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IMPROVEMENTS IN THE DEVELOPMENT OF SCIENTIFIC COMPETENCE IN FIRST GRADERS STUDENTS IN A HIGH SCHOOL IN URUGUAY

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Abstract. It is necessary to provoke a change in learning to achieve motivation, taste for science, and the development of scientific competence in students. Thus, during the action research, didactic sequences were developed, and evaluations were applied at the beginning and the end of the school year to analyze the influence of working with Research Projects on the development of scientific competence in two groups. The mixed-cut research was carried out in a lyceum with an unfavorable sociocultural context. The selection of the teacher was carried out by empirical sampling. It was the teacher who selected the best group of first-graders and the one with the greatest difficulties. In total, 38 students participated in the study. Documentary analysis was carried out. It included the rubrics applied to the diagnostic proposal and the final evaluation. At the beginning of the year, the results in the group 1st grade 1 correspond to 50% of acceptable answers, whereas the group 1st grade 3 achieved a 38.9%. In the final evaluation, the groups which worked in Research Projects obtained 56.9% and 54.9% respectively. When the differences are analyzed in the light of all the indicators measured, it can be seen that while in 1st grade 1 there were significant improvements in three of the nine indicators; in 1st grade 3 the improvements were evident in four of them.

Keywords: scientific competence, Research Projects, rubrics.

MEJORAS EN EL DESARROLLO DE LA COMPETENCIA CIENTÍFICA EN ESTUDIANTES DE PRIMER AÑO DE SECUNDARIA EN UN LICEO DE URUGUAY

Resumen. Se hace necesario un cambio en el aprendizaje, que logre el gusto por las Ciencias y desarrollo de competencia científica en los estudiantes. Se elaboraron secuencias didácticas y se aplicaron evaluaciones al inicio y al final del año lectivo, con el objetivo de analizar la influencia del trabajo con Proyectos de Indagación en el desarrollo de la competencia científica en dos grupos de la investigación acción. La investigación de corte mixto, se realizó en un liceo de contexto sociocultural desfavorable. La selección de la docente se efectuó por muestreo empírico. La docente seleccionó el mejor grupo de primer año y el de mayores dificultades. Intervinieron 38 estudiantes. Se efectuó análisis de documentos de las rúbricas aplicadas a la propuesta diagnóstica y a la evaluación final. Al inicio del año los resultados en 1º 1, corresponden a un 50 % de respuestas aceptables, en tanto 1º 3, logra un 38,9 %. En la evaluación final los grupos que trabajaron en proyectos de indagación obtuvieron un 56,9 % y 54,9 % respectivamente. Cuando se analizan las diferencias para primero 1 para cada uno de los indicadores medidos se aprecia que, de forma significativa, mejoran en tres de los nueve indicadores y para primero 3, en cuatro.

Palabras clave: competencia científica, proyectos de indagación, rúbricas.

Introduction

This research is relevant to the scientific community because it seeks to raise teachers' awareness and make them reflect on how they plan their lessons and teach them in their classroom while taking into account research in science teaching. It is also important because the results obtained are not limited to the perception of teachers or students, it transcends those since the results obtained are evaluated, in the process carried out by students, during a school year. The progress that first-year students achieve in a high school which is in an unfavorable socio-cultural context, in the development of scientific competence, when the teacher works with Projects within the teaching model of inquiry learning is analyzed in this article.

The data was collected during research conducted in 2017, corresponding to the Doctoral thesis.

The mixed-cut research was approached from a socio-critical perspective since it was intended to analyze the situation and transform it. It corresponded to an action-research, which was implemented through project planning based on the curricular contents, to favor the development of scientific competence. It was supplemented with a quantitative approach when compared with a control group.

The need to implement this research arose because currently, it continues to be observed that classroom teaching does not produce good results. Solbes and Tarín (2007) state that it is verified that students are no longer interested in science; instead, Sánchez (2013) shows that project-based collaborative learning constitutes a stimulus for learning and students develop proactive capacity. They also add that having the possibility of selecting activities based on their interest favors the deepening of the course contents.

In another research conducted by Rodríguez-Sandoval, Vargas-Solano, and Luna-Cortés (2008) called "Evaluation of the strategy: project-based learning", 80% of the respondents consider that they learned to plan, consult the literature, apply acquired knowledge, interpret and analyze data, communicate results and work in groups.

In a study conducted by Chin and Osborne (2008), 75% of sixth-year students chose to investigate questions prepared by themselves. The young people described the job as “exciting, fun, and interesting,” indicating the importance of building on their curiosity.

This teaching model has proven to be very valid in other communities. Franco Mariscal (2015, p. 231) describes research learning, starting from the contextualization of a situation. The research corresponded to a case study on metal corrosion.

He worked with seven dimensions, which were taken as a reference in the present research: “research approach; information management; research planning and design;

data collection and processing; data analysis and issuance of conclusions; communication of results, attitude or critical reflection and teamwork ”(Franco-Mariscal, 2015, p. 240)

The importance of considering teachers as designers can also be seen in the research conducted by Llorente, Domènech, Ruiz, Selga, Serra, Domènech-Casal (2017). They found that, through the design of Research Projects arising from this context, the conceptual, procedural, and epistemic dimensions of Scientific Competence can be developed.

Meanwhile, Crujeiras (2015) researched the “practice-based learning approach” in chemistry. The research main results indicate that progress is observed in the performance of the students, observing that, at the end of the study, they develop designs that enable them to solve tasks and analyze and interpret data, without the help of the teacher.

In 2012 Uruguay participated for the fourth time in "Program for International Student Assessment" (PISA). Science scores for Uruguay were 416, while the Organization for Economic Co-operation and Development (OECD) average was 501 and Shanghai 580. The questions with the highest percentage of omission are those that need to be elaborated by the student. While in 2006, with 43%; and 2009, with 37% the omission, it corresponded to the “living systems category, ability to explain phenomena scientifically”, in 2009 an explanation should be proposed about the action of antibiotics on bacteria (ANEP, 2013, p. 198)

It is considered that, if teachers participate in an action-research, even if they do not read the research in teaching, referred by Gil Pérez and Vilches (2013), they will be able to know this teaching model and implement it.

The objective of this research was to analyze the impact of the research-based learning teaching model, on the development of scientific competence in high school students.

Method

Design

The methodology corresponds to mixed longitudinal research framed from the perspective of participatory action research, which is complemented with an AB design of repeated averages.

An initial diagnosis was proposed at the beginning of the course, which proposed a problematic situation that covered different activities, and that allowed assess the different competences in science. The capacities displayed by the students to solve the proposal assignment were assessed with a rubric.

During the year, we worked on the planning of three sequences, using different strategies of the inquiry-based learning teaching model to develop different dimensions and capacities in scientific competence. Each sequence made it possible to develop an inquiry project.

At the end of the year, an open-ended problem situation arose, and the capacities of students' scientific competence to solve it were observed.

The tests were framed in real or possible situations, since it is intended to measure the knowledge, knowing how, and knowing how to be, in context.

To observe the development of scientific competence in the course of the research and prepare the initial and final assessment, Table 1 was prepared, in which the categories, dimensions, and capacities designed by Franco Mariscal (2015) are taken and incorporated a new category, which is extracted from the PISA assessment, which corresponds to scientific knowledge (ANEP, 2016).

Table 1
Categories, dimensions, and capacities included in scientific competence.

Categories	Dimensions	Capacities
Scientific knowledge	Knowledge of Biology Contents	*Identify scientific questions.* *Explain phenomena scientifically.* *Use scientific evidence.*
Knowledge about science (procedural and epistemic)	Research approach	*Identify scientific problems.* *Define the objectives of the research.* *Formulating hypotheses.*
	Information management	*Search for information from different sources and evaluate them critically and thoughtfully.*
	Research planning and design	*Identify variables.* *Design a methodology.* *Experiences.*
	Data collection and data processing	*Observe systematically.* *Select and use the most suitable measuring instrument.* *Process the results in different formats (tables, graphs).*
	Data analysis and issuance of conclusions	*Interpret the results.* *Formulate conclusions.*
	Communicate the research results	*Reporting of the results.*
Attitude towards scientific activity	Attitude, critical reflection, and teamwork	*Interest in scientific problems, scientific approach evaluation, and environmental awareness.* *Reflect critically on the results.* *Work as a team, respect, and value colleagues' ideas, and make decisions.*
The social relevance of science (personal, local, and global context)	Linking science in context, with society's norms and values.	*Identify beneficial scientific practices for most citizens.* *Participate as members of a community in collective reflection from the research process.*

Note: Authors' creation, modified by Franco Mariscal (2015, p.240) and PISA cited in ANEP (2016)

Participants

The selection of the city where the high school is located was made taking the suggestions of the Secondary Education Board. The city of Paso de los Toros, in the department of Tacuarembó, was chosen.

The high school of critical social context was taken as a sample since it is where students who are generally demotivated, and who stop attending class during the year attend.

The classification of high school in an unfavorable socio-cultural context is based on the categorizations used by the Secondary Education Board. It is an institution that also registers lag and school dropout at the end of the first semester. These education centers are the ones that most urgently require a change in the methodologies applied in the classroom.

A collaborative work team was formed together with three high school teachers, and the research was implemented in six courses, two courses for each teacher, which corresponded to a total of 115 students at the beginning. This article only refers to the work of a teacher with two first-year groups.

The teachers were selected according to the workplace (empirical sampling), that is, they were chosen from among the teachers who work in the selected high school. Also, as it was an action-research, the willingness to carry out the experience and the openness of the teachers to plan as a team, and share the work of the students was taken into account, characteristics that correspond to a type of intentional sampling. Likewise, their seniority (located between the second and fourth grade of the ranking), training (graduates of teacher training institutes), and permanence during the school year were considered.

Regarding the courses, those that the teachers considered to be the best and those that presented the greatest difficulties were selected, respectively, from each of them, so that there was representativeness in middle school students regarding the diversity present in the classrooms. Two control groups were added to the sample, in which the final assessment was applied.

Instruments

As an instrument, an initial proposal for the first year is developed. Before the application, it was assessed by biology teachers who made their contributions, and later with these contributions, a pretest was carried out in groups different from the first years that made up the sample. It establishes the items to evaluate each of the capacities that make up scientific competence. After preparing it, the presentation was adapted, with a more attractive design, to interest the students (Annex 1).

Rubrics were prepared to evaluate the initial and final proposal, both are similar, they only vary about the conceptual contents, for this reason, only the one used to evaluate the initial proposal is presented in Annex 1.

Table 2

Rubric to evaluate the initial proposal of 1st year.

		Excellent	Very good	Acceptable	Does not satisfy
1	*Identify scientific questions.* *Explain phenomena scientifically.* *Use scientific evidence.*	Correctly interpret the information in the graph and mention some factors in the growth of water lilies.	Correctly interpret the information in the graph and mention a factor in the growth of water lilies.	He or she cannot interpret all the information on the graph. The factor you mention is incorrect or confusing.	He or she does not correctly interpret the informatio n in the graph and mention some factors in the growth of water lilies.
2	*Identify scientific problems.* *Define the objectives of the research.* *Formulating hypotheses.*	Confront objectives and/or hypotheses with the results appropriately.	It refers to the objectives and/or hypotheses and the results but fails to contrast them to draw a conclusion.	The conclusion refers to the results without considering objectives and hypotheses.	The conclusion is not related to the research carried out.
3	*Search for information from different sources and evaluate them critically and thoughtfully.*	He or she correctly diagram a poster with all the items it must contain. The design of the paper is correct.	He or she diagram correctly, but some items are missing. The design of the paper is correct.	He or she diagram correctly, but many items are missing. Unsuitable design on paper.	The items mentioned for the poster are not selected correctly.
4	*Identify variables.* *Design a methodology.* *Design experiences.*	Has a correct management of teamwork, and respect for the opinion of colleagues to make decisions	He or she has correct management of teamwork and respects the opinion of colleagues but undervalues the opinion of others to make decisions.	He likes to present his ideas but does not value the opinion of colleagues to make decisions or criticizes without contributing	He or she does not intervene in teamwork.

		Excellent	Very good	Acceptable	Does not satisfy
				or works without criticism.	
5	*Process the results in different formats (tables, graphs).*	Disseminate the research results in different ways for the community to participate. He or she proposes to raise awareness in society about the care of green spaces.	He or she disseminate the research results in a way. He or she does not propose to raise awareness in society about the care of green spaces.	He or she does not disseminate the research results in a way. He or she proposes to raise awareness in society about the care of green spaces.	He or she does not interact with the community .
6	*Formulate conclusions.*	Correctly interpret the information in the graph and mention some factors in the growth of water lilies.	Correctly interpret the information in the graph and mention a factor in the growth of water lilies.	He or she cannot interpret all the information on the graph. The factor you mention is incorrect or confusing.	He or she does not correctly interpret the informatio n in the graph and mention some factors in the growth of water lilies.
7	*Reporting of the results.*	Confront objectives and/or hypotheses with the results appropriately.	It refers to the objectives and/or hypotheses and the results but fails to contrast them to draw a conclusion.	The conclusion refers to the results without considering objectives and hypotheses.	The conclusion is not related to the research carried out.
8	*Work as a team, respect, and value*	He or she correctly diagram a poster with all	He or she diagram correctly, but	He or she diagram correctly,	The items mentioned for the

		Excellent	Very good	Acceptable	Does not satisfy
	colleagues' ideas, and make decisions.	the items it must contain. The design of the paper is correct.	some items are missing. The design of the paper is correct.	but many items are missing. Unsuitable design on paper.	poster are not selected correctly.
9	*Identify beneficial scientific practices for most citizens. Participate as members of a community in collective reflection from the research process.*	Has a correct management of teamwork, and respect for the opinion of colleagues to make decisions	He or she has correct management of teamwork and respects the opinion of colleagues but undervalues the opinion of others to make decisions.	He likes to present his ideas but does not value the opinion of colleagues to make decisions or criticizes without contributing or works without criticism.	He or she does not intervene in teamwork.

Note: Author's creation.

To assess the process carried out and obtain data for the research, a final proposal was prepared, which allowed the results to be compared at the beginning, and the end of the school year. The final proposal consisted of different items that allowed evaluating the 9 capacities of scientific competence mentioned above (Annex 2)

Data analysis

To carry out the analysis, the scores that arose from the rubrics applied by the teachers to the works of each of the students were taken for this purpose; and then the totals scores obtained by each student and group in each of the capacities were summarized. Finally, the scores obtained in the initial and final proposals were compared.

With the statistical package SPSS v.25 (IBM, 2017), the quantitative analyzes were carried out. On the one hand, to check the possible association between the course variable (VI) and the dimension variable (DV), a Crosstab Analysis was carried out using a contingency table, using the X2 index, between both first-year courses. Subsequently, the hypotheses of differences between the averages of the scores obtained in each of the indicators and the courses are tested by averages of the tests: F (Anova) for the parametric contrast and Mann-Whitney U for the non-parametric contrast, once the assumption of variance homogeneity was verified using the Levene test.

For this article, the data corresponding to the rubrics analyzed for the first year is used, they were 38 from the initial proposal; and 34 from the final.

Results

In each test, the nine dimensions of scientific competence presented in Annex 2 were analyzed.

To assess the results of the tests, a rubric with four performance levels was applied: excellent, very good, acceptable and not achieved, each level corresponds to a score of 3, 2, 1 and 0 respectively, which allows the student to be scored on the scale of 1 to 12 used in the educational system. The total score that could be obtained in the test was 27 points. To analyze the results of this research, the total score obtained by each student was translated into qualitative categories through a scale, in which the values from 23 to 27 corresponding to the category of excellent, 18 to 22 very good, 13 to 17 acceptable, and 1 to 12 insufficient.

In the initial proposal of the 18 first-year students 1, only three obtained acceptable. In the first year, 3, only one student out of the 20 who take the assessment gets acceptable.

For the purposes of the analysis, it is considered that the group, in general, obtains an "acceptable" when 70% of the students reach the "acceptable" or higher grades in the initial and final evaluations in each of the abilities.

If it is analyzed by group and dimension of scientific competence, in table Nor 4 in first 1, dimensions 1 and 5 are those in which the greatest number of students reach the acceptable one, followed by dimensions 2 and 8. The dimensions in which they present the greatest difficulty are 4 and 7.

In the case of 1st 3, dimension 3 is the one with the best results, followed by dimensions 1 and 2. The dimensions in which students present the greatest difficulty are 6 and 7, which correspond to "formulating conclusions" and "reporting of results", respectively.

Considering that teachers were asked to choose the best group and the group with the greatest difficulties, it is possible to see differences between the groups.

While 1st 1, obtains 50% of acceptable responses, 1st 3 achieves 38.9%.

Table 3

Results of the initial and final proposals in the groups of 1st 1 and 1st 3.

	Initial proposal		Final proposal		Total students with correct answers in each item	
	1st 1	1st 3	1st 1	1st 3	Initial P.	Final P.
1. Identify scientific questions. Explain phenomena scientifically. Use scientific evidence.	13	12	17	16	25	33
2. Identify scientific problems. Define the objectives of the research. Formulating hypotheses.	11	12	15	16	23	31
3. Search for information from different sources and evaluate them critically and thoughtfully.	10	14	6	7	24	13
4. Identify variables, design a methodology, carry out experiences.	4	5	8	5	9	13
5. Process the results in different formats (tables, graphs).	13	10	10	10	23	20
6. Formulate conclusions.	8	2	4	3	10	7
Reporting of results.	3	0	5	2	3	7
Teamwork. Appreciating the ideas of colleagues and making decisions.	11	11	13	16	22	29
9. Identify beneficial scientific practices for most citizens.	8	4	9	9	12	18
Total items answered correctly.	81	70	87	84	151	171
Total students who took the test.	18	20	17	17	38	34
% correct items / total students	50	38.9	56.9	54.9	44.2	55.9

Note: Author's creation

Concerning the final evaluation proposal, in the first 1, seven students obtain acceptable in the test, while in the first 3, there are five. There is a slight improvement in the results compared to the initial proposal.

In an analysis by category, both groups obtained better results in categories 1, 2, and 8, and the worst results were found in categories 5 and 6, corresponding to "processing results" and "formulating conclusions".

The group with the worst results at the beginning is 1st 3, which obtains 70% only in one dimension, however, at the end of the year it achieves 70% in three dimensions, generating progress in two dimensions

In the final proposal, the initial differences between the groups of the same grade are not observed. It is essential to highlight that in the first year, the initial scores go from 50% for 1st 1 and 38.9% in 1st 3 to scores of 56.9% and 54.9% respectively. An advance in the results is appreciated, in addition to achieving a leveling out in them.

Regarding the score obtained according to the dimensions of scientific competence, they achieve the best result in dimension 1, in which all students respond acceptably and dimension 5, where 88% manage to respond in an acceptable or very good way.

If the total of items answered correctly by both groups of the action research is analyzed, at the beginning it is 44.2% and in the end, they manage to respond acceptably 55.9%. Slight progress is observed in the development of scientific competence.

The analysis of the possible relationship (behavior) between the two courses concerning the indicators (items) measured, carried out with the X 2test, offers insignificant results in all the indicators except for 6 (Formulate conclusions). In other words, both courses show a similar distribution in student achievement, except for indicator 6 (Formulate conclusions), which show a more favorable association for first 1 students (higher acceptable and very good scores)

Table 4

Results of contrasting before and after averages in the groups 1or 1 and 1or 3. Author's creation.

	First 1	First 3
1. Identify scientific questions. Explain phenomena scientifically. Use scientific evidence.	F (1.33) = 15,000 p= 0.000	F (1.36) = 50,602 p= 0.000
2. Identify scientific problems. Define the objectives of the research. Formulating hypotheses. **	F (1.33) = 9,202 p= 0.005	F (1.36) = 27,366 p= 0.000
3. Search for information from different sources and evaluate them critically and thoughtfully.	F (1.33) = 0,565 p= 0.458	F (1.36) = 0.511 p= 0.479
4. Identify variables, design a methodology, carry out experiences.	U= 105.00 p= 0.060	U= 152.00 p= 0.494
5. Process the results in different formats (tables, graphs).	F (1.33) = 0.122 p= 0.729	F (1.36) = 0.137 p= 0.713
6. Formulate conclusions.	F (1.33) = 0.135 p= 0.715	U= 156.00 p= 0.472
7. Reporting of results.	U= 132.00 p= 0.343	U= 150.00 p= 0.120
8. Teamwork. Appreciating colleagues' ideas and making decisions.	F (1.33) = 2.250 p= 0.143	U= 105.00 p= 0.019
9. Identify beneficial scientific practices for most citizens. *	U= 131.00 p= 0.421	U= 104.50 p= 0.019
Participants' total score**	F (1.33) = 4.155 p= 0.715	F (1.36) = 13.977 p= 0.001

Note:* indicators whose differences have been significant in one of the first courses.

** indicators whose differences have been significant in both first-grade groups.

The analysis of the differences between the groups offers the results described in Table 4, where it is observed that both courses improve significantly in the total score of the test: 1st-1 goes from obtaining an average score of 7.11 with Dt = 4.35, to an average score of 10.76 with Dt = 6.14. The 1st-3 course goes from obtaining an average score of 5.95 with Dt = 4.73, to an average score of 11.64 with Dt = 4.48. This improvement also occurs in both courses for dimensions 1 (course 1st-1: M_{before}= 0.94 Dt = 0.80; M_{after}= 2.58 and Dt = 0.89; and course 1 -3: M_{before}= 0.65 Dt = 0.58; M_{after}= 2.35 and Dt = 0.86) and for dimension 2 (course 1st-1: M_{before}= 0.88 Dt = 0.96; M_{after}= 1.94 and Dt = 1.08; and course 1st-3: M_{before}= 1.00 Dt = 1.02; M_{after}= 2.64 and Dt = 0.86).

In course 1st-1, there are no further improvements. On the other hand, in year 1st- 3 there were statistically significant improvements in dimensions 8 (M_{before}= 1.55 Dt = 1.50; M_{after}= 2.70 and Dt = 0.77) and 9 (M_{before}= 0.25 Dt = 0.55; M_{after}= 1.11 and Dt = 1.26)

Discussion and Conclusions

It is noteworthy that the initial differences between the groups towards the end dissipate, tracing the lower results to reach similar results between the groups of the same grade.

Students do not achieve the expected progress in the different capacities of scientific competence, however, a slight improvement can be seen between the application of the evaluation proposal at the beginning and the evaluation they carry out after working with research projects.

The small progress achieved, although it cannot be compared, is related to the results obtained in a research conducted by Sánchez (2013) on project-based collaborative learning, which took engineering students as study subjects, the results indicate that the experience was made possible for the students to develop their learning process, favored the deepening of the course content and to take more responsibility for participation.

On dimension five, corresponding to “analyzing the results” in which the students had the most difficulty, Harlen (2007) mentions that, over the school year, there is a growth in the experience of the students, for which they will be able to collect information more complex as they progress in this type of task. Developing scientific competence is a process that takes time and is not achieved in a school year, for this reason, the progress that could be observed, even if little, is important.

Concerning dimension six of “drawing conclusions”, Harlen (2007) refers to the difficulties that students present when drawing conclusions. This author points out the difficulty in both dimensions, which together with a scarce approach to them, can have an impact on the low results, from which it can be deduced the importance that the development of scientific competence must be promoted throughout schooling.

Both groups achieved an improvement in the dimensions of scientific competence, with meager progress over a school year, but very important for the beginning of the middle school journey, taking into account that they correspond to groups that completed their first year. Likewise, it is possible to observe the differences in the results achieved by the groups that worked on research projects and those that did not.

The difficulties involved in developing scientific competence are also demonstrated in the analysis by capabilities, some dimensions of competition require more effort and work than others.

After applying for the project work, at the end of the course, both groups achieved an improvement. Sánchez (2013) also mentions the fact that feeling responsible for the success of the activity facilitated the learning of all the students and their integration.

Likewise, it is important to remember that the experience was carried out in a high school with an unfavorable socio-cultural context, for which, although the progress is little, it is valued as very positive.

These results warrant further research, it would be important that the instrument used at the beginning and end, also be applied throughout the year, for the purposes of the research, since the students were evaluated during the school year through an authentic evaluation, with the presentation of the projects and their defenses, therefore, the final proposal was unknown and decontextualized for the students.

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Annexes

Annex 1

Capacity: 1 Identify scientific questions. Explain phenomena scientifically. Use scientific evidence.

Problem situation: Diego and Flavia go out to play in the yard and find that Diego's father has planted grass in his garden to make him look nice.

Diego runs into the grass and Flavia tries to stop him saying: "Stop Diego! Can't you see you're going to kill him?"

DIEGO: “Who?”

FLAVIA: “The grass!”

DIEGO: “What are you saying? The grass is dead”

a. *What is the problem?*
b. *What can Flavia do to prove to her friend what she claims?*

Capacity: 2 Identify scientific problems. Define the objectives of the research. Formulating hypotheses.

If you had to carry out a research concerning the above problem, what question would you pose?

Read the following sentences and indicate in each one if it is a research objective or hypothesis:

- ✓ *Check if the grass is a living being.*
- ✓ *Observe if the grass completes a life cycle.*
- ✓ *Grass is not a living being because it fulfills vital functions.*
- ✓ *Grass is a living being because it fulfills a life cycle.*
- ✓ *Grass is a living being because it is made up of cells.*

Capacity: 3 Search for information from different sources and evaluate them critically and thoughtfully.

Read the following texts:

a. *"Grass is the plant food that grows on the soil of fields and is intended for animal feeding". Pérez Porto, J., Merino, M. (2013, p.1)*
b. *Awareness of the population regarding the importance of the meadows is raising in Uruguay. However, this is yet to be known about its ecology, the structure of plant and animal communities, as well as the functioning and human impact (De León y Gasdía, 2008).*

b) *Which of the two texts do you think has scientific knowledge? A or B?*
c) *What information in the text did you consider when responding?*
d) *Capacity 4: Identify variables. Design a methodology. Design experiences.*
e) *a) According to the searchable question you posed, identify the variables.*
f) *b) Explain how you will proceed to answer the searchable question.*

Capacity: 5 Observe systematically. Select and use the most suitable measuring instrument. Process the results in different formats (tables, graphs).

In a study on aquatic lilies, a plant was introduced in Lake Maracaibo (Venezuela) and its growth was observed. A graph was then made to analyze the results shown in Figure 1.

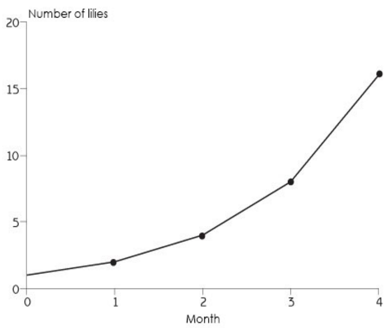

Figure 1. Lily growth in Lake Maracaibo

Note: Source Marten, (2001)

Look at the graph and answer:

a) *In how many months did the study of the lilies last?*

b) *In two months. Approximately, how many lilies grew?*

c) *In four months, how many lilies grew?*

d) *What can the increase in lilies be due to in the last month? Mentions several possibilities.*

Capacity: 6 Interpret the results. Formulate conclusions.

Draw up a conclusion for the previous research, bearing in mind that the objective was: Know the growth of lilies on Lake Maracaibo.

Capacity: 7 Reporting of the results.

Make a poster with the titles you would put in to present your research.

Capacity: 8 Take an interest in scientific problems. Reflect critically on the results. Work as a team, respect, and value colleagues' ideas, and make decisions.

Which of the following statements characterizes your actions when working as a team?

a) *You do consider that the most valid ideas are yours, and that is why you do not let other colleagues speak.*

b) *You enjoy listening to everyone, and then you give your opinion.*

c) *After listening to all ideas, you always consider yours to be more valid.*

d) *You reflect on what is being discussed and may consider a classmate's idea to be more valid.*

Capacity: 9 Identify beneficial scientific practices for most citizens. Participate as members of a community in collective reflection from the research process.

What action would you take in your community after completing your research?

Annex 2

Capacity 1:

Luis's mother is breeding chickens for the family's consumption, but she is concerned that the chickens are not growing as she expected, and they will not be ready by the date she needs them. Luis wants to help his mother and thought that perhaps, by changing some of the conditions in which the chickens are, he will be able to have better results.

According to what you studied in high school, answer:

Is there a scientific basis for Luis' idea?

Write an explanation about what Luis thinks.

Indicates what scientific evidence he may be used.

Capacity 2:

If you were to inquire into the problem posed above, what question would you ask for further research?

Defines the purpose of the research.

Pose two hypotheses for the question.

Capacity: 3

Select two texts to make a theoretical framework:

A. *Cultivating tomatoes under greenhouse substrate conditions produces excellent quality fruits. It also complies with food safety standards. Also, currently, the demand for organically developed products has increased because organic fertilizers make it possible to improve the quality of vegetables consumed by humankind (Dimas et al, 2009).*
B. *"The plantain production systems in the area analyzed present important limitations for its harvesting, some of which are phytosanitary problems, inadequate agronomic management, unsuitable cultural practices, unwise use of agrochemicals, among others." (Barrera, Combatt and Ramirez, 2011, p. 188).*
C. *"Plants are living beings, and they need us to grow. Talk to your plants. This is how you can release carbon dioxide, thus promoting their growth. Also, you should check the plant periodically to avoid the appearance of pests". (Alm, 2013, p. 1).*

What did you consider for the election?

Select a quote.

Paraphrase it.

Capacity 4:

According to the searchable question you posed, identify the variables.

Explain how you will proceed to answer the searchable question.

Capacity 5:

At the veterinarian: chickens grow very fast. Prepare a graph with the chickens' growth data from the neighborhood veterinarian:

Table 5

Chickens grow in 21 days.

Time (days)	Mass (g)
1	30
7	150
14	400
21	800

Note: Author's creation.

What factors can affect chicken growth?

Capacity: 6

Lamb growth curve

Look at the graph and answer:

g) *How many months did the study of growth in lambs last?*
   a. *In 100 days. Approximately how much do they weigh?*
   b. *In 200 days. How much do they weigh?*
   c. *What differences do you notice between males and females?*

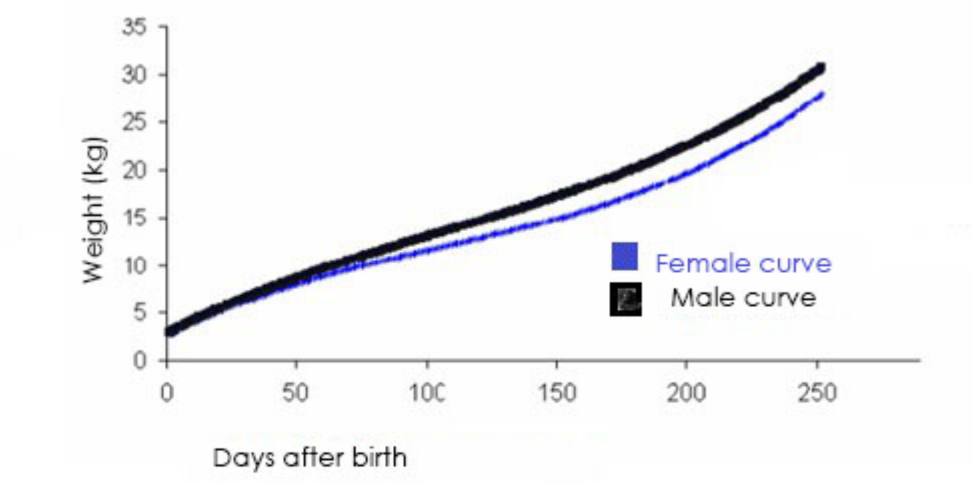

Figure 2. Curve of lamb growth by sex (González Garduño, Torres Hernández, Castillo Alvarez, 2002, p. 17) Author's own translation.

It draws a conclusion for the previous research considering that the objective was to know the growth of Blackbelly lambs between birth and final weight, in Mexico's humid tropics.

Capacity 7:

Make a poster with the titles you would put in to present your research.

Capacity 8:

Which of the following statements characterizes your actions when working as a team?

1. *You do consider that the most valid ideas are yours, and that is why you do not let other colleagues speak.*
2. *You enjoy listening to everyone, and then you give your opinion.*
3. *After listening to all ideas, you always consider yours to be more valid.*
4. *You reflect on what is being discussed and you may consider a classmate's idea to be more valid.*

Capacity 9:

What action would you take in your community after completing your research?