FaSMEd

Raising Achievement through Formative Assessment in Science and Mathematics Education

The Archaeologist Giancarlo – Part 3

Subject:	Maths
Age of students:	9-12 years
Hardware:	Tablets, pc, IWB or data-projector
Software:	IDM-TClass
Functionalities:	Sending and displaying
Time:	2-3 hours
FaSMEd partner:	University of Turin
Short Abstract:	This activity is framed within the context of **early algebra**. It is aimed at guiding students to interpret a graph as another representation of a given relation between two variables with the aim of identifying new information that it provides.

Premises: theoretical tools

In presenting our methodology and the way of developing this activity we refer to two main theoretical tools.

The first theoretical tools are the Formative Assessment (FA) strategies proposed by Wiliam and Thompson (2007):

1) Clarifying/ Understanding/ Sharing learning intentions and criteria for success,
2) Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding,
3) Providing feedback that moves learners forward,
4) Activating students as instructional resources for one another,
5) Activating students as owners of their own learning.

The second theoretical tools are the Functionalities of Technology (FT) introduced within the FaSMEd Project (see the complete description on FaSMEd website https://microsites.ncl.ac.uk/fasmedtoolkit/theory-for-fa/the-fasmed-framework/):

(a) sending & displaying,
(b) processing & analysing,
(c) providing an interactive environment.

1. Content

Activities “The Archaeologist Giancarlo-part 1” and “The Archaeologist Giancarlo-part 2” are propaedeutic to this one. The topic on which it is focused is again early algebra. In particular, after having worked with verbal and symbolic representations of the relations introduced within the text of the problem, students are now asked to interpret a graph as a different way of representing relations. Moreover, they are guided to identify new information provided by the graph and to think about the possibility of indefinitely extending this graph.

2. Activity

This activity is an adaptation from activities developed within the ArAl Project (Cusi, Malara and Navarra 2011). It can be developed referring to a set of *six worksheets*.

2.1 The worksheets: focus and aims

Worksheet 4 introduces a new part of the story within which the problem is presented: the archaeologist Giancarlo finds a graph within which other archaeologists have represented all the incisions they found in the desert. Students are asked to interpret this graph to understand what kind of new information was provided to Giancarlo. In particular they have to notice that, since the incisions represented in the graph are six, there are two incisions that were not discovered by Giancarlo (these are the so called "missing incisions").

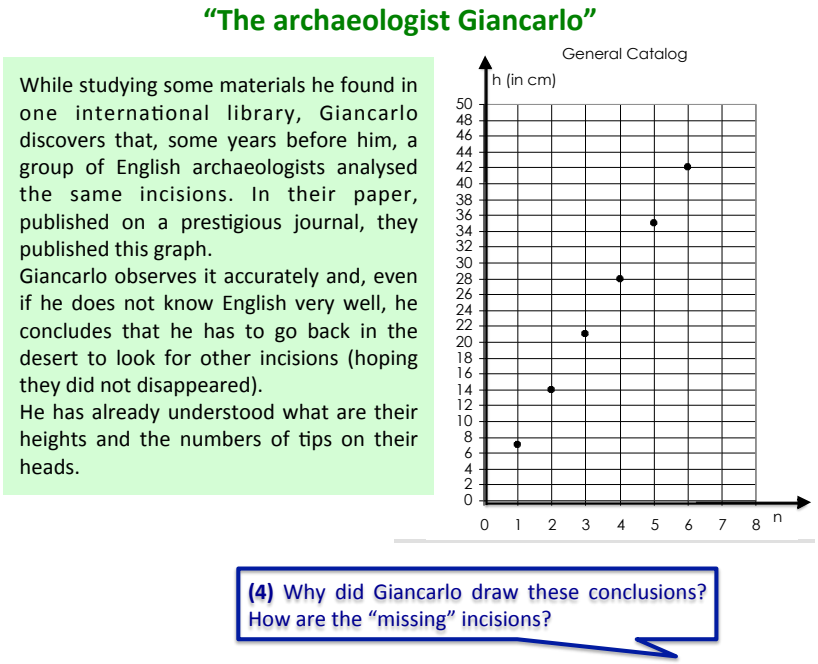


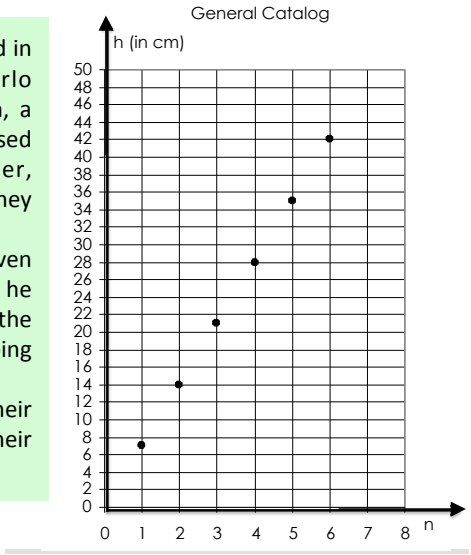
Fig. 1: Worksheet 4

Worksheet 4 is aimed at introducing the graphical representation of a given relation. Students are first of all asked to find out new information within the graph, grasping the meaning of the points: each point in the Cartesian plane provides two pieces of information, that is the number of tips on the head of an incision (horizontal axis) and the height of the same incision (vertical axis). In this way, the students can also interpret the graph as the representation of the relation between the numbers of tips and the heights that has been introduced through the previous activities, activating conversion from the graphical to the verbal register (Duval, 2006).

Worksheet 4A is a helping worksheet. It could be sent to the students that face difficulties in interpreting the graph.

"The archaeologist Giancarlo"

While studying some materials he found in one international library, Giancarlo discovers that, some years before him, a group of English archaeologists analysed the same incisions. In their paper, published on a prestigious journal, they published this graph.
Giancarlo observes it accurately and, even if he does not know English very well, he concludes that he has to go back in the desert to look for other incisions (hoping they did not disappeared).
He has already understood what are their heights and the numbers of tips on their heads.



(4) Why did Giancarlo draw these conclusions? How are the "missing" incisions?

Let's focus on the horizontal axis. What kind of information does it provide? And the vertical one? What do the different points within the graph represent?

On the horizontal axis we read …
On the vertical axis we read …
The different points represent …

Now, can you say how are the "missing" incisions?

Fig. 2: Worksheet 4A

Worksheet 4A could be sent to students to help them focus on the meaning of the different point within the graph. Thanks to the questions, students are guided to reflect on the specific information that each point brings.

Worksheet 5 is a worksheet aimed at prompting a specific discussion. It has to be displayed (or sent to the pairs/groups of students) in case, during the class discussion on worksheet 4, the idea that other incisions (in addition to those discovered by the English archaeologists) can be constructed referring to the same rule.

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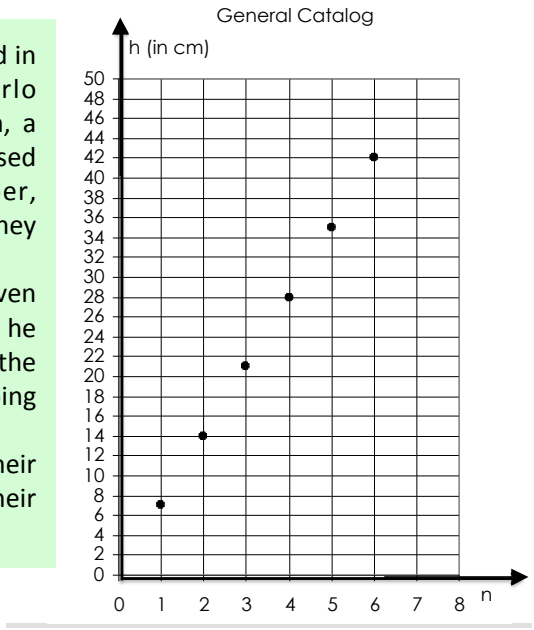

(5) Supposing that, in addition to those discovered by the English archaeologists, other incisions exist, constructed referring to the same rule. How could they be?

Fig. 3: Worksheet 5

Worksheet 5 can be proposed in case, during the discussion on worksheet 4, students show not to have completely grasped that there is a rule according to which all the incisions have been constructed. A specific aim of the discussion to be carried out referring to this worksheet is to introduce the idea that the graph could be indefinitely extended, through the construction of other points, which represent couples of values that are in relation.

Worksheets 5A, 5B and **5C** are conceived to support the discussion on worksheet 5 in case the students are blocked in front of the question of identifying other incisions that can be constructed following the same rule.

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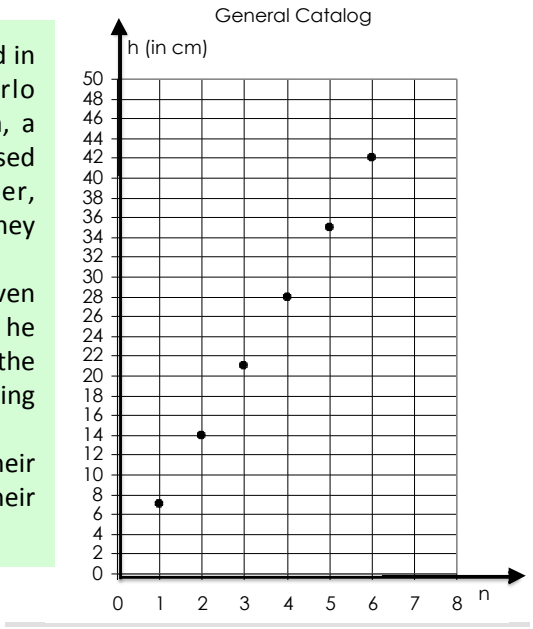

(5) Supposing that, in addition to those discovered by the English archaeologists, other incisions exist, constructed referring to the same rule. How could they be?

There could be another incision whose height is 45cm.

A student from another class wrote this answer. Do you agree? Why?

Fig. 4: Worksheet 5A

The discussion on the statement in **worksheet 5A** ("there could be another incision whose height is 45cm") should lead students to highlight that, since the number of tips is a natural one, the height of every incision should be a multiple of 7.

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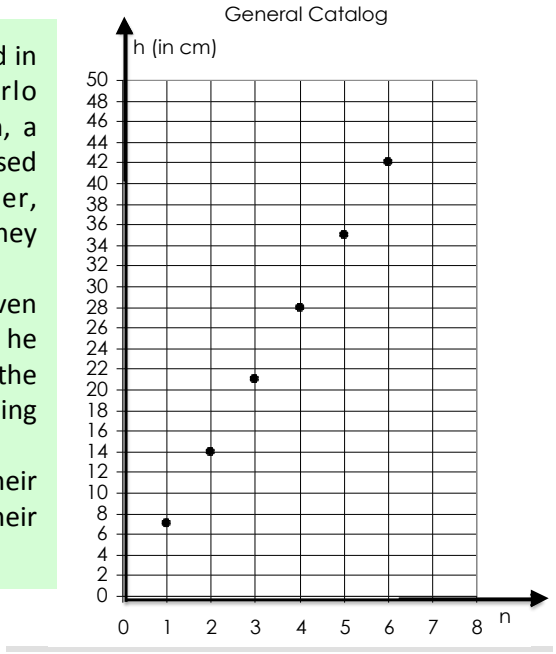

(5) Supposing that, in addition to those discovered by the English archaeologists, other incisions exist, constructed referring to the same rule. How could they be?

There could be another incision with 7 tips.

What should be the height of the incision to which this answer refers? Why?

Fig. 5: Worksheet 5B

The question in **worksheet 5B** ("there could be an incision with 7 tips"; "What should be the height of this incision?") is aimed at making students consolidate the observations developed discussing on worksheet 5A, determining the height multiplying the number of tips by 7.

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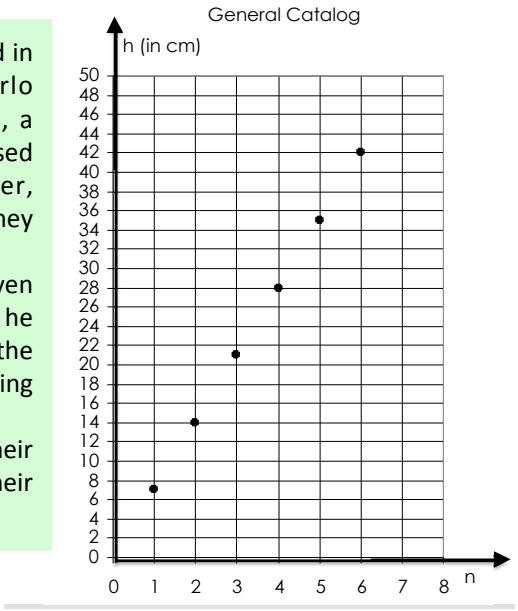

(5) Supposing that, in addition to those discovered by the English archaeologists, other incisions exist, constructed referring to the same rule. How could they be?

Another incision could have 8 tips and be 56cm high.

How could the student who wrote this answer have found an incision with these characteristics?

Fig. 6: Worksheet 5C

Also the statement in **worksheet 5C** ("Another incision could have 8 tips and be 56cm high") is aimed at consolidating what have been already discussed, focusing on how, referring to the rule that connect the number of tips to the height, other point could be added within the graph.

2.2 Methodology

Our hypothesis is that, in order to raise students' achievement, Formative Assessment (FA) has to focus not only on basic competences, but also on metacognitive factors (Schoenfeld, 1992). Accordingly, we planned and developed class activities with the aim of: (a) fostering students' development of ongoing reflections on the teaching-learning processes; (b) focusing on making thinking visible (Collins, Brown & Newmann, 1989), through the sharing of their ideas with the teacher and the classmates.

For this reason, we suggest that, during the activities, the teacher guides the students to focus on the analysis and comparison of not only their *products* but also the *processes* that led to these products. In particular, the class should be led to discuss, on one side, the written productions and, on the other side, the strategies developed to carry out the tasks.

As regards the collective analysis of the students' written productions and the developed strategies, in particular, we refer to *argumentation* as a possible FA tool in the interaction between teacher and students. Specifically, argumentation is promoted to support the development of effective class discussions, starting from questions such as: "Explain what you did", "Explain why your approach is effective", and to guide students in assessing the correctness, the clearness and the completeness of given explanations (their own or others).

The methodology adopted is in tune with these hypotheses. It will be clarified in section 2.4, after the introduction of the technology used (section 2.3).

2.3 Technology

In tune with the hypotheses presented in the previous section, we explored the use of a CCT, which connects the students' tablets with the teachers' laptop and allows the students to share their productions, and the teacher to easily collect the students' opinions and reflections during or at the end of an activity: IDM-TClass.

In the use of IDM-TClass to support FA processes, we in particular focused on the following three main functions of this software:

- the possibility of distributing documents to students and collecting documents from the students' tablets (related to the functionality *Sending and Displaying*);
- the possibility of creating instant polls and immediately showing their results to the whole class (related to the functionality *Processing and Analysing*);
- the possibility of displaying the students' written productions through the data projector or the interactive whiteboard (related to the functionality *Sending and Displaying*).

Each school was provided with tablets for the students and computers for the teachers, linked to IWB or data projector. In order to foster collaboration and sharing of ideas, students were asked to work in pairs or in small groups on the same tablet.

2.4 Structure of a typical lesson and aspects of Formative Assessment

In the following, we present the typical structure of a lesson developed during the teaching experiments carried out in Italy, in this case with specific reference to worksheets 4, 4A, 5, 5A, 5B, 5C.

Usually the activity starts with a worksheet focused on one or more questions (in this case **worksheet 4** and possibly **5**), sent from the teacher's laptop to the students' tablets (functionality *Sending and Displaying*). Students work in pairs or small groups of three.

After facing the task and answering the questions, the pairs/groups send back their written productions (functionality *Sending and Displaying*) to the teacher. The teacher can decide to send helping worksheets (*FA strategy 3*, aimed at the activation of *FA strategy 5*) to some groups, or the groups can ask for them. In this case, the helping worksheet **4A** could be sent to support the students in focusing on the information provided by each point within the graph.

After all groups have sent back their answers, the teacher sets up a classroom discussion (*FA strategy 2*) in which the students' written productions are shown (functionality *Sending and Displaying*) and feedbacks are given by the teacher and by classmates (*FA strategies 3 and 4*, aimed at the activation of *FA strategy 5*). The discussion is engineered starting from the teacher's selection of some of the received written answers, shown on the IWB. The discussion aims at highlighting (*FA strategy 3*): (a) typical mistakes; (b) effective ways of processing the tasks; (c) the comparison between the different ways of justifying claims. In this, the criteria for success could be clarified through the analysis and comparison of the different written productions (*FA strategy 1*).

If not all the aspects that should be highlighted arise during the class discussion, the teacher can display (functionality *Sending and Displaying*) the worksheets conceived to prompt a discussion (in this case **worksheets 5** and, possibly, the worksheets **5A**, **5B**, **5C**, aimed at supporting the discussion on worksheet 5). These kinds of worksheets are aimed at supporting the activation of *FA strategy 2*.

Polls (functionality *Processing and Analysing*) could also be used to prompt the discussion (*FA strategy 2*, that could lead to the activation of other FA strategies, such as 3, 4, 5) during different parts of the lessons. In this case no worksheets aimed at prompting polls were constructed, but it is possible to organize instant polls. For example, a poll could be constructed, instead of using worksheet 5A, 5B, 5C, as a starting point for the discussion on worksheet 5.

3. Further Information

We recommend that, when the teacher introduces the worksheets that are going to be sent to the students, she stresses some aspects. This is especially crucial with younger students (grade IV and V).

As regards **worksheet 4**, it is very important to clarify the meaning of the terms "missing incisions". The text of the problem could be, in fact, misinterpreted by the students: some of them could not be aware that the graph represents also incisions that were not discovered by Giancarlo and his team. So students could try to find new incisions applying the rule ("multiplying the number of tips by 7 you can find the height of the incision") instead of identifying the new information looking at the graph. Other students could interpret "missing incisions" as "the incision that are not in the graph" (so they can anticipate the question on which worksheet 5 is focused), proposing (7,49) and (8,56) as possible points that characterise the "missing incisions".

During the teaching experiments we carried out, we used **worksheets 5**, **5A**, **5B** and **5C** very few times because the discussion on worksheet 4 (since there were often students who proposed, as "missing incisions", those with 7 or 8 tips) enabled also to focus on the idea of extending the graph using the rule to identify new points.

4. References

Collins, A., Brown, J.S., & Newman, S.E. (1989). Cognitive Apprenticeship: Teaching the Crafts of Reading, Writing and Mathematics! In L.B. Resnick (Ed.), *Knowing, Learning, and Instruction: Essays in Honor of Robert Glaser* (pp. 453-494). Hillsdale, NJ: Lawrence Erlbaum Associates.

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Further information about the software IDM-TClass can be found on the webpage http://www.tecnilabedu.com/prodotto05EN.html