

THE IMPORTANCE OF THE RELATION BETWEEN THE SOCIO-POLITICAL CONTEXT, INTERDISCIPLINARITY AND THE LEARNING OF THE MATHEMATICS

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We analyze the design and implementation of a learning milieu around the topic of nutrition. This local curricular design was part of a larger project aiming at developing a curriculum for 7th grade students, inspired by the tenets of critical mathematics education. The design propitiated interdisciplinary learning in mathematics, natural sciences and computer science. It also involved in a direct way the students' social, cultural and political context, as a way to contributing to the education of democratic and critical citizens.

INTRODUCTION

In 2008, a curriculum development and research project was carried out at a public school called Federico García Lorca (FGL) in Bogotá, Colombia. This project was sponsored by the Institute for Educational Research and Pedagogical Development (IDEP, Colombia), the National Pedagogical University (UPN, Colombia), and Aalborg University (AAU, Denmark), in collaboration with Francisco José de Caldas Distrital University (UD, Colombia). The project intended to contribute to the improvement of mathematics teaching for 7th grade students in an area of economic, social and political conflict. The project was inspired by some key ideas of critical mathematics education (Skovsmose, 1994). One of the central concepts in this approach, as we understand it, is to find a relationship among mathematical meaning, students' activities and students' socio-political lives. The project involved a team of teachers from the school and a team of teacher educators and researchers from the universities mentioned above. The curricular development and research team worked collaboratively in proposing alternative ways of teaching mathematics for the 7th graders (Mancera, Carreño & Camelo, 2008; Peñaloza & Segura, 2008), as well as in theorizing the experience in relation to the possibilities of critical mathematics education inspired approaches for contexts such as the one FGL's school represent (Camelo, García, Mancera & Romero, 2008; Mancera, Camelo, Romero, García & Valero, 2009).

In this paper it is our intention to present one of the learning milieus designed and implemented and comment on its effect in terms of the relationship between the students' socio-political context, the need for interdisciplinarity and the learning of mathematics. In order to do so, we start with a contextualisation of the locality, the students and the school's curricular organisation. Secondly, the collective interaction of the team involved in setting and performing the project is illustrated. Thirdly, the activities concerning the specific learning milieu where students took part are

presented, supported by the theoretical referents that framed this proposal. Finally, a couple of conclusions about the three aspects of socio-political context, interdisciplinarity and learning are presented.

CONSIDERING THE CONTEXT

Following Valero (2004), one of the important elements in developing this project was paying attention to the way in which the series of layers of context surrounding the mathematics classroom play a role in the possibilities for teachers and students to engage in mathematics education. Therefore, for researchers and teachers it was important to inquire about the important features of the setting of the school and of the students.

FGL is a government school, located in Usme (Bogotá, Colombia), where economic issues and social problems arise in large numbers. Such difficulties reflect the permanent contradictions present in the way its inhabitants tend to solve their problems (Camelo & Martinez, 2006). According to Galvis and Soler (2006, p. 2) this is an area of rural traditions, which used to be a native village, nowadays in the process of joining the Capital District of Bogotá due to its urban expansion. The way in which people come to populate the area is determined by land trade on the side of former land owners and also, more recently, because this area offers one of the biggest possibilities of urban expansion for Bogotá. Hence, in this district, problems such as inappropriate uses of land, illegal land occupation and disputes, and water-source environmental issues come together. All these conflicts bring about different forms of violence that are associated with a high-rate urban growth and the poor conditions in which people from the area live. As far as the population is concerned, many of the inhabitants of the area come from conflict zones of the many different “wars” in Colombia. Displaced populations from other parts of the countries move to this locality in search for a safer life and for a possibility of doing a living in the capital city. As a result, coexistence and security problems are the rule in the locality.

The locality has seven Zone Planning Units (UPZ). Five of these Zones are being used as residential areas for poor people of the lowest socio-economic groups, who live in either squatter settlements or social interest buildings. Most of these five UPZs have not been totally urbanised and are known as “non-consolidated peripheral areas”. They also show deficiencies in infrastructure, accessibility, community facilities and public space. One of these UPZs is a scarcely developed area with its lands largely occupied; another UPZ is a big area aimed at the production of urban and metropolitan construction supplies —sand and stones— known as “The Quarry’s Zone”, which exploitation must be dealt with under special regulations due to its large size compared to the whole urban structure of the locality.

FGL is one of the big public schools servicing the population in this locality. After many years of discussion about the pedagogical mission of the school, the school community decided to construct a pedagogical profile making of formative moral values as well as a cultural historical approach (Camelo & Martinez, 2006) the core

of its Institutional Pedagogical Project. This means that in the school teachers should strive for creating “learning situations” based on: i) considering that students are immerse in a particular historical-social-cultural context and; ii) the fact that everyone’s beliefs and conceptions must be considered by teachers when planning such situations. The conjunction of these two conditions would make possible for teachers to lead students to develop more complex knowledge, capabilities and attitudes building on their previous conditions and eventually helping them reaching more advanced development stages.

Within this general approach, the mathematics teachers have been working together in constructing a pedagogical proposal in mathematics that would be in accordance with the general institutional proposal. Therefore, they set themselves the task of finding and implementing teaching methodologies that allow bringing together three aspects simultaneously: an emphasis on formative values, a cultural-historical approach, and a focus on conceptual change (Camelo & Mancera, 2005). The focus on conceptual change is based on considering problem-posing-and-solving as the most significant way to encourage students to develop desired levels of complex mathematical thinking. Four aspects are taken into account: i) the relationship between individuals and every single meaningful aspect of a proposed situation; ii) the history or “tissue of situations” upon which students have built up their knowledge iii) the implicit models students associate with this knowledge and; iv) the kind of conceptions students will reject when solving the problem, the kind of mistakes they will avoid, the “savings” they will seek, the new formulations they will re-take, etc.

In 2007 an interdisciplinatory group of teachers, including the mathematics teachers, at FGL started implementing their pedagogical ideas with a group of 120 students from 4 different grades, all of them aged between 11 and 13 years old. This work made it possible to accurately condense the social, academic, cultural and political problems that characterized FGL, and it also evidenced some of the difficulties related to classroom management and teaching practice itself (Camelo, Carreño & Mancera, 2008). From that work emerged a characterization of the students in the school. The following excerpts from teachers’ assertions illustrate the image that teachers in FGL used to have about their students:

Students who have little formative values, since their gestures as well as their oral, written and graphic expressions show that they move around a world wherein “normality” appears to be represented by verbal and physical aggression.

Students who show little or no interest in their own learning, particularly in learning maths.

Those who lack a well-defined attention focus and therefore bring about awkward dynamics in the classroom, overwhelming other students who otherwise would be willing to get involved in the proposed activities.

Students who in spite of being relatively close to public libraries, have not form a habit of using this kind of facilities nor of devoting some time to reading.

Having very few community centres that promote artistic and cultural activities in the district, and also the fact that they are mostly unknown to children and youngsters, limits the intellectual, sports, social and artistic development of the activities conducted at school.

In 2008, a group of teachers in the school looked for collaboration with researchers in order to tackle some of the problems mentioned above. The project resulting from the collaboration generated great expectations among groups of students in seventh grade who were —as mentioned before— representative of youngsters and their problems in the locality.

FIRST STAGES OF THE PROJECT

The project began by forming teams of teachers intended to perform “collaborative” tasks where teachers from FGL contributed their practical knowledge and teachers from UPN, UD and UAA added their theoretical mastery. It is important to mention that every team had been already working (on their own) on the different teaching-and-learning phenomena in the classroom, especially on the lack of interest shown by students in education in general and in the learning of mathematics in particular. In this way, the group of teachers at FGL focused their efforts on developing projects aimed at raising critical awareness among students, particularly of the role they play in society regarding topics such as the role played by women in a community where sexual inequality and male control has prevailed. Students had already become interested and critical awareness was being built among them (Camelo, Avila, Carreño & Peñaloza, 2008).

Meanwhile, teachers at UPN working in a network of rural mathematics teachers and with teachers in other depressed areas of Bogotá were conducting some research. They were mainly concerned about the lack of interest shown by students during maths lessons and the lack of support given to primary and secondary school teachers, especially to maths teachers when it comes to facing the large amount of problems related to their job at school. The purpose of the project was to identify the contribution of doing collaborative practice among participants of different academic disciplines and views, and holding research-exploratory lessons in order to transform the curriculum and contribute to the professional development and qualification of the math teachers involved in such collaborative groups (García, 2006).

The SMERG group at Aalborg University (UAA) has develop a perspective on critical mathematical education, characterised by issues such as: i) the relation between maths, society and power; ii) the relation between school maths and social-political, inclusion-exclusion processes of different groups of people; iii) the relation between school maths and other fields of knowledge; iv) the development of inclusive-dialogue pedagogical practices; v) the contribution of maths teaching to

social democratisation and vi) cooperation between researchers and teachers aimed at curricular development and production of relevant knowledge about it (Skovsmose, 1999; Valero, 2004).

Sponsored by IDEP and COLCIENCIAS, these three teams of researchers and teachers got together with the purpose of, among others, exploring a curriculum development strategy inspired by some of the tenets of critical mathematics education and of a socio-political approach to mathematics education. Central points of inspiration were ideas such as:

1. The creation of learning milieus (Skovsmose, 2000) that allow teachers moving from the paradigm of exercises to a landscape of investigation for an active learning of mathematics.
2. The organization of learning around problematic areas and the realization of collaborative projects among students.
3. The consideration of students as full socio-political beings and not just cognitive agents (Valero, 2002) and therefore the need of addressing students' intentionality for learning in terms of the relationship between their backgrounds and foregrounds as an important source for the creation of meaning (Skovsmose, 2005).

Given that it was necessary to get to know students so as to think about the most appropriate topics for the design of significant learning milieus, it was decided that the project should begin by broadly contextualising the different groups of students, their interests and concerns (Peñaloza, 2008). As a result, three possible themes emerged as a possible topics for the project-based work that was intended for students to do: free time activities, design and nutrition. In a pilot stage, every maths teacher involved in any of the teams was in charge of making and implementing a design with his students. All findings had to be reported to the whole team on a regular basis in order to reflect on what had happened and to find a new target for the students' activities. As it has been mentioned, this paper concentrates on the milieu about nutrition in grade 701.

NUTRITION AS A MILIEU FOR LEARNING MATHEMATICS

A "learning milieu" (Skovsmose, 2000) was constructed and applied in the first six months of the research project, based on the results from the discussions and actions taken within the context of the project. This "milieu", in this particular case designed by teachers and university researchers jointly, must be understood as "a scenario" that allows teaching and learning practices wherein mathematical contents are connected with situations and activities that students find significant. The process of designing and implementing the milieu served as a first entry for identifying some relevant aspects that were to be considered when conducting the main activities of the project.

In order to design and develop learning environments that regarded student-interest problematic areas, we attempted to identify social-real situations and their

relationship with mathematical modeling processes. Following ideas from Valero (2008), the first step was to acknowledge that: i) mathematics is not neutral knowledge, but it is knowledge used by human beings in many different social-life situations to promote a particular view of the world; ii) there are different kinds of mathematical knowledge associated to various social and cultural practices, and iii) mathematical learning practices can not be exclusively defined in terms of individual thinking processes.

The creation of the learning milieu about nutrition began when suggesting that students should reflect on and analyse the impact of the media on family decisions about what they eat every day. The aim was to discuss and identify the nutritional contribution that daily diets offer to school students.


The second activity allowed making connections between biology, mathematics and the social-political-cultural context, since items such as calories intake and nutritious information of some of the food students eat on a daily basis were studied and analysed. This kind of activity involved an immediate context that makes interdisciplinary work possible with the aim of allowing students exploring mathematical contents in order to shape the situation.

Alimentación y bienestar

Discutiendo la alimentación

Lean detenidamente cada una de las afirmaciones sobre hechos relacionados con la alimentación:

- Los medios de comunicación, principalmente por medio de los anuncios publicitarios, influyen a muchas personas en la escogencia de los alimentos.
- Es fundamental estar atento a las citadas propagandas, ya que aumentar el consumo de determinados alimentos o medicamentos es el principal objetivo.
- Una alimentación inadecuada trae prejuicios a la salud, lo que puede ser verificado con estudios que indican un elevado índice de colesterol en niños, problema que en general se debe a los adultos.
- La alimentación es una necesidad biológica vital, común a todos los seres vivos. Tenemos la necesidad de consumir diariamente sustancias fundamentales para la construcción y el funcionamiento del cuerpo. Sin embargo, la alimentación de muchas personas es pobre en vitaminas y proteínas.



Discuta las afirmaciones con sus compañeros. Después respondan.

1. ¿Esta de acuerdo con cada una de las afirmaciones anteriores? Justifique su respuesta.
2. De tres ejemplos para ilustrar cada una de las ideas (use dibujos, tablas, ilustraciones...)

Activity 1

Given that, at a first stage, students had to analyse the nutritional habits of the rural-Usme inhabitants compared to the Food and Agriculture Organisation of the United Nations (FAO)' recommendations found on the internet, the third activity attempted to link both the context and the most recent reflections in a direct way. At a second stage, students had to devote some time to analysing their home nutritional habits.

An interesting part of the discussion with students in the first activity focused on the approach one of the groups adopted regarding the fact that although the media has an impact on what they consume, consumption habits are also influenced by the products themselves and the way they are displayed in local shops and supermarkets. Every one agreed that when it comes to do the shopping, most mothers tend to buy cheap products in small amounts; otherwise money would not be enough to cover their everyday needs.

The situation allowed some initial change in the classroom environment, as students did not limit themselves to follow the instructions given on the teacher's worksheet, but instead, they queried some of the written statements on the sheet itself broadening

the point of view that was to be discussed. A critical position began to appear as one of the groups stated that they could not afford to buy the kind of products advertised on TV, since the products sold in their neighbourhood were cheap, low-quality, and normally packed in small quantities by the resellers in local shops .

As a result, in the second activity, it was decided to analyse some of the nutritional information labels attached to students' daily consumption products. This was intended to challenge whether students' nutrition was appropriate or not. As the analysis seemed endless and based on the descriptions given by students, it was decided to limit this exercise only to the analysis of the amount of calorie-intake. Then, it was possible to bring together two subjects like natural science and maths. It was also evident from the discussion that mathematical content appeared as a tool to understand one's own situation by solving direct proportional problems that involved multiplication of decimal numbers.

Alimentación y bienestar

Las calorías

¿Qué tanto saben ustedes de las calorías?

Caloría—es abrevia cal— es la unidad de medida de la energía, usada para indicar el total de energía que un alimento puede ofrecer, también se utiliza para indicar la energía consumida por un hombre o mujer en sus actividades físicas o mentales.

Para expresar el total de calorías ofrecida por un alimento o consumidas en una actividad usamos como medida la Kilocaloría (Kcal). El prefijo Kilo, representado por la letra K, significa "mil". Así,

1 Kcal = 1000 cal

Un error bastante frecuente en revistas, empaques, y hasta en libros, es usar el termino caloría en lugar de Kilocaloría. Se afirma por ejemplo, que un hombre adulto necesita consumir diariamente, en promedio, 2500 cal, cuando en realidad necesita es 2500 Kcal.

1. Observen los rótulos de información nutricional de algunos alimentos que se consiguen en el mercado y propongan una tabla indicando cuantas kilocalorías ellos ofrecen por 100 gramos del producto.
2. Busque en los rótulos de los productos de paquete que ustedes consumen la información nutricional y establezca para cada uno de ellos, cuantas Kilocalorías ofrecen por 100 gramos del producto.

Entre las sustancias fundamentales para la vida del ser humano están los carbohidratos, los lípidos y las proteínas. Investigue:

¿Cuál es la función de cada una de las sustancias en la manutención de la vida?, ¿los alimentos mas ricos en cada una de ellas? Y ¿Cuántas Kilocalorías hay en cada una de ellas?

A propósito, ¿Cuántas Kilocalorías consumen cada uno de ustedes en un día?

Información Nutricional	
Alimento: Leche descremada (1% de grasa)	
Porción por porción: 1/2 taza (125 ml)	
Energía Total: 42 Kcal	85 kcal
Energía de la Grasa: 10 Kcal	20 kcal
Grasa Total: 2 g	4%
Grasa Saturada: 1 g	2%
Grasa Trans: 0 g	0%
Carbohidratos: 12 g	24%
Carbohidratos Totales: 12 g	24%
Proteína: 8 g	16%
Fibra Dietética: 0 g	0%
Alcohol: 0 g	0%
Vitamina A: 100 IU (20%)	
Vitamina B12: 0.5 mcg (10%)	
Vitamina C: 0 mg (0%)	
Vitamina D: 0 IU (0%)	
Vitamina E: 0 mg (0%)	
Vitamina K: 0 mcg (0%)	
Calcio: 125 mg (25%)	
Hierro: 0 mg (0%)	
Zinc: 0 mg (0%)	
Sodio: 10 mg (2%)	
Potasio: 40 mg (8%)	
Magnesio: 5 mg (12%)	

Información Nutricional	
Alimento: Leche descremada (2% de grasa)	
Porción por porción: 1/2 taza (125 ml)	
Energía Total: 47 Kcal	94 kcal
Energía de la Grasa: 15 Kcal	30 kcal
Grasa Total: 3 g	6%
Grasa Saturada: 2 g	4%
Grasa Trans: 0 g	0%
Carbohidratos: 12 g	24%
Carbohidratos Totales: 12 g	24%
Proteína: 8 g	16%
Fibra Dietética: 0 g	0%
Alcohol: 0 g	0%
Vitamina A: 100 IU (20%)	
Vitamina B12: 0.5 mcg (10%)	
Vitamina C: 0 mg (0%)	
Vitamina D: 0 IU (0%)	
Vitamina E: 0 mg (0%)	
Vitamina K: 0 mcg (0%)	
Calcio: 125 mg (25%)	
Hierro: 0 mg (0%)	
Zinc: 0 mg (0%)	
Sodio: 10 mg (2%)	
Potasio: 40 mg (8%)	
Magnesio: 5 mg (12%)	

Información Nutricional	
Alimento: Leche descremada (3% de grasa)	
Porción por porción: 1/2 taza (125 ml)	
Energía Total: 52 Kcal	104 kcal
Energía de la Grasa: 20 Kcal	40 kcal
Grasa Total: 4 g	8%
Grasa Saturada: 3 g	6%
Grasa Trans: 0 g	0%
Carbohidratos: 12 g	24%
Carbohidratos Totales: 12 g	24%
Proteína: 8 g	16%
Fibra Dietética: 0 g	0%
Alcohol: 0 g	0%
Vitamina A: 100 IU (20%)	
Vitamina B12: 0.5 mcg (10%)	
Vitamina C: 0 mg (0%)	
Vitamina D: 0 IU (0%)	
Vitamina E: 0 mg (0%)	
Vitamina K: 0 mcg (0%)	
Calcio: 125 mg (25%)	
Hierro: 0 mg (0%)	
Zinc: 0 mg (0%)	
Sodio: 10 mg (2%)	
Potasio: 40 mg (8%)	
Magnesio: 5 mg (12%)	

Información Nutricional	
Alimento: Leche descremada (4% de grasa)	
Porción por porción: 1/2 taza (125 ml)	
Energía Total: 57 Kcal	114 kcal
Energía de la Grasa: 25 Kcal	50 kcal
Grasa Total: 5 g	10%
Grasa Saturada: 4 g	8%
Grasa Trans: 0 g	0%
Carbohidratos: 12 g	24%
Carbohidratos Totales: 12 g	24%
Proteína: 8 g	16%
Fibra Dietética: 0 g	0%
Alcohol: 0 g	0%
Vitamina A: 100 IU (20%)	
Vitamina B12: 0.5 mcg (10%)	
Vitamina C: 0 mg (0%)	
Vitamina D: 0 IU (0%)	
Vitamina E: 0 mg (0%)	
Vitamina K: 0 mcg (0%)	
Calcio: 125 mg (25%)	
Hierro: 0 mg (0%)	
Zinc: 0 mg (0%)	
Sodio: 10 mg (2%)	
Potasio: 40 mg (8%)	
Magnesio: 5 mg (12%)	

In the third activity students got to relate their own context directly with their eagerness and interest in doing the activities. Some of them came up with expressions like “country dwellers never eat meat in their meals! It can't be possible!” One group of students even decided to find out more on the internet in order to validate the information given in the lesson. As a result, the need for students to study their own nutrition arose out of a suggestion made by one of the groups. Then, students and teacher conducted a survey on the members of their families at home so that they could determine the amount of proteins, nutrients and vitamins each person was consuming in a single day. This activity allowed the maths lesson to go far beyond the walls of a classroom, since information was being gathered from external sources. Additionally, all mathematical contents were learned due to a genuine need to know whether nutritional conditions were appropriate compared to the recommendations posted on the internet by official international organisations such as FAO.

Unfortunately, the amount of information gathered by students made them repeat the same sort of calculations several times. As a result, students lost the interest they had already taken. Having this situation, an attempt was made to use a spreadsheet for the calculations, but the organisation of the school did not allow quick, effective access to the computer room, which led to the end of the activity with each group presenting their results in front of their classmates.

CONCLUSIONS

Taking into account that critical mathematical education intends to enhance the political, cultural, social and mathematical skills of an individual towards forming democratic citizens, it is remarkable that the learning milieu described made it possible for students to begin to understand the problems, their context and the mathematical tools to be used when querying their living conditions.

Firstly, students realised that, for example, the media does not allow reflection about the quality and convenience of food regarding the needs of the district inhabitants so as to supply them with nutrients appropriate for the jobs they do, the weather of the region, etc.

Secondly, students found that their consumption habits were also influenced by financial matters, since they must be fed on cheap food in order to buy enough supplies for “the whole” family. Given the social conditions of the district the most important thing is to be “filled up” rather than being “well nourished”.

Thirdly, such reflections made it possible to tackle the lack of interest in learning mathematical contents previously observed on students, since students conceptualized ideas about science (food components), mathematics (table and chart interpretation, proportions, survey design and data collection) and computer science internet information search); all this thanks to the creation of a learning milieu that surpassed the shared-awareness of contents and engaged students by giving them “a role” different from the one of just listening to and repeating what the teacher says and writes on the blackboard.

Fourthly, it is important to highlight that the organisation of the institution has a strong influence upon any initiative that may arise towards alternative teaching and learning proposals. In fact, such organisation at the beginning allowed teachers teamwork, which led to successful student learning. However, this did not happen at the end of the experience, leading students to lose interest as the amount of information involved required database use and access to the school computers was not granted. Last but not least, the whole experience shows that it is possible to make proposals, inspired on critical mathematics education, aimed at democratic citizen education that allow us to dream about a society where justice and equity may come true.

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