significantly reduced. Fewer topics sequenced and taught over several years will result in greater understanding of science and how it can be used to approach everyday problems and issues having scientific or technical components.

4. Concepts and principles of science should be approached at successively higher levels of abstraction over several years making it possible for all students to overcome the enormous amount of science misconceptions.

5. There is a need of a new pedagogical strategy in order to reduce the enormous amount of science misconceptions at the middle school level. Indeed, misconception in science is a problem of a broad educational significance, which requires a solution strategy of longer duration.

If we accept the theory that all children have unique and special needs, positive results can be attained in our relationships with all children. What the child will be able to accomplish individually, in the middle school setting, is determined largely by the opportunities provided. Interactions with materials and with adults who are knowledgeable about both science and child development are vital. An active involvement of students in dealing with science and society issues will not only eventually determine the outcomes of these problems, but also will be a driving force in the successful solutions of problems that will arise in the future.

Dissemination

Several guests were invited to observe and participate during the implementation phase of this practicum. The senior foreign language curriculum coordinator, the science chair, and several colleagues from the French and German departments have expressed their interest in using a similar approach. The report's abstract, data and results in general were compiled and distributed to the immersion teachers.

The writer has been invited to publish the main strategy and results from this practicum, in the Revista Colombiana de Educación [Colombian Magazine of Education]. This magazine is published by the "Centro de investigaciones de la Universidad Pedagógica Nacional de Colombia -CIUP- [National Pedagogic University - Center for The Research in Education].

The writer is also planning to present a summary of this practicum, and its results, at the North Central Conference on The Teaching and Learning of Foreign Languages.

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APPENDIX A

PERCENTAGE OF STUDENTS MASTERING SCIENCE SKILLS AT CENTRAL MIDDLE MAGNET SCHOOL AS MEASURED BY THE MISSOURI MASTERY AND ACHIEVEMENT TEST

Table 7

Percentage of Students Mastering Science Skills at Central Middle Magnet School as Measured by the Missouri Mastery and Achievement Test.

Science Skills	0 — 20 — 40 — 60 — 80
Metric Measurements	**** (12%)
Laboratory equipment	***************(25%)
Requirements for life	*********************(34%)
Parts of plants	**************(23%)
Photosynthesis	*****(13%)
Plant/Animal growth	********************************(50%)
Electricity	*******************(33%)
Electromagnets	*****************(28%)
Friction	**************(25%)
Potential/Kinetic energy	*******(16%)
Chemical change	************(19%)
Acid/Bases	*******(15%)
Simple machines	****(11%)
Minerals	*****************(30%)
Soil erosion	*****(12%)
Fossils	******(14%)

Note. Key skills mastered by the median student: 3/17 = 18%

APPENDIX B

PERCENTAGE OF SPANISH IMMERSION STUDENTS RECEIVING C's, B's, and A's IN GENERAL SCIENCE CLASS AS MEASURED BY GRADE REPORT CARDS

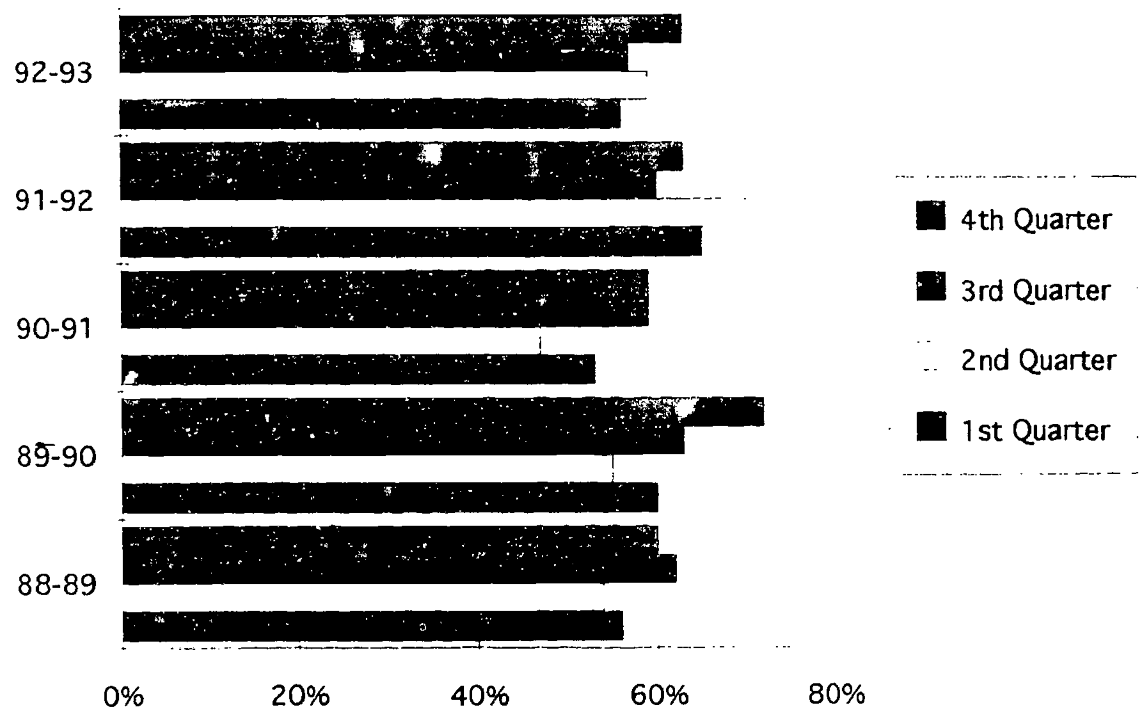


Figure 1. Percentage of Spanish immersion students receiving C's, B's, and A's in general science class as measured by grade report cards.

APPENDIX C

PERCENTAGE OF ELEMENTARY TEACHERS REPORTING NON-INSTRUCTION OF SOME SCIENCE CONCEPTS

Table 8

Percentage of Elementary Teachers Reporting Non-Instruction of Some Science Concepts

Item Description	1	2	3	4	5
Introduction to the scientific method	95%	95%	80%	84%	70%
Laboratory equipment	98%	95%	92%	90%	90%
Measurement					
Longitude	88%	67%	65%	72%	85%
Area	99%	97%	88%	90%	90%
Life science					
Cell as basic unit	85%	70%	67%	68%	38%
Parts of a cell	95%	70%	80%	71%	40%
Plants and animal cell	72%	60%	62%	59%	34%
Human body	88%	74%	60%	75%	73%
Natural environment	51%	63%	36%	44%	31%
Relationships in ecosystems	72%	65%	44%	51%	37%
Food chains & food webs	62%	38%	21%	34%	17%
Physical science					
What is energy?	62%	53%	26%	32%	17%
Atoms and molecules	77%	78%	64%	71%	49%
Forms of energy	77%	65%	33%	49%	29%
What is electricity?	56%	45%	33%	34%	57%
Earth/Space science					
Earth forms and features	54%	50%	39%	22%	31%
Earth, sun & moon	26%	13%	18%	12%	9%
Water cycle	26%	33%	15%	32%	29%
Earth layers	82%	75%	44%	27%	31%

Note. From "Formative evaluation of the third year elementary foreign language magnet" by Clay P. , 1990, Kansas City, MO : Kansas City, Missouri School District, Evaluation Office.

APPENDIX D

SCIENCE ACHIEVEMENT OF THE TWENTY-ONE SIXTH GRADE SPANISH IMMERSION CLASS MEASURED BY THE IOWA TEST OF BASIC SKILLS

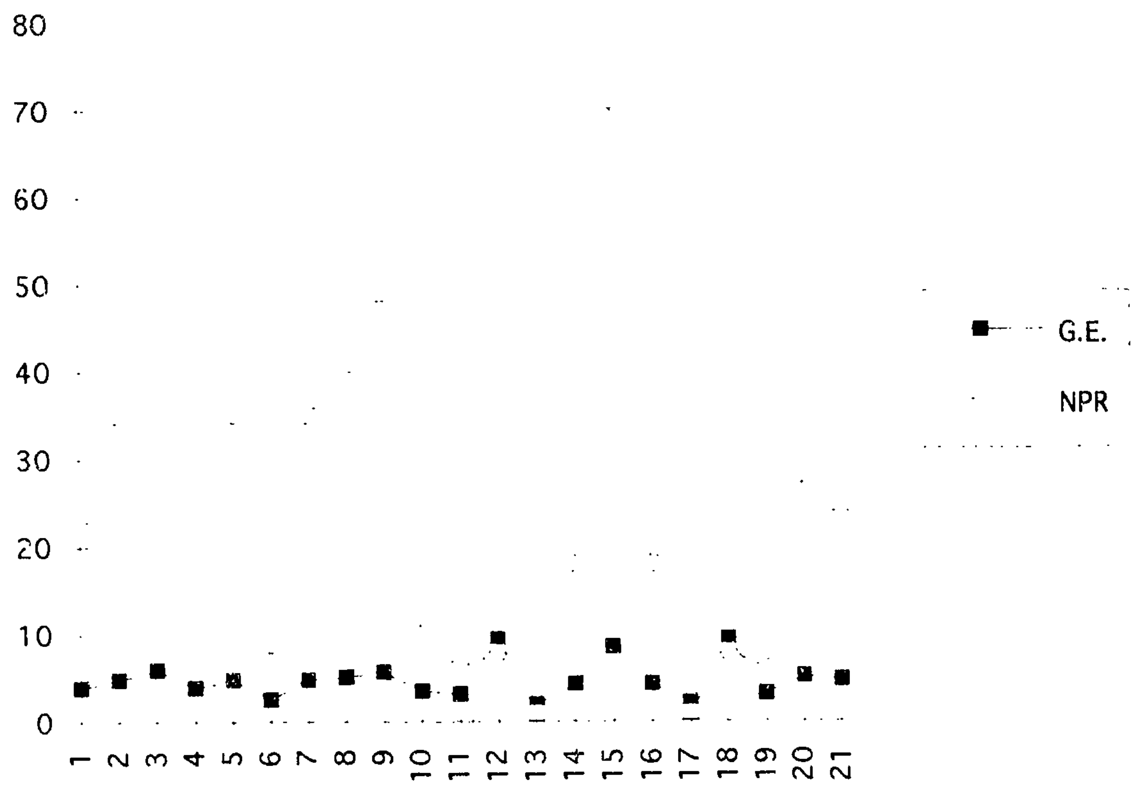


Figure 2. Science achievement of the twenty-one sixth grade Spanish immersion class measured by the Iowa Test of Basic Skills.

APPENDIX E

EL EXAMEN DE CIENCIAS NATURALES
[THE NATURAL SCIENCE TEST]

Nombre:______________________
Fecha :______________________
EXAMEN DE CIENCIAS NATURALES

Marca con una X la respuesta correcta.

1. En qué etapa del método científico estamos, cuando utilizamos instrumentos como: el metro, la balanza, el termómetro, y el dinamómetro?

a. medición

b. clasificación

c. experimentación

d. hipótesis

2. Cómo se llama el primer paso del método científico?

a. medición

b. observación

c. formulación de hipótesis

d. conclusión

3. Cuál de los siguientes instrumentos se utiliza para medir la masa de los cuerpos?

a. balanza

b. microscopio

c. embudo

d. cronómetro

4. Cuál de los siguientes instrumentos es utilizado para observar células?

a. microscopio

b. telescopio

c. dinamómetro

d. balanza

5. Cuando medimos qué "tan caliente o frío un cuerpo está," estamos midiendo la temperatura del cuerpo. Cómo se llama el instrumento que debemos utilizar?

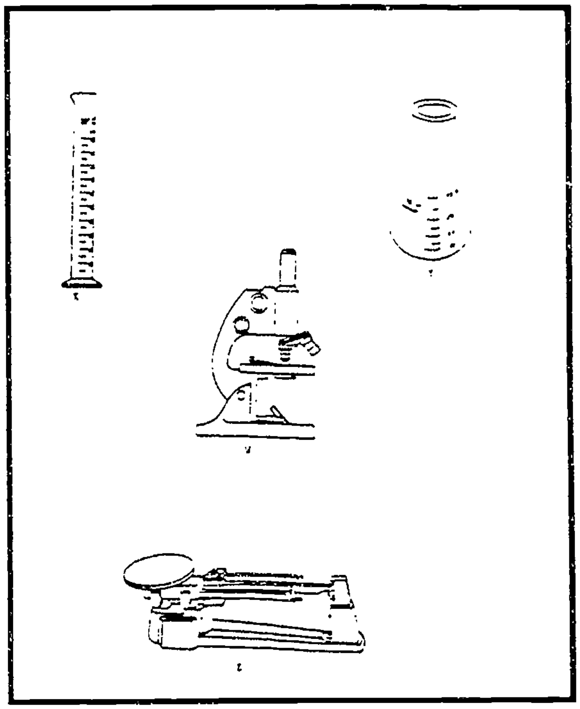
a. barómetro

b. termómetro

c. dinamómetro

d. metro

Observa detalladamente las siguientes figuras y responde las preguntas 6, 7, y 8.



6. Cuál es el nombre de la figura marcada por la letra W?

a. probeta

b. tubo de ensayo

c. microscopio

d. lupa

7. Cuál es el nombre de la figura marcada por la letra Z?

a. balanza

b. microscopio

c. embudo

d. cronómetro

8. Cuál es el nombre de la figura marcada por la letra X?

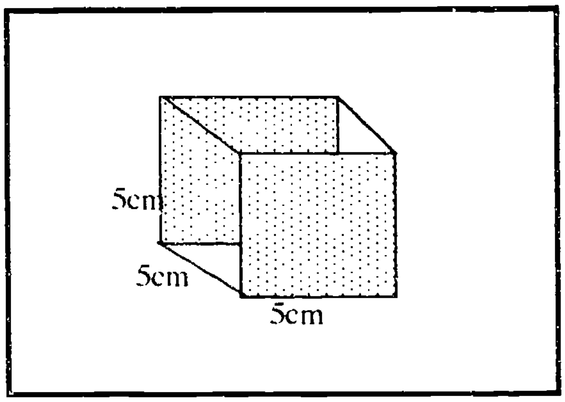
a. probeta

b. tubo de ensayo

c. microscopio

d. lupa

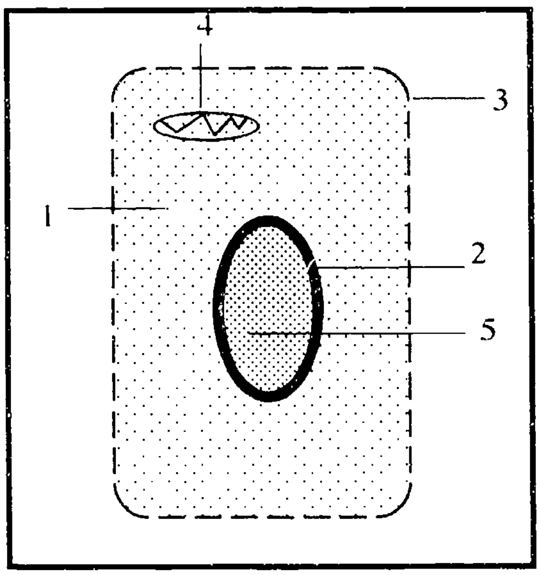
Observa detalladamente la siguiente figuras y responde las preguntas 9 y 10.



9. Cuál es el área del cubo?
a. 5 cm
b. 25 cm cuadrados
c. 125 cm cúbicos
d. 15 cm

10. Cuál es el volúmen del cubo?
a. 5 cm
b. 25 cm cuadrados
c. 125 cm cúbicos
d. 15 cm

Observa detalladamente las siguiente figura y responde las preguntas 11, 12, 13, y 14.



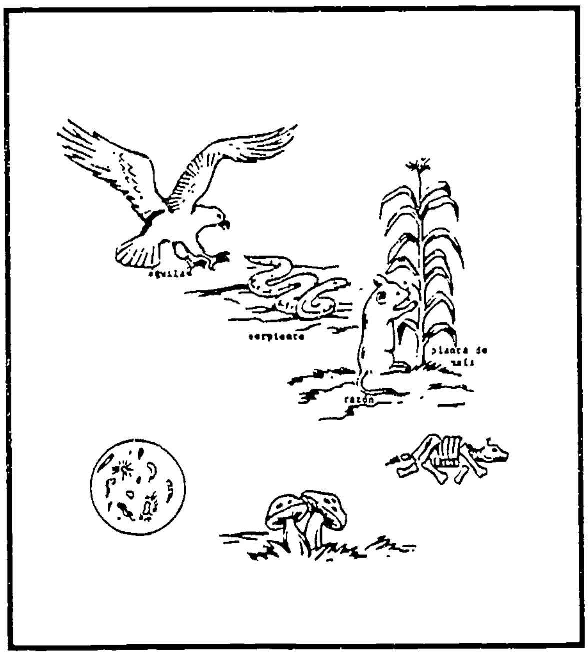
11. Cuál es el nombre de la figura # 1?
a. núcleo
b. citoplasma
c. membrana celular
d. membrana nuclear

12. Cuál es el nombre de la figura # 2 ?
a. núcleo
b. membrana celular
c. membrana nuclear
d. citoplasma

13. Cuál es el nombre de la figura # 3 ?
a. núcleo
b. membrana celular
c. citoplasma
d. membrana nuclear

14. Cuál es el nombre de la figura # 4 ?
a. cloroplasto
b. núcleo
c. citoplasma
d. mitocondria

Observa detalladamente las siguiente figuras y responde las preguntas 15, 16, 17, y 18.



15. Cómo llamaríamos a la planta de maíz en la anterior cadena alimenticia?

a. consumidor de tercer orden

b. productor

c. descomponedor

d. consumidor de primer orden

16. Cuál sería el orden "normal" en la anterior cadena alimenticia?

a. planta de maíz - ratón - cadáver - águila

b. planta de maíz - águila - ratón - serpiente

c. planta de maíz - ratón - serpiente - águila

d. águila - planta de maíz - ratón - bacteria

17. Cuál organismo al morir afectaría enormemente la cadena alimenticia?

a. águila

b. planta de maíz

c. ratón

d. serpiente

18. Cuál es el ser vivo mas importante en la anterior cadena alimenticia?

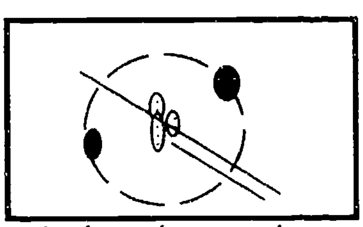
a. águila

b. ratón

c. serpiente

d. planta de maíz

Observa detalladamente la siguiente figura y responde a la pregunta # 19



19. Cuál sería el nombre con el que se le conoce a la figura anterior

a. electrón

b. átomo

c. molécula de azúcar

d. compuesto químico

20. Cuál es el elemento mas importante para la vida de las plantas, los animales, y los seres humanos?

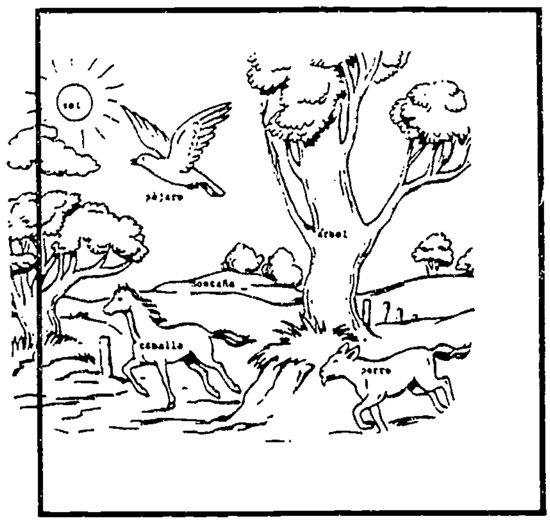
a. oxígeno

b. nitrógeno

c. carbono

d. hidrógeno

Observa detalladamente la siguiente figura y responde las preguntas 21, y 22.



21. Cuál de los seres en la figura anterior representa claramente el concepto de energía cinética?

a. caballo

b. árbol

c. roca

d. montaña

22. Cuál de los seres en la figura anterior representa claramente le concepto de energía potencial?

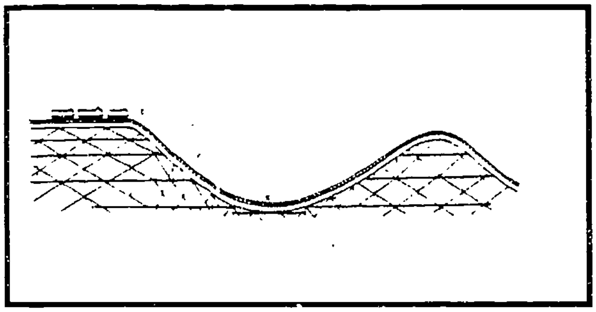
a. sol

b. caballo

c. perro

d. pájaro

Observa detalladamente la siguiente figura y responde las preguntas 23, 24, y 25.



23. En que lugar el carrito tendrá mayor energía potencial?

a. en el lugar marcado por la letra x

b. en el lugar marcado por la letra w

c. en el lugar marcado por la letra z

d. en el lugar marcado por la letra y

24. En que lugar el carrito tendrá mayor energía cinética?

a. en el lugar marcado por la letra x

b. en el lugar marcado por la letra w

c. en el lugar marcado por la letra z

d. en el lugar marcado por la letra y

25. En que lugar el carrito tendrá menor energía potencial?

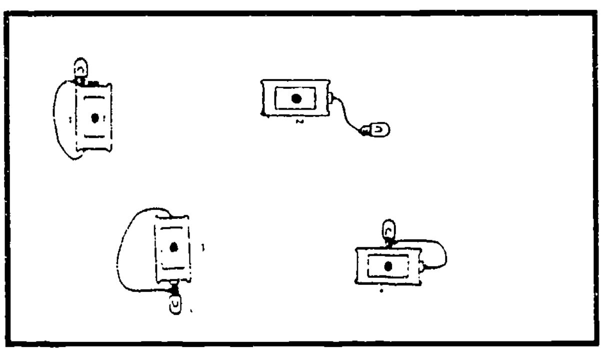
a. en el lugar marcado por la letra x

b. en el lugar marcado por la letra w

c. en el lugar marcado por la letra z

d. en el lugar marcado por la letra y

Observa detalladamente las siguientes figuras y responde la pregunta # 26



26. Cuál de los arreglos anteriores prenderá el bombillo?

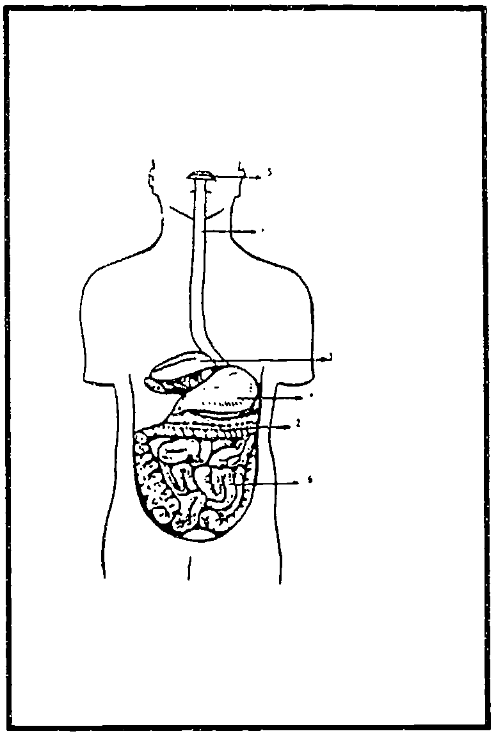
a. el arreglo # 4 prendera el bombillo

b. el arreglo # 3 prendera el bombillo

c. el arreglo # 2 prendera el bombillo

d. el arreglo # 1 prendera el bombillo

Observa detalladamente la siguiente figura y responde las preguntas 27, 28, 29, y 30.



27. Cómo se llama la parte del cuerpo indicada por la figura # 1?

a. boca

b. esófago

c. hígado

d. estómago

28. Cómo se llama la parte del cuerpo indicada por la figura # 5?

a. boca

b. esófago

c. hígado

d. estómago

29. Cómo se llama la parte del cuerpo indicada por la figura # 3?

a. estómago

b. hígado

c. intestino grueso

d. intestino delgado

30. Cómo se llama la parte del cuerpo indicada por la figura # 4?

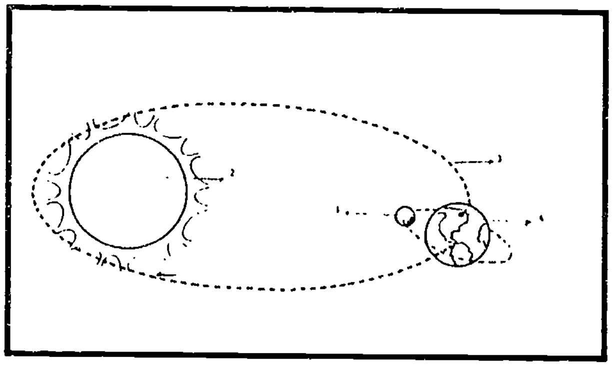
a. boca

b. hígado

c. estómago

d. intestino grueso

Observa detalladamente la siguiente figura y responde las preguntas 31, 32, y 33.



31. Cómo se llama el cuerpo espacial representado por la figura # 1?

a. sol

b. órbita

c. tierra

d. luna

32. Cómo se llama el cuerpo espacial representado por la figura # 2?

a. luna

b. tierra

c. órbita

d. sol

33. Cómo se llama el cuerpo espacial representado por la figura # 3?

a. órbita

b. tierra

c. sol

d. luna

34. Cuál de las siguientes afirmaciones no es verdadera?

a. la tierra gira alrededor del sol

b. el sol es una estrella

c. la luna es un satélite natural de la tierra

d. la luna es mas grande que la tierra

35. Cuál de las siguientes afirmaciones es verdadera?

a. la hidrósfera es la capa sólida de la tierra

b. el sol es la única estrella en el universo

c. la atmósfera es la capa gaseosa de la tierra

d. La tierra es el único planeta del sistema solar.