FaSMEd

Raising Achievement through Formative Assessment in Science and Mathematics Education

Linear functions with tablets and formative assessment lessons

Subject:	Mathematics
Age of students:	14 - 15 years
Hardware:	Tablets and teacher PC (internet), IWB
Software:	NetSupport School (CCT), OneNote and Maple TA for tablets
Functionalities:	Sending & displaying, processing & analysing, providing an interactive environment
Time:	4 lessons of 1 hour
FaSMEd partner:	Ecole Normale Supérieure de Lyon
Short Abstract:	This sequence aims to approach the study of linear functions. Formative assessment data rely on a series of quizzes on the same fundamental competencies, on instant surveys and on the collection of students' work.

1. Content

This sequence of lessons is a first approach to the study of linear functions. The first lesson is about the definition of linear functions and the calculation of images and inverse images. The second lesson deals with graphical representation of linear functions, and particularly with the role of the parameters *a* and *b* of the equation $y = a\,x + b$. The third lesson studies how to graph linear functions, and how to deduce the algebraic equation of a linear function starting from its graph. The fourth lesson has the objective of evaluating students' achievement throughout all the sequence and going back on persistent difficulties.

2. Activity

2.1 Aims

The main objective of the sequence is building the notion of linear function and making the link with proportionality. The lessons aim at mastering the four following competencies:

- Calculating/detecting images;
- Calculating/detecting inverse images;
- Recognising a linear function;
- Shifting from the graphical frame to the algebraic frame and vice versa.

2.2 Structure / Methodology

First lesson

The teacher writes algebraic expressions on the IWB and, for each of them, he makes a survey via NetSupport School: "Is it a linear function, yes or no?". He comments on the students' responses, giving feedback, with an explanation when the answer is wrong and some additional information when needed. See the proposed equations, the survey results and teachers' comments in the IWB excerpt: "linear functions-lesson1-survey".

Afterwards, students are required to answer four questions (3 open; 1 true/false) on Maple T.A., in the form of an individual quiz, previously prepared by the teacher. Each question makes students work on a specific competence (see "linear functions-quiz prototype").

Finally, the teacher provides the correction of the four exercises on the IWB.

Second lesson

Students explore the role of the coefficient *a* and *b* in the expression $f(x) = ax+b$. The teacher orchestrates the students' work: they write their ideas on their own tablet, he makes some screenshots of their work and displays them on the IWB, amending their conjectures and adding information (Fig. 1).

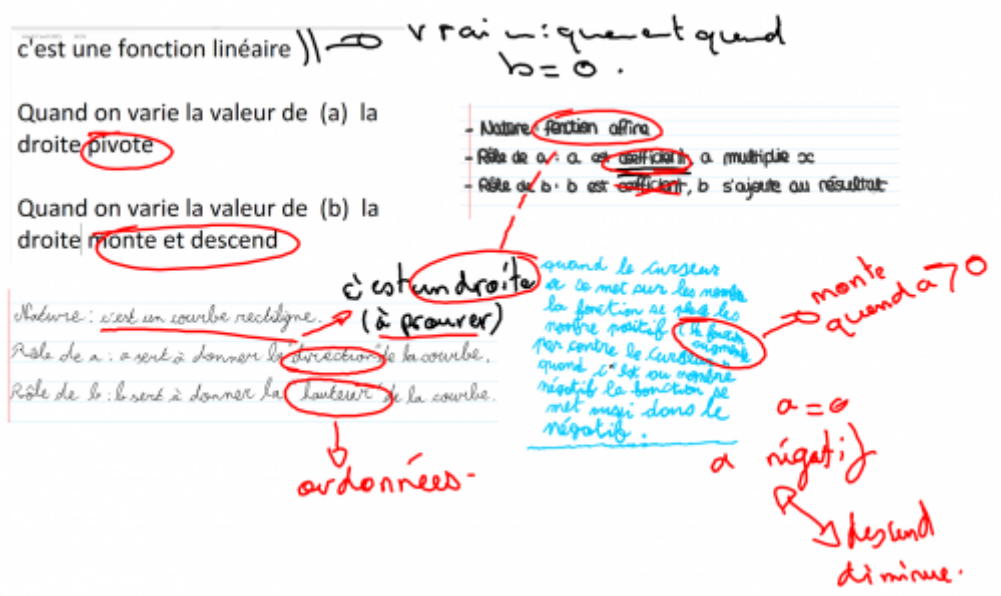


Fig. 1 Collection of students' proposals on the IWB with teacher's remarks

Students have to take a second quiz: the questions are of the same kind as the first quiz (see "linear functions-lesson1-quiz prototype"). The teacher gives a correction of the four questions on the IWB providing feedback to the whole class.

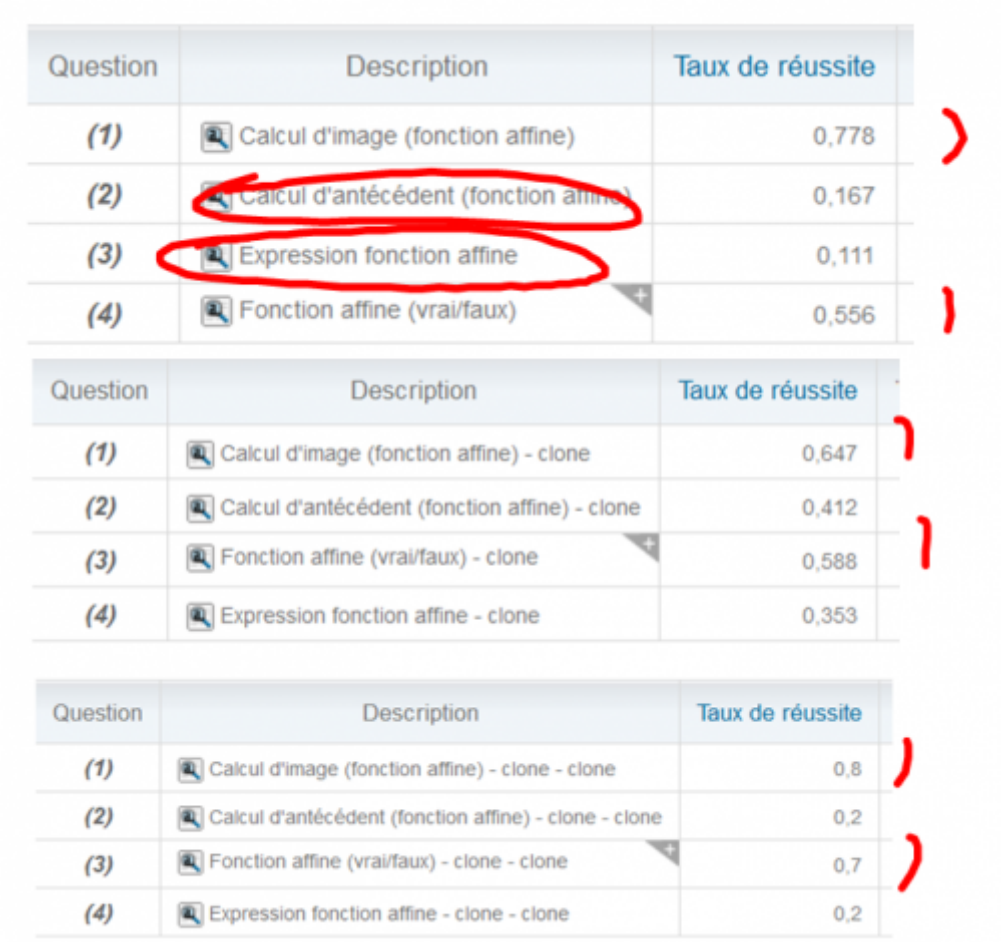
Third lesson

Students have to take a third quiz (see "linear functions-lesson1-quiz prototype"). Students individually correct exercises in the OneNote environment of their tablets. The teacher collects some students' work and gives the correction on the IWB integrating students' solutions (see "linear functions-lesson3-correction").

The following task is given to the students: constructing the graphical representation of the function $f(x) = 0{,}5x + 3$. Students work individually in the OneNote environment of their own tablets. The teacher selects and collects the work of a student for displaying it on the IWB, and uses it as the basis for the correction.

Fourth lesson

The teacher displays the students' results at the three quizzes taken during the previous lessons (Fig. 2).



Question	Description	Taux de réussite
(1)	Calcul d'image (fonction affine)	0,778
(2)	Calcul d'antécédent (fonction affine)	0,167
(3)	Expression fonction affine	0,111
(4)	Fonction affine (vrai/faux)	0,556

Question	Description	Taux de réussite
(1)	Calcul d'image (fonction affine) - clone	0,647
(2)	Calcul d'antécédent (fonction affine) - clone	0,412
(3)	Fonction affine (vrai/faux) - clone	0,588
(4)	Expression fonction affine - clone	0,353

Question	Description	Taux de réussite
(1)	Calcul d'image (fonction affine) - clone - clone	0,8
(2)	Calcul d'antécédent (fonction affine) - clone - clone	0,2
(3)	Fonction affine (vrai/faux) - clone - clone	0,7
(4)	Expression fonction affine - clone - clone	0,2

Fig. 2 Students' results at the three quizzes: quiz1(top) - quiz2(middle) - quiz3(bottom)

The teacher discusses the results and the class' progression in some competencies, and detects those to be addressed again. Since he has already made this analysis before the lesson, he has prepared a fourth quiz with only two questions involving the two competencies that need more work. Thus, he proposes the quiz to students on Maple TA.

Finally, he shows in real-time the class' results at the last quiz and comments them.

2.3 Technology

These lessons have been implemented in a "tablet-classroom", that is to say a classroom in which each student has his/her own tablet and all tablets are part of a network. Moreover, each student can access the platform Maple TA (individual testing system) on his/her tablet. Every lesson, students have to answer individually to the proposed questions on Maple TA. After having submitted all the answers, each student can read on his tablet his/her percentage of success and has access to solutions: the system highlights his/her right or wrong answers, interacting with the students (the functionality of providing an interactive environment is exploited). The teacher's correction on the IWB complete Maple TA's feedback. Such a correction often integrates students' work in OneNote: the teacher exploits the functionalities of the tablets network, provided by NetSupport School, of sending and displaying information. The software NetSupport School is used in this sequence as the main connected classroom technology for classroom instruction, orchestration, monitoring and management. It plays a relevant role in the way the teacher orchestrates the classroom activity and guides the lesson. NetSupport School allows him to collect in real-time the

students' work and to send quick surveys to students, in order to immediately display results that can support and foster discussion in the classroom. The functionalities of the IWB allow the teacher to process the collected data by commenting and correcting students' proposals, which are thus integrated in the corpus of the lesson notes.

2.4 Aspects of Formative Assessment

Establishing where the learners are in their learning

In the different phases of the lesson, the teacher pays a great attention to the level of understanding of students and the surveys gives him such information. Drawing on the survey results, the teacher engineers effective classroom discussions and other learning tasks that elicit evidence of student understanding. At the same time, teachers' correction gives to students the possibility to position themselves with respect to the class' level and to become owners of their own learning. These FA strategies are implemented also through different tasks that the students have to solve individually in the OneNote environment of their tablets, so that the teacher can collect and share their work with the class. Discussing the proposals of one (or several) student(s) with the class by displaying them on the IWB is a FA strategy that aims to engage all students as the owners of their learning but also to encourage each student to be a resource for others.

Establishing where learners are going and what needs to be done to get them there

Maple TA's feedback, augmented by the teacher's correction on the IWB, provided a complete feedback to students. When the teacher displays the students' results to the quizzes, he comments on the class' progression but also clarifies and shares the learning objectives with the students. This analysis leads him to select and engineer particular tasks for moving students forward with respect to specific competencies, and to justify his choice drawing on students' progression.

3. Further Information

After the experiment with Maple TA, the teacher declares:

"*The correlation between students' engagement and their acquisition of technical competencies is evident. I identify a great qualitative improving in terms of both classroom management and students' learning. The level of achievement of their competencies has considerably improved and they make progress with pleasure*."

4. References

Panero, M. & Aldon, G. (2016). How teachers evolve their formative assessment practice when digital tools are involved in the classroom. *Digital Experience in Mathematics Education, 2*(1), 70-86. DOI : 10.1007/s40751-016-0012-x.

NetSupport School: http://www.netsupportschool.com/

Maple T.A.: http://www.maplesoft.com/products/mapleta/

For further information on this sequence (in French):

https://ife.ens-lyon.fr/fasmed/spip.php?rubrique18