# FaSMEd

Raising Achievement through Formative Assessment in Science and Mathematics Education

# The Archaeologist Giancarlo – Part 4

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|---|---|
| **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 analyse a graph, with also the support of tables, to find out the relation that it represents, together with ist symbolic expression. |

## 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”, “The Archaeologist Giancarlo-part 2” and “The Archaeologist Giancarlo-part 3” 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 (part 1 and part 2) and interpreted a graph as another way of representing relations and a source of new information, students are now asked to analyse graph with the aim of determining a new relation that it represents. Moreover, they are asked to find out the symbolic representation of this relation. The focus is therefore on the capability of activating different conversions from the graphical to the verbal and, then, to the symbolic register (Duval, 2006).

# 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

In **Worksheet 6** the mediating figure of Martjin appears again to introduce a new graph that students are asked to interpret. In particular, they have to identify, looking at the graph, a relation between the numbers of tips and the heights of the new incisions constructed by Martjin and his classmates, together with its symbolic representation.

**"The archaeologist Giancarlo"**

**Martjin's classmates have drawn other incisions, constructing them referring to a different relation between the number of tips on the heads of the incisions and their heights. This is the graph they have constructed:**

1) **What is the relation between the numbers of tips and the heights of the incisions drawn by Martjin's classmates?**

2) **Represent the relation also through a symbolic expression to be sent to Martjin's classmates to show them what you have observed.**

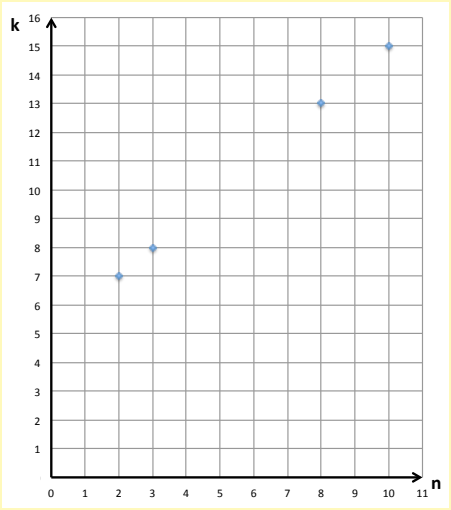


Fig. 1: Worksheet 6

*Worksheet 6* is aimed at consolidating the competencies in the interpretation of graphs developed during the previous activity. In particular, students have to analyse the graph with the aim of identifying the new relation between numbers of tips and corresponding heights, according to which Martjin and his classmates constructed new incisions. They are also asked, after having identified this relation, to construct its symbolic representation. This worksheet, therefore, is mainly aimed at making students activate conversions from the graphic to the verbal and, then, to the symbolic register (Duval, 2006).

**Worksheet 6A**, **6B** and **6C** are helping worksheets. The helps provided in these three worksheets are different (see next section), so the teacher has to decide what to send to students according to the level of difficulties they face in interpreting the graph.

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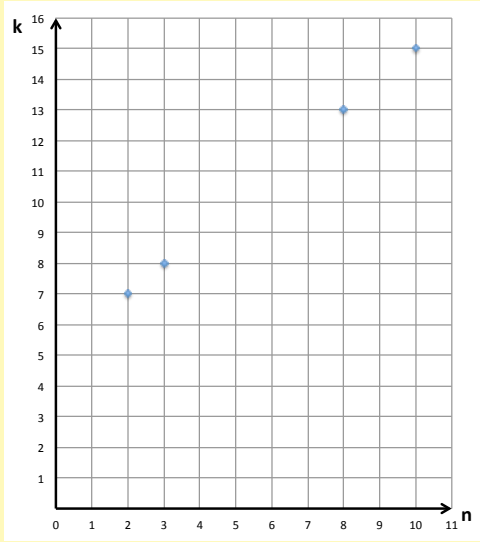


**HELP:**

Try to understand what kind of information is provided by the first point within the graph: What does 2 mean? What does 7 mean?

Find the information provided by the other points within the graph.
Use these information to identify a general rule that characterise the relation between the numbers of tips and the heights of the incisions.

Fig. 2: Worksheet 6A

*Worksheet 6A* is aimed at suggesting students to look at the graph, focusing on the information that each point provides, like when facing the activity "The Archaeologist Giancarlo – part 3". Specifically, the suggestion is to interpret the meaning of the coordinates of the first point in the graph, (2,7), and then to look at the other point within the graph to highlight the meaning of their coordinates.

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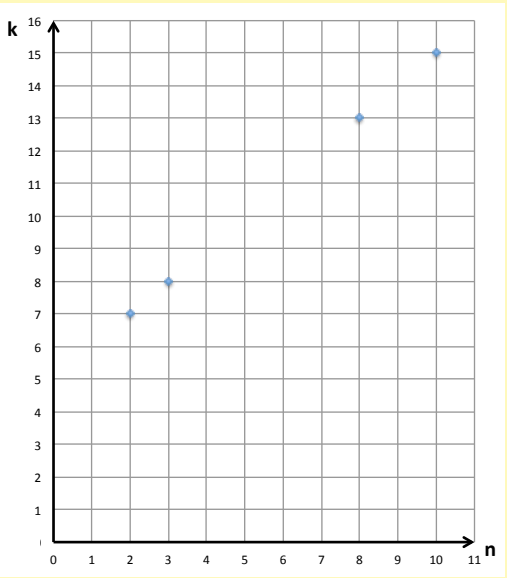


**HELP:**

Let's use the following table to collect all these information (complete it!):

n=2 k=7

n=3 k=

n= k=

n= k=

What is the relation between the number of tips on the head of one incision (n) and the height of the same incision (k)?

Fig. 3: Worksheet 6B

*Worksheet 6B* provides a further help, explicitly suggesting to construct a sort of table to collect all the information within the graph. Specifically, students are suggested to write down, on one column, the values of the variable n (that is the numbers of tips) and, on the other column, the values of the variable k (that is the corresponding heights). In this way, the table can support them in easily identifying the possible rule according to which the heights could be determined starting from the number of tips.

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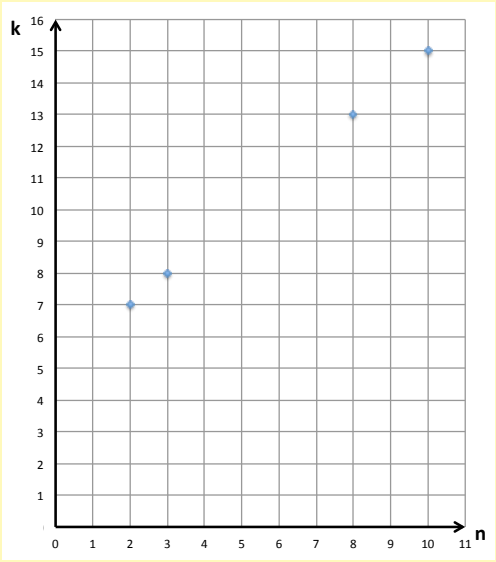


**HELP:**
We have collected the information provided by the graph, writing the values of k in order to highlight the relation between n and k.
Complete the following table:

| n | k |
|---|---|
| 2 | 7=5+2 |
| 3 | 8=5+3 |
| 8 | 13=5+… |
| 10 | 15=… |

What is the relation between the number of tips on the head of one incision (n) and the height of the same incision (k)?

Fig. 4: Worksheet 6C

*Worksheet 6C* is conceived to support those students that, even after having received worksheet 6B, are not able to identify the relation between the numbers of tips and the corresponding heights. Within the table completed previously, in the k-column, some values of k are written in order to make the relation between n and k explicit: 7=5+2, 8=5+3. Students are asked to complete the table and to look at it to find out the rule.

**Worksheets 6D a**nd **6E** are optional worksheets, aimed at prompting a specific discussion. They could be used in case, during the collective discussion on worksheet 6, the two possible relations (direct and inverse) between the numbers of tips and the corresponding height were not highlighted.

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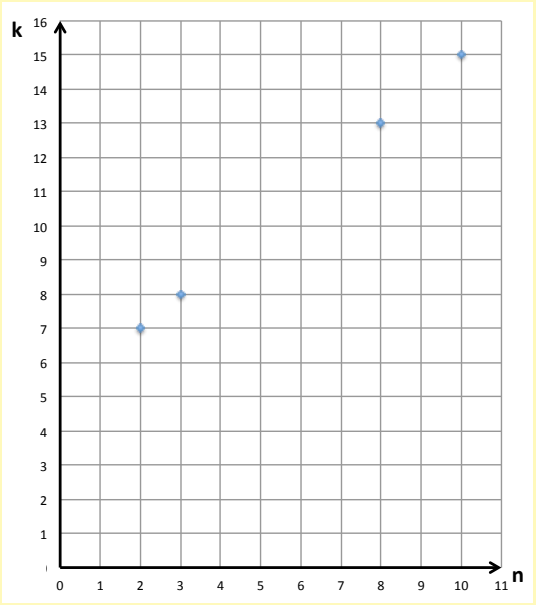


If I consider the height and I subtract 5 from it, I always find the number of tips.

I think that k could be always found if we consider n and then add 5 to it.

Two students from another class gave these answers. What do you think about these observations? Are they correct? Why?

Fig. 5: Worksheet 6D

*Worksheet 6D* is aimed at fostering a discussion on specific aspects, in case these aspects are not highlighted during the discussion on worksheet 6. It introduces two possible verbal representations of the relation between the number of tips and the corresponding heights, introducing both the additive relation (k can be found adding 5 to n) and its inverse (n can be found subtracting 5 to k).

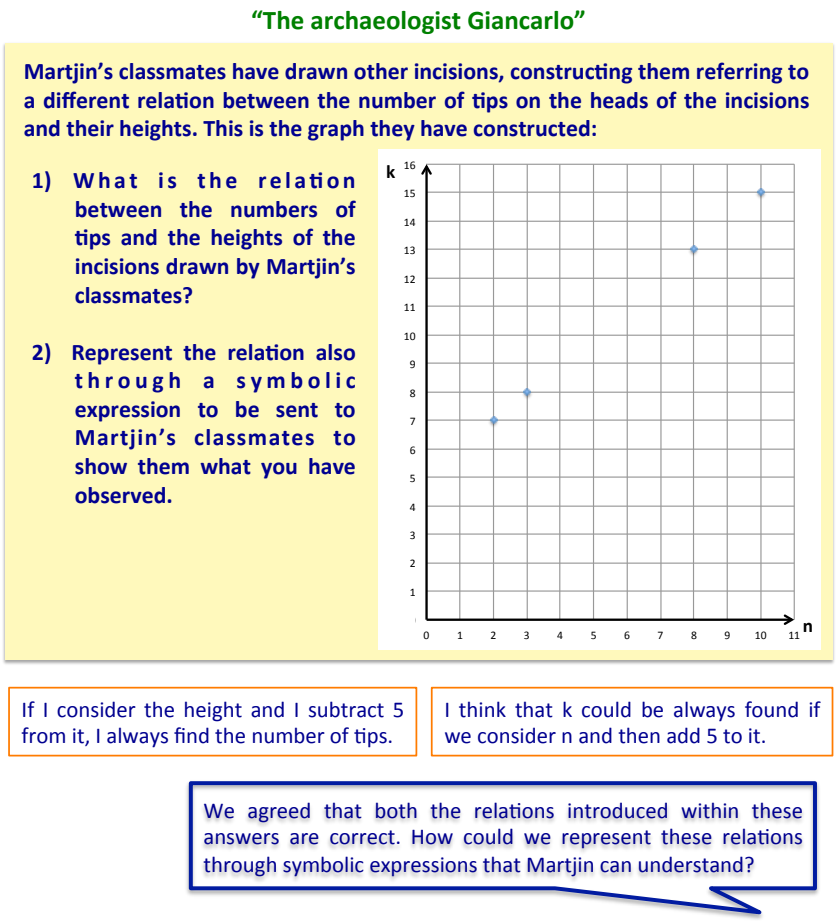


Fig. 6: Worksheet 6E

*Worksheet 6E* is conceived as a possible support during the discussion on worksheet 6D, in particular in guiding students to construct the possible symbolic expressions that represent the direct and the inverse relation on which worksheet 6D is focused.

## 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 6, 6A, 6B, 6C, 6D, 6E.

Usually the activity starts with a worksheet focused on one or more questions (in this case **worksheet 6**), 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 **6A**, **6B**, **6C** could be sent to support the students in focusing on the information provided by each point within the graph. The idea is to give to students who need help, according to the difficulties they face, worksheet **6A** or **6B**. Worksheet **6C** can be sent to those students for whom worksheets 6A and 6B are not effective.

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 6D** and **6E**, aimed at supporting the discussion on worksheet 6). 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 5E, to propose students to choose the correct symbolic representations of the relation between the variable n and k.

## 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 6**, for example, it is important to stress that the incisions constructed by Martjin and his classmates do not follow the same rule followed by the incisions discovered by Giancarlo and his team.

During our teaching experiments, some students faced difficulties in identifying the relation between the numbers of tips and the corresponding heights because they tried to refer to a multiplicative model, since the relation studied in the previous parts of the activity "The Archaeologist Giancarlo" involved a multiplication (the height can be obtained as the result of the multiplication between 7 and the number of tips). The fact that, in this case, the relation is additive (the height can be obtained adding 5 to the number of tips) caused blocks in some students, even when provided with helping **worksheet 6B**. Helping **worksheet 6C**, conceived for this reason, was very effective in supporting these students.

During the teaching experiments we carried out, we used worksheets 6D and 6E very few times because the discussion on worksheet 6 enabled also to focus on the inverse relation (n can be obtained subtracting 5 from k). Moreover, many students, thanks to the work developed during the activity "The Archaeologist Giancarlo-part 2", proposed directly symbolic representations of the relation, together with the verbal one.

## 4. References

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