

# Can Formative Assessment Practices Appear Spontaneously during Long Distance Learning?

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**Abstract:** Within the context of Long-Distance Learning (LDL) during the first Italian lockdown due to Covid-19 pandemic, our eye as researchers in mathematics education looks at the modification of student-teacher interactions regarding the exchange of feedback. We claim that digital-technology based environment fostered the spontaneous emergence of teaching and learning practices that can be associated with formative assessment. Through the analysis of answers to a questionnaire and the observation of a class during LDL we outline the relation between the theoretical construct of formative assessment and observed practices. This analysis allows to highlight what factors of digital-technology based environment shape class interaction and what directions can be taken to exploit the potential of digital technologies in teaching and learning context, in particular within mathematics education field.

## 1 INTRODUCTION

Starting from February 2020 Italy has been overwhelmed by the Covid-19 pandemic. This resulted in a strong national lockdown that lasted until June 2020. To maintain the educational relationship teachers and students have adapted their practices to long-distance learning (LDL): this adaptation process was not neutral nor painless and has brought to a deep change in teachers-students interaction modalities. LDL allowed the emergence of many relevant spontaneous phenomena. Within this context, our eye as researchers in mathematics education look at the modification of student-teacher interactions regarding the exchange of feedback: on the one hand, feedback from the teacher on student's work, on the other hand, feedback for the teacher on what the student has understood, or on the acquired skills. We focus on the modification of these exchanges and their reason, which we identify as the use of certain digital technologies to mediate student/teacher communication. We can conceive this change as an emerging phenomenon characterized by an enormous density of didactical information. In this position paper, we claim that such emerging phenomenon, often perceived by teachers as overwhelming, can be

shaped using the theoretical construct of Formative Assessment (FA). We also believe that the FA construct can not only be a lens but also a tool for managing such a phenomenon. In order to support our claim, we propose to think about it as an example of an *eye of a theoretician* in Radford's (2010, p.4) sense:

*Mathematicians' eyes have been culturally educated to organize the perception of things in particular rational ways [...] The domestication of the eye is a lengthy process in the course of which we come to see and recognize things according to "efficient" cultural means. It is the process that converts the eye (and other human senses) into a sophisticated intellectual organ – a "theoretician".*

According to his perspective, in this work, the observer, or the *eye*, is the researcher in mathematics education who knows the FA construct, the observed phenomenon (thus, the *perceived thing*) is the spontaneous didactical practice during pandemic induced LDL, and the *theoretical* lens that domesticates the eye is FA. Not all the involved teachers were aware of the construct of FA, anyway, as we are going to show, some widespread spontaneous practices in managing the huge amount of "didactical data" during LDL can be linked to some theoretical features of FA.

The paper is organised as follows: in Section 2 we introduce the construct of FA and we specify how we use it in our analysis, then in Section 3 we specify our claim in the light of the theoretical framework. In Section 4 we present some data, in Section 5 we clarify our approach to these data then in Section 6 we analyse them in order to support our claim. In the last Section 7 we outline how and why this work can be valuable both for teachers and researchers to analyse and exploit the experience of LDL.

## 2 THEORETICAL FRAMEWORK

Our reflections embrace the idea of promoting the use of FA as a tool for improving the mathematics teaching-learning process. To frame our observation, we refer to the theoretical framework of LLP-Comenius Project FAMT&L – Formative Assessment for Mathematics Teaching and Learning (Bolondiet al., 2016). One of the main objectives of the FAMT&L project was to improve the skills of mathematics teachers in the use of FA as a tool for methodological quality in mathematics teaching (Ferretti, Michael-Chrysanthou, & Vannini, 2018; Gagatsis et al., 2019) and one of the outcomes of the project was the following definition of FA in mathematics (Ferretti et al., 2018, p.33):

*The FA is connected with a concept of learning according to which all students are able to acquire, at an adequate level, the basic skills of a discipline. The learning passes through the use of teaching methodologies which can respond effectively to different learning time for each student, their different learning styles, their zones of proximal development.*

*The FA is an assessment FOR teaching and learning.*

In line with the FAMT&L framework (Ferretti et al., 2018), we embrace the idea that the FA: i) is part of the teaching-learning process and regulates it; ii) identifies, in an analytical way, the strengths and weaknesses of student's learning, in order to allow teachers to reflect on and may modify their own practices; iii) allows in a form of formative feedback to establish a dialogue between teacher and student and to design educational interventions aimed to the recovery; iv) promote and foster the learning of all students through differentiated teaching that ensures each student different rhythms and different teaching and learning strategies; v) involves the student in the

analysis of own errors/weaknesses and own ability to promote self- and peer-assessment and active participation in the teaching-learning process. In particular, our approach of FA is in line with the definition given by Leahy, Lyon, Thompson, & Wiliam (2005) and Black & Wiliam (2009), where FA criteria and strategies are also highlighted:

S1. Clarifying and sharing learning intentions and criteria for success.

S2. Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding.

S3. Providing feedback that moves learners forward.

S4. Activating students as instructional resources for one another.

S5. Activating students as the owners of their own learning.

In the following, we simply refer to these as *five FA strategies* or as S1, S2, S3, S4, S5. Starting from these strategies, within the FAMT&L project, the structured FAMT&L Grid, a specific video analysis tool was designed, built and used.

The FAMT&L Grid was developed starting from the international debate on FA, and it is composed of several indicators. For our work, we considered a subset of 72 indicators, chosen in agreement with two of the authors of the grid as the more suitable, to detect FA within the LDL context. Moreover, we decided to categorize these indicators according to S1, S2, S3, S4, S5. The result of this work is a table, which we make available in an external online document<sup>1</sup>. The table has taken the role of a *theoretical tool* of analysis, and it enabled us to highlight what aspects of the lesson could be linked to specific features of the construct of FA, and to better understand how some phenomenon, typical of the digital environment, could be related to strategies of FA.

## 3 CLAIM

In line with the eye of a theoretician perspective (Radford, 2010), the theoretical framework allows us to redefine the initial claim as it follows: a researcher in mathematics education, observing some spontaneous practices in LDL, if carried out with appropriate platforms, can recognise features that create a fertile ground for FA. Especially, we argue that teaching and learning practices conducted in some digital-technology based environment have

<sup>1</sup>[https://docs.google.com/document/d/1gilm-hSpV7t10iNRX1FsyApzZaB6376qSy\\_ywt3jktU/edit?usp=sharing](https://docs.google.com/document/d/1gilm-hSpV7t10iNRX1FsyApzZaB6376qSy_ywt3jktU/edit?usp=sharing)

characteristics that can be associated with at least three out of five FA strategies, in particular:

1. Immediacy and automaticity of storage and collection of documentation, which allows monitoring over time of the students' path, related to S1 and S2.
2. Individualisation of didactics: the increased documentation about the student's work allows the teacher to give more individualised feedback and to enhance more individualised strategies, related to S3.

## 4 DATA

The data we consider for this work are part of a research on LDL teaching and learning practices in Italian schools of different order and grade during the lockdown. In this context, our focus is on some questions of a questionnaire administered to teachers and on ethnographic observation of teaching-learning practices in a grade 12 class, both conducted during the first Italian lockdown. We highlight that this is not a data collection specifically designed to support our hypothesis but, rather, it is the sharing of some of the evidence in favour of the thesis that we wish to introduce here.

### 4.1 Questionnaire

The questionnaire has been administered during the month of April 2020 in order to gain information on a fluid process started a month earlier and that was settling itself day by day. The questionnaire contains 32 questions, both open-ended and multiple-choice ones, organized in five sections according to the aim. For a detailed description of the entire questionnaire, we refer the reader to Del Zozzo, Garzetti, & Santi (2020).

We selected a convenience sample: the need to reach teachers during a fixed period has guided the selection, we spread the questionnaire through mailing lists of teachers that collaborate with us in other projects, asking, when possible, to share it with others. Overall, from secondary school teachers, we obtained 99 answers. In this study we consider only the following three questions in order to give a broader picture in relation to the phenomenon we are discussing.

- One item of a question where teachers are asked to express their agreement/disagreement with different items: *I can give feedback to each student for every task she sends me, and it seems to me that some students are improving.*
- Two subsequent questions where teachers are asked to rank the differences in feedback restitution between LDL and physical classroom and to explain the reason of the difference.

These data allowed us both to notice that practices that could be related to FA were emerging among teachers, and to shape the classroom observation. We found consistency between teachers' word in the questionnaire and observed teachers' practices.

### 4.2 Classroom Observation

From 11<sup>th</sup> of May until the end of classes (between 5<sup>th</sup> and 10<sup>th</sup> of June), we had the opportunity to conduct ethnographic observation in several classes of different school grades during LDL.

In this paper, we refer to one of the observed classes: a grade 12 class of a Technical Institute enrolled in the G Suite for Education<sup>2</sup> (GSE). It appears important to highlight how the analysed didactical practices did not consist in a controlled and planned intervention organised by the researchers, and thus the involved teachers were not aware of FA construct. Here, we do not go into the methodological details of this observation, for which we refer to Ferretti, Del Zozzo & Santi (2020). Nevertheless, it is important to remark that, as far as classroom practice in the context of LDL is concerned, each virtual classroom is dichotomous, and it has two components: one synchronous and one asynchronous. When our observation began, we were provided with a link to access the synchronous component - implemented with Google Meet<sup>3</sup> (GM) - and access to the asynchronous component - implemented with Google Classroom<sup>4</sup> (GC). In particular, regarding GC, two of us were added to the class in the platform with the role of additional teachers. This choice allowed us to access the entire archive of materials and all the message exchanges (both public, with the whole class, and private between the teacher and each student) that had taken place since the beginning of the creation of this class in GC, the 27<sup>th</sup> of February. Thus, our observation was conducted as follows. Regarding classroom dynamics in the synchronous component, it was indirect (since we only know what is reported

<sup>2</sup> <https://edu.google.com/products/gsuite-for-education/> GSE is now called Google Workspace for Education.

<sup>3</sup> <https://support.google.com/meet/?hl=en#topic=7306097>

<sup>4</sup> <https://support.google.com/edu/classroom/?hl=en#topic=10298088>

or described in GC) for what happened between 27<sup>th</sup> of February and 9<sup>th</sup> of May, direct from 11<sup>th</sup> of May until the end of the school year, on 5<sup>th</sup> of June. Regarding the classroom dynamics in the asynchronous component, we had the opportunity to analyse the entire teaching flow from the first day of class creation in GC (27<sup>th</sup> of February) to the last day of interaction between teachers and students in the platform (12<sup>th</sup> of July).

For clarity, in GC there are different areas of work and interaction with different functionalities and permissions for action and access among teacher and students; the main areas we considered are the *Stream* page, the *Classwork* page, and the *Assignment* space. In the following, using "episode" we mean what happens in the virtual classroom, in both its synchronous and asynchronous components, in a fixed time starting with a teacher's assignment on a certain set of exercises or tasks, and ending with the assignment of a new task on a different set of exercises. With respect to the aim of the present work, we focus on the following three episodes, that we consider as paradigmatic of the teaching and learning practices we observed: episode 1 between 17<sup>th</sup> and 20<sup>th</sup> of March, episode 2 between 24<sup>th</sup> and 30<sup>th</sup> of March, and episode 3 on the 18<sup>th</sup> of May.

**Episode 1: First Assignments on GC.** During episode 1, only asynchronous exchanges on the GC platform are considered. On 17<sup>th</sup> of March, a task is assigned to be completed by March 20<sup>th</sup>, and in this time frame, we consider the interactions between T and students that occurred in the various spaces of the platform. In the following, the unfolding of episode 1 is presented, with the aim of showing how the different spaces interact with each other during the different activities. In the descriptions of the remaining episodes, we do not repeat this pattern and only highlight the changes in the structuring of the activities involved. T indicates the mathematics teacher, and the class was composed of 29 students.

*17<sup>th</sup> of March.* In GM: 2-hour synchronous lesson. In GC: on the instruction page a homework assignment (exercises from the textbook) is published with deadline 20<sup>th</sup> of March; in the Stream, it appears the notification of the assignment with the link to access it.

*18<sup>th</sup> and 19<sup>th</sup> of March.* In GC: one student communicates in her workspace that she has not the textbook. Consequently, in the instruction page T modifies the assignment by adding the scanning of the pages of the book in which the exercises are presented. Also, public exchanges between students and T appear in this space. Contextually, in other students' workspaces, we see private exchanges

between students and T about the assignment and we also see that 24 out of 29 turn in their homework by sending photos of their notebooks.

*20<sup>th</sup> of March.* In the Stream of GC, a reminder of the meeting on GM is posted with the related topic: homework correction. Then, in GM: 1-hour synchronous lesson is conducted in which the exercises are corrected. After the lesson, in GC, in students' workspaces, there are requests for feedback on the correction carried out synchronously during the meeting. In particular, one student sent her own, report of correctly completed exercises and of errors, and uploaded photos of her corrected work with corrections marked in red. We see that this practice becomes a routine for the whole classroom from episode 2.

**Episode 2: The Institutionalisation of Self-correction.** Episode 2 opened with an assignment on GC, like episode 1. The difference with episode 1 is the institutionalisation of a process of correction of the assignment which will be maintained until mid-May: the teacher asked for the assignment to be handed in on 27<sup>th</sup> of March and on that date, she published videos with the correction of the exercises. She then assigned as a task on GC the correction of the exercises already done, asking the students to do it on the text of the exercises already done in a different colour than the one used previously. Throughout the process, there are synchronous lessons and many asynchronous exchanges between T and individual students.

**Episode 3: Peer Assessment on GM.** Episode 3 occurred in GM: for the entire duration of the episode, the teacher shared the screen. It is a planned assessment session involving four students. The session consisted of three phases. In the first phase, the teacher asked them to carry out a function study in a document shared with and editable by the whole class: each of the 4 involved students carried out a part of the exercise and corrected the work of the previous students. In the second phase, the teacher asked the whole class to draw the graph of a function given certain characteristics, and then she shared and analysed the answers of the four involved students. In the third phase, it took place the correction of one of the exercises assigned to the whole class and conceived as preparation for the assessment period. The correction discussion involved all four students and was triggered by the solved exercise of one of them.

So far, we described the data, without making explicit our intentionality as researchers in mathematics education. Now we try to systematize our process in support of our claim referring to Radford's work.

## 5 OUR APPROACH

Using the metaphor of the eye of the theoretician (Radford, 2010), quoted in Section 1, we recall the structure of our work as it has been conducted and will be presented in the first analysis. We emphasize that a crucial point is the objectification process (Radford, 2008) in which the students encounter the object of knowledge. In our case the object is FA, the theoretical eye is our eyes as researchers, and the students are the teachers involved in the project.

Table 1: Parallelism with Radford's quote (p.4), continuing from section 1.

Radford's quote	In our context
[...] The domestication of the eye is a lengthy process in the course of which <b>we come to see and recognize things according to "efficient" cultural means.</b> [...]	In the observed practices, the researchers recognized features that are consistent with the FA construct.
I am not saying that the students did not see two rows. They surely did. But <b>they did not deem it important to recognize</b> the figures as being divided into two rows.	The teachers who do not intentionally perform FA, but the researcher links teachers' practices to a construct she is aware of, the construct of FA.
the capacity to intuit and attend to them in certain manners rather than others, belongs to those <b>sensibilities that students develop as they engage in processes of objectification.</b> "	Teachers can develop their sensibility as they engage in a process of objectification of FA.

Section 4 outlines the data collected, now we need to start the process of justification described in the last two rows of Table 1: in this respect we introduce the analysis of the data and the first results obtained both from the questionnaire and from the observation.

## 6 ANALYSIS

### 6.1 Analysis of the Questionnaire

**Working Methodology.** Our starting point has been the answers to the questions in which teachers highlighted how their way of giving feedback to students was changed. Looking at the answers we could find a relation between the tools used for LDL and the changes, but we could also find some examples of the changes. More precisely, we selected the ones where we found coherence between the

content of the answer and at least one of the five strategies of FA.

**Analysis Outcome.** Most teachers declared changes in the way they were giving feedback (79%) to students, and almost 60% of the involved teachers agreed with the claim *I can give feedback to each student for every task she sends me, and it seems to me that some students are improving.*

This phenomenon found a first explanation in the open answers to question Q24: How did it change [in the way you give feedback]? In the answers, 41 out of 99 of the teachers referred to individualization of feedbacks and to an increased possibility to check on students' work giving personalized corrections. The results show a strong presence of the strategies S2 and S3. Indeed, globally, watching at the 41 selected answers we see that at least one between S2 or S3 is present. As some of the teachers affirm, this can be a direct consequence of the technological environment involved in LDL, which structurally leads to the dematerialization of didactical materials, including students' work. Indeed, there are at least two important common features of such technological environment: one is the automatic storage of the huge amount of data exchanged by participants and the other is the ease of access to these data. We see in this sense a parallelism with Goody's observation (1977, p. 37) regarding the invention of writing and printing:

*It changed the nature of communication beyond face-to-face contact as well as the system for the storage of information. [...] No longer did the problem of memory storage dominate man's intellectual life; the human mind was freed to study static "text" (rather than be limited by participation in the dynamic "utterance").*

The questionnaire provides an overview of an emerging phenomenon, that we, as researchers in mathematics education, associate with FA: this does not mean that *it is* FA, but that *it shares some characteristics of FA*, related to S2 and S3.

### 6.2 Analysis of Classroom Observation

**Working Methodology.** Starting from our theoretical framework we tried to define an observation tool grounded in the definition of FA given by the literature that could detect the specific practices observed during LDL. In order to do so, we first needed to redefine some of the usual classroom practices in the new environment. The definitions we present here clarify the effect of some of the structural features of the classroom in a virtual environment during the lockdown, that is, the structure given by the mediation of digital technologies that allows

maintaining the educational relationship between students and teachers in that context.

The result of our work is in the following: we indicate the aim of an action in the classroom, then we show the instantiation of that action in LDL classroom with GSE tools in comparison to the classroom in the school building.

*Action:* Positioning in the classroom.

*School Building:* Desk/teacher desk, objects used, body/physical presence, etc.

*Virtual Classroom:* It is multiple: on one side the physical workstation with objects used (pen, notebook, hardware...), on the other the software used, and the different accounts, etc.

*Action:* Communicative interaction in the classroom.

*School Building:* written and oral communication, deictic language, gestures, etc. Oral interactions are mostly public, and the exchanges can have different objectives (explanation, evaluation, feedback, affective-relational), etc.

*Virtual Classroom:* written and oral communication, via mail, private messages, public messages, videoconferencing; content exchange in class subgroups or pairs. In the case of the asynchronous component in GC, any activity assignment that the teacher makes to the whole class (or to a group of students) also implies that this activity is sent to each student in the class (or belonging to the group). The need to mediate communicative intentions and deictic language by using "additional" devices (e.g., indicating becomes moving the mouse in a screen that is situation visible to the other), etc.

*Action:* observing student's work.

*School Building:* rotating between desks; calling to the teacher's desk, etc.

*Virtual Classroom:* flexible mode depending on the software used: grid view on GM, scrolling through delivered tasks on GC, use of collaborative documents and/or applications that allow you to see the work being done, asking for screen sharing, etc.

*Action:* to collect/send materials.

*School Building:* delivery on paper, writing on the blackboard (or teacher's PC screen projection), use of textbook and other resources, use of electronic register, etc.

*Virtual Classroom:* sending photos of paper materials, using shared collaborative documents, sharing web resources via links (i.e., text string

sharing, indeed, each web resource associated with a link), etc.

As a second step, we analysed the three episodes using the chosen FAMT&L indicators categorised according to the five FA strategies, as we describe in the theoretical framework (Section 2). It is worth mentioning that the FAMT&L table was created for the analysis of video recordings of lessons in the physical classroom. Nevertheless, we assume that it is legitimate to use it to analyse the unfolding of a possible lesson on LDL in a non-experimental environment for which we have documentation. Each of the three selected episodes in the classroom was analysed individually by two researchers: the aim was to find out which practices were implemented according to the ones in the table. After the individual selection the inter-rater reliability was calculated through Cohen's K (Landis & Koch, 1977) obtaining good concordance for all the three episodes (respectively 0,69, 0,63 and 0,69 for episode 1,2 and 3). The union of the indicators selected by each researcher has been chosen as the final option after a discussion about the indicators on which the researchers initially disagreed. We provide the reader with the three coding tables of episode 1,2 and 3 in an external online document<sup>5</sup>; the analysis which follows refers to such tables. In the external document also examples taken from each episode are given.

**Analysis Outcome.** We observe that out of 72 considered indicators, 38 are detected in episode 1, taking place mid-March, 49 are detected in episode 2, taking place at the end of March, and 53 in episode 3, which takes place the 18th of May. Moreover, we also see a distribution of the detected indicators along the five FA strategies. This makes our assumption well-founded: we can affirm that FA can be used as a lens to look at some of the emerging phenomena in LDL, when implemented with the described tools. In particular, looking at the 30 indicators present in all the three episodes, we find that 9 of them can be considered a consequence of the use of a specific LDL environment, in this case some tools of the GSE. We comment on them briefly.

*1.T fixes with the students the date for the assessment.*

*13.T distributes the text of the test/task.*

When considering the platform GC, together with any assignment, not only the assignment is sent to the students, but also notifications and reminder related to the task. Moreover, once an action is done in the

<sup>5</sup> <https://docs.google.com/document/d/1l2Yu5Lth6QAmB MHdJxxmU1XyOfGJ1BeXlQp0nSmU6MA/edit?usp=sharing>

platform, every person that is part of that GC class and has the right to see that action can immediately access to and interact with it.

26. *T asks questions to the whole class.*

27. *T asks questions to a single student.*

These two indicators can be stackable on some occasion on GC: for example, when an assignment is sent to the whole class, each student receives it individually and has at his disposal a private space of interaction with the teacher.

36. *T uses a structured tool of observation.*

37. *T takes some record of the behaviour of one/all student/s.*

38. *T takes some record about how much the students have achieved to handle the content of the test/task.*

39. *T takes records from her/his desk.*

40. *T takes records passing among the students.*

These five are related to the structure of the technological environment which leads to the dematerialization of didactical materials, including students' work, and their automatic archiving for its own design, as affirmed also by some of the teachers involved in the questionnaire.

We affirm that these 9 indicators, which we have seen as being structural to some tools used for LDL, are sufficient to create a fruitful ground for FA practices. Actual practices of FA then obviously depend on the teacher's intentions.

Considering the observed teacher T, she managed all the information granted by the environment she was in, in specific ways during LDL, and especially along the three analysed episodes. Observing her actions with our theoretical tool, we noticed that among the other indicators that were presented in all the three episodes, 11 could be related to the 9 previously listed: they effectively represented her specific way to manage the information she was getting from students through the media used. Thus, the spontaneous emerging of FA practices can be related to this managing of the structural characteristics of the considered LDL environment: we can say that at least the following 11 indicators make the teacher's practices in LDL readable as effective FA practices:

4. *T asks some questions to the students to verify if the students understood the aims of the assessment.*

8. *T asks some questions to the students to verify that the students understood the test/task instructions.*

20. *T provides advices or suggestion during the test/task.*

22. *T gives enough time so that every student can work through the test/task (without anxiety).*

30. *T asks a new question based on a wrong answer to the previous one.*

31. *T asks a new question based on the previous one.*

42. *T illustrates the results of the test/task to the whole class.*

45. *T gives back the results in a short time.*

46. *T describes the mistakes as an occasion to learn.*

68. *T analyses the data she/he collected in the classroom.*

70. *T writes the profiles with respect to knowledge.*

We care to mention one last practice that was implemented by T during episode three. In two different moments T, who has at her disposal the solution of the same task as made by the student, decides to communicate with one student upon her answer using the answers of other students producing a sort of dialogue between answers. This dialogue involves T, the students, and their written productions: it elicits evidence of student understanding (S2) and it activates students as instructional resources for one another (S4), and for this reason can be considered a practice of FA. However, it cannot be easily tracked by FAMT&L's indicators because, as far as we noticed, it is strictly linked to the structure of a digital technology-based environment and especially storage and ease access we mentioned in Section 6.1.

Recalling our claim, we argue that teaching and learning practices conducted in digital-technology based environment have characteristics that can be associated with at least three out of five FA strategies and can therefore be a starting point to enhance practices of FA. Thanks to classroom observation we were able to better understand the emergent phenomenon, dividing what is structural to the used tools, and what is specific to the teacher's actions and choices. More precisely, we structured our perception of observed classroom dynamics during the lockdown with the lenses of FA, and with the five FA strategies and the selection of indicators we described in the theoretical framework (Section 2).

Summarising, we noticed that there are 9 out of 72 FAMT&L indicators of FA whose existence is a consequence of the digital tool used for the teaching environment (e.g., GC). These 9 indicators are associated with the strategies S1 and S2 regarding the possibility to elicit evidence of student understanding and the clarification of learning intentions and criteria for success. Observing T's agency and its unfolding under the lens of FA and our theoretical tool, we were able to see that a specific managing of the effect of the 9 indicators leads to practices readable as effective FA practices according to our construct.

## 7 CONCLUSIONS

Digital technologies have allowed the realization of LDL during the first Italian lockdown, resulting in a massive use of such technologies for almost the entire school population over three months. On the one hand, the possibility of collecting and sharing information in an efficient way is a known effect of digital technologies. On the other hand, during the first lockdown in our country, the widespread use of digital technologies has become constitutive of any didactical practices, generating a huge amount of data at the disposal of students and teachers. Despite the undeniable difficulties encountered, this period will result in a wealth of experience on which teachers and students can decide to work, making the most of it. Within this work, we tried to shape this wealth of experience using the construct of FA, that guides our eye as researcher in mathematics education and limits the multiple phenomena we observed during LDL. More precisely, we structured a theoretical tool based on FA theoretical framework in order to link FA indicators to spontaneous teachers' and students' actions and behaviours we observed. We found that the listed above 9 out of 72 indicators can be ensured simply by being in a digital-technology based environment and they are responsible for the huge amount of didactical data that can be managed. Nevertheless, not every teacher takes advantage of this possibility in the same way, some of them feel overwhelmed by all the received information. One way to manage the increased workload could be the intentional use of FA construct in its entirety, and FA practices. For example, the use of S4 and S5 would allow the teacher to redistribute workload between her and the students. We could say that is the management of the effect of the 9 indicators that led to the emerging of practices that could be associated with the FA construct. We have evidence of at least one teacher whose spontaneous didactical agency can be described using more than half of the FA indicators, widespread along with the five FA strategies and we believe that other teachers can take advantage from this work. Indeed, every teacher that implemented asynchronous practices, or that recorded her synchronous lessons during LDL, has at her disposal a huge amount of data of the same kind we analysed about her didactical practices, and can eventually analyse them herself. Moreover, professional development on FA from now on could work not only on shared experiences and individual practices, but also in the direction of a decreasing of the workload thanks to intentional use of FA from the teachers' side. As we show in the analysis of classroom observation,

some peculiarities of such environment impact the deepest feature of human interaction, for instance, we can refer to the storage and access to data introduced in section 6. Thus, another direction seems to be of high relevance within the context of digital-technology based environment: the study of the specific instantiations of known theoretical constructs of mathematics education.

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