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THE ORCHESTRATION OF INTEGRATED ACTIVITIES OF SCIENCES AND MATHEMATICS IN THE 5TH SCHOOLING GRADE: THE ROLE OF QUESTIONS

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Abstract

The aim of this poster is to analyze the questions of a training teacher and of those their students in a sciences and mathematics integrated environment. The study wants to understand what type of questions will be crucial to mediate the learning in such context. The examined data belong to a research entitled "The enquiry in sciences class of 5th grade students: an approach integrating mathematics". The methodology used was influenced by: Balance Model (Kiray, 2012) for integrating mathematics and science; the ideas of Myhiil and Dunkin (2005) and Carlsen, Erfjord and Hundeland (2009) about the teachers' questions; and the ideas of Moreira (2012) about student's questions in the classroom.
The results seem to show that the students identify the abiotic factors through analyzing graphs elicited by questions. They also used processes of interpretation and intuition. Although the students had posed few questions, they had opportunity to deal with questions of different types and functions. The types of questions that seem to us to be the most crucial to mediated the learning (Carlsen et al. (2009) are: *asking for argument, problem solving invitation* and *concluding*. The science textbook, used in the class, didn´t take in account the mathematic curriculum. In order to promote science and mathematics learning, it seems important the textbook take in account the mathematics and science curricula according to the year of schooling.

Keywords: *Orchestration, integration, questions, sciences and mathematics, teaching and learning 5th schooling grade.*

1. Introduction

The integration of disciplines in the school curriculum has been discussed and considered necessary for all disciplines. "Mathematics and Science, are much more suitable for integration because of their fields of application and their mutual scientific approach towards problem-solving. Science and mathematics are two closely related systems of knowledge; they are both related to the physical world, and science provides concrete samples, while mathematics provides abstract samples" (Kiray, 2012, p.1182). However, Mathematics and Science integration may not always be possible and therefore a model, called "the balance model" vas developed, in which Science and Mathematic contents are central (Kiray, 2012).

The orchestration is a word used to describe what teachers do when they develop learning activities. To orchestrate activities the teacher has to plan, think forward, act in the moment, follow students' questions and comments, adapt questions for each students (Hundeland, Erfjord, & Carlsen, 2017). "The teacher's role is to orchestrate the supporting features – the visual cues, the prompts, the questions, the instructions, the demonstrations, the collaborations, the tools, the information sources available, and so forth" (Carlsen et al., 2009, p. 2568).

The teacher should act as an instigator and enabler of thinking processes, but rather encourage and promote challenges, giving space for students to think, discuss and present arguments (Calleja, 2016).

The inquiry thus becomes a strong strategy to increase and improve learning, because it promotes social interaction in the classroom (Silva & Lopes, 2015). The inquiry should be based on asking questions, solving problems, formulating, imagining, exploring, investigating, reasoning, encouraging discussions and looking critically (Jaworski, 2015). Asking questions is a social activity that provides the interaction between teacher and students and between students (Hayashi, 2012). The classroom questions have been categorized in different ways: questions formulated by teachers (Myhiil & Dunkin, 2005; Carlsen et al., 2009) and questions posed by students (Moreira, 2012).

Myhiil and Dunkin (2005) analyzed the questions of the teachers in 54 classes with students from 6 to 7 and from 10 to 11 years of age, categorizing them related to their form and function. The form questions were categorized into: *factual*, *speculative*, *process* and *procedural*. The function were categorized in: *class management*, *factual elicitation*, *cued elicitation*, *building on content*, *building on thinking*, *recapping*, *practicing skills*, *checking prior knowledge*, *developing vocabulary*, *checking understanding* and *developing reflection*. Carlsen et al. (2009) conducted a study with children and identified six categories of teachers' questions: *suggesting action*, *open*, *asking for argument*, *problem solving invitation*, *re-phrasing*, *concluding*.

The questions formulated by the students in classroom also were an important role in meaningful learning. Moreira (2012) used a classification system of questions according to three levels of complexity: *Acquisition*, *Specialization* and *Integration*. Moreira (2012) also classifies students' questions on *routine* questions, which relate mainly to aspects of classroom management.

2. Design

As above mentioned, this poster is based on a qualitative, descriptive and interpretive study described in a Final Report "The questioning in Sciences classes in the 5TH Schooling Grade: an approach integrating Mathematics" (Guerra, 2018), carried out under the Master's Degree in Teaching of the 1st Cycle of Basic Education and of Mathematics and Natural Sciences in the 2nd Cycle of Basic Education of the Higher School of Education of Coimbra. This study was developed in the classroom (twenty-one students) and was fundamentally influenced by the ideas of: Paul (1995, cited by Vieira & Tenreiro-Vieira, 2005) about Socratic method; Vieira, Tenreiro-Vieira and Martins (2011) about Science, Technology and Society (STS) perspective; Leite (2001) and Martins et al. (2007) about practical work in Sciences; Rees (2001) about tables and graphs; Curcio (1989, cited by Arteaga & Batanero, 2011) about chart interpretation; Kiray (2012) about Integration of Science and Mathematics in the balance model; Myhiil and Dunkin (2005) about the classification of teachers' questions; Moreira (2012) about the classification of students' questions.

The methodology used in this study was closed with Cheng and Ling (2013) ideas and involving three phases: “planning”, “implementation” and “evaluation”. In the planning phase the topics of Sciences and Mathematics have been chosen: “The influence of abiotic factors on the behavioral and morphological adaptations of animals” and “the interpretation of graphs” using an inquiry strategy; and to design a teaching sequence of three classes: “When is snail activity most active?”; “What is the influence of environmental factors on the behavior of animals?”; and “What is the influence of water, light and temperature on the behavior of earthworms?”. The implementation phase was involving a teaching sequence in Sciences classroom. The evaluation phase of methodology was always present during the study and was supported by the two groups: training group and the reflection group.

3. Objectives

The main objective of this poster is to examine the questions of the teacher and the students in an integrative environment of Sciences and Mathematics in a 5th year Sciences class in order to understand what kind of questions will be crucial to mediate learning in such an environment.

4. Methods

In this poster the analyzed data are transcripts of audio records of in the excerpts from the lessons “In what period are the snails more active?” and “What is the influence of water, light and temperature on the behavior of earthworms?”. The date was subjected to content analysis.

The teachers' questions were classified according of Myhiil and Dunkin (2005) and Carlsen et al. (2009) and the students' questions were classified according to the classification of Moreira (2012).

In these two classes, the main resource used was the textbook and PowerPoint about “the influence of abiotic factors on morphological and behavioral adaptations of animals”.

5. Discussion

The students rarely posed questions, and only two types of questions: *acquisition* (questions associated with simple ideas and/or processes or concepts, which do not imply evaluation, judgment or conclusions - “*Teacher, this is the school thing, is not it?” but doesn’t this thing belong to the school?*) and *integration* (questions that want to reconcile different ways of thinking, to solve conflicts, and to test circumstances of understanding complex ideas -*“Have they gone to the school at midnight to see the snails?”).*

According to Myhiil and Dunkin classification´s (2005), the questions posed to the students by training teacher may be: *factual*, *speculative*, *process* and *procedural*, *class management*, *factual elicitation*, *cued elicitation*, *building on content*, *building on thinking*, *developing vocabulary* and

checking understanding. Looking at the classification of Carlsen et al. (2009) the training teacher posed the following questions: *open, asking for argument, problem solving invitation, re-phrasing* and *concluding*. To classify the question according to both classifications is a difficult task. For instance, the question *"Why, how can we see that?"* may be a *process* question or an *asking for argument* question. So, we have decided to use in this study the classification of Carlsen et al. (2009) because we consider it to be more systematic and appropriate to the situation. The study seems to point that in a Science and Mathematics integrated environment the teacher should promote the "inquiry" through posing questions as: *asking for argument, problem solving invitation* and *concluding*.

6. Conclusions

The results appoint that the students worked mainly with content of Science ("the influence of the abiotic factors on the behavior of the animals and the biodiversity") and mathematical graph. The students used processes of interpretation, justification, intuition, imagery and inferences.
The study showed one Science and Mathematics integrated environment that used an inquiry strategy. The main resource of this environment was the textbook. However, many of the graphs present in the textbook weren't appropriated to the mathematics curriculum of those students.
The study also evidenced the need of given to the student's opportunities to exercise their own questions in order to promote active learning and metacognition according to the ideas of Wong (2012).

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