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ORIGINAL ARTICLE

The TRiTS model: teacher roles in introducing digital technology into a school curriculum

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Abstract The wide use of digital technology for educational purposes opens up some issues regarding its integration within the school curriculum. Our research aims to contribute to the current discussion about how mobile/portable technology can be integrated into formal education. In this perspective, we consider digital technology and media as a potential integral part of school activity that could effectively support educational achievement. However, the way in which it is applied by teachers in a real context can substantially change its impact on effective achievements. In our research, we extensively investigated the role of the teacher in using digital technology for stimulating and prompting classroom activities in class in-line with the school curriculum. In this paper, we first present a model that illustrates the roles of teachers in transforming digital technology as a resource for developing skills as required in educational curricula. The teacher role in introducing technology at school—TRiTS—model has been conceived by combining relevant literature and findings from a case study that we have been running in a primary school over the last 4 years. We then discuss the influence of the different teacher roles on students (their attitude and level of participation), as emerged from our study.

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1 Introduction

School investments in technology have increased dramatically over the last decade. Nonetheless, there is still little understanding regarding how such systems can be designed in order to be integrated into the existing curriculum. What is clear is that school districts introduce digital artifacts in order to improve teaching and learning practices for achieving the educational goals.

Our research purpose is to investigate the way technology can be designed and introduced within the school curriculum, examining the school as a complex ecology made of a variety of actors. Indeed, digital technology can facilitate and support interactions within the school community and between people and resources, e.g., teacher–student, student–student, teacher–teacher, students–resources and teacher–resources. In particular, teachers play a crucial role in effectively introducing digital artifacts into school as worthwhile instruments and resources. It is up to teachers to adapt the official institutional curriculum to the specific school/class context. The curriculum includes teaching strategies, educational objectives and learning practices, which the teachers have to customize in accordance with the needs and the potentialities of the class. In our case study, it emerged strongly how the teacher's understanding of the class context, and of the potential benefits of digital technology specific for each class, is essential for its positive introduction into educational practices.

We observed that digital technology can be instrumental in many activities and can transversally support different

practices at school. The socio-technical issues surrounding the introduction of digital technology in education have been explored from several research perspectives. We aim to complement and contribute to the current discussion by investigating how to design and integrate digital technology into formal education, and transform it into a valuable resource by providing a model that explains the role of teachers in this process.

The contribution of this paper is twofold:

1. Providing insights into the use of digital technology for supporting teaching activities at primary school.
2. Presenting a model—teacher role in introducing technology at school (TRiTS)—that describes the different roles teachers can have in introducing digital technology into school curricula and practices.

These outcomes arose from a series of studies where we explored the various facets of using digital tools in class in order to understand the limits and opportunities for teachers when adopting new tools.

In this article, we first summarize related work and present the relevant literature on which our research is grounded. In particular, we focus on some of the most relevant models concerning the introduction and use of technology in school for educational purposes. The analysis of their strengths and weaknesses inspired us to build the TRiTS model. We will then introduce our case study and the description of our model, with particular focus on the influence of the different roles on students' levels of participation and engagement. In the conclusion, we summarize the main contributions of our research.

2 Background

Mobile technology has the potential to change the nature of learning and teaching by substantially modifying how pupils and teachers access and manipulate content, and also the type of multimedia and interactive content produced.

Here we explore approaches and theories that, supported by data gathered in our user study, have guided us in the definition of our model.

Naismith (Naismith et al. 2009) identifies two possible pedagogical perspectives in using technology in education: didactic and discursive learning. The first is based on content such as e-books and other resources available on the Web. The second is grounded on the development of interaction practices among the community members: learners, teachers and practitioners. Nevertheless, integration with the educational curriculum is crucial for the success of technology in a school context (Blumenfeld et al. 2000). Teachers, school staff and parents are fundamental in facilitating the process, as well as in achieving concrete results in projects that aim to develop innovative solutions for supporting education. Research needs to consider teaching strategies and school curricula (Yarosh et al. 2011) in order to enable the effective implementation of such innovations (Fishman et al. 2006).

Crosby and Harden (Crosby and Harden 2000) conducted a study in the medical education context and identify twelve types of teaching roles. In the model, they differentiate each role in terms of two main dimensions: (1) contact with students and (2) expertise in teaching and in the topic (medical knowledge). The 12-role model provides an overview of the different facets of a teacher and how each of these could impact on learning strategies and teaching objectives. Although the model was constructed to describe the higher education and medical school contexts, it encompasses elements that could be adapted to different learning scenarios.

Another interesting approach that contributed to the constitution of our model is the teaching–learning mobile model (TLMM) developed by Henríquez and Organista (2012). This model focuses on the use of portable technology in higher education and, in particular, on the social interaction between students and teachers and the interactivity with bodies of information. The TLMM is based on three main elements: portable technology, students and teachers. Henríquez and Organista (2012) consider these elements to be interrelated with the education process and with the teaching/learning activities that are supported by the technology. Their perspective is based on the fact that the intersection of the three elements (portable technology, students and teachers) represents the "ideal situation for the development of mobile learning" (Henríquez and Organista 2012). The intersection between the teacher and students concerns educational processes such as strategies for interacting with content, while the intersections between technology and teachers and technology and students are concerned with the way the artifact is used in educational practices. The convergence of aspects relating to the three elements concerns the activities, the strategies and the objectives conceived for favoring introduction and adoption of mobile technology in the teaching–learning process.

In the same direction, FRAME *(framework for the rational analysis of mobile education)* (Koole 2009) aims to drive the development of mobile education intervention encompassing the device, content and strategies. This model is inspired by the constructivist perspective and focuses on the convergence of mobile technology with human cognition and social relationships.

Although all of the aforementioned models are extremely valuable, they were constructed in a higher education context, quite different from that of primary education. First of all, the concepts studied at elementary school are less complex than those studied in higher education, and the elementary school curriculum is easier to adapt to the

skills and abilities of the pupils. In addition to this, digital technology and media production are part of the primary school curriculum, but in higher education area considered a competence already acquired. Moreover, in primary school, teachers are unlikely to have an explicit technological background, while children, being "native digital," tend to have a very enthusiastic approach toward technology. In this context, it is important to have a model that helps teachers and school curriculum designers to plan the introduction of digital and mobile technology. As well as understanding how each player could be involved in the most effective way, it will help school stakeholders to understand the impact in terms of achieving the pedagogical objectives.

However, from our perspective, these models are inspiring because they are centered on human factors (learners, teachers and their interactions), include the technological aspects (device, connections and digital contents) and refer to pedagogical strategies (for learning and teaching).

Our model, teacher role in introducing technology at school (TRiTS) aims to direct the design of digital technology education intervention (from tools to content and strategies) in primary education, in accordance with the curriculum. Our model also enables us to relate students' reactions to the different roles played by teachers.

In the next section, we present the national curriculum and then the case study that allowed us to develop the model.

3 The school context

3.1 Swiss national curriculum

The Swiss government defines the primary school national curriculum in an official document. This text specifies: the expected learning outcomes, the resources for each subject and their organization, the educational strategies, the teaching methods, the assessment procedures and the procedures for managing the curriculum. The curriculum includes six main subjects: First Local Language, Second Language, Science-History-Geography, Art and physical expression, and religion. Primary school is divided into 5 years, and children start school in primary one when they are 6 years old. Each class is composed of a maximum of 20 pupils and one teacher.

3.2 Focus on a subject area: storytelling

In our project we focus on a specific area of the curriculum: Local/First Language and, in particular, the subarea of storytelling. Pupils have to develop various linguistic competences (phonology, spelling, morph syntax and lexicon) and learn how to write a narrative in different genres. In the creation of a narrative, children also train the other linguistic competences. In accordance with the curriculum, each teacher has to dedicate 2 h per week to this activity. The educational goals are defined by the curriculum and change according to the ages of the children and the school grade.

3.3 Benefits of the digital storytelling at school

During our project, as teachers shifted from analog storytelling to digital storytelling (DST), our role was to provide the right tools and to support them in the utilization of digital technology in class, as well as to identify the breakthroughs and the breakdowns of each solution we provided. Researchers and educators are becoming increasingly interested in the introduction of DST in education, primarily due to its potential for fostering educational benefits, thus complementing the role traditionally occupied by storytelling as a teaching/learning tool.

According to Bruner (1996), narrative plays an important role in mediating the construction of meaning and a child's organization of knowledge. Bruner considers narrative to be a primitive function of human psychology and a fundamental aspect in the construction of meaning. Furthermore, for this specific study, pupils are asked to develop a narrative as a collective effort. In the literature, it is well known that collaboration and social interaction can support the development of socio-cognitive abilities in pupils. Our research focusses particularly on group-based story creation in formal learning environments, and the educational benefits potentially fostered by this. Moreover, building on a constructionism perspective (Papert 1991), group interaction and sharing in a creative activity can make the learning process remarkably effective. According to Nicolopoulou (1997), creative activities conducted in groups involved negotiation with the other members of the team and are therefore a way of training social skills.

In the following section, we describe our case study and we present the findings that enabled us to build the model.

4 Study setting

In order to investigate how Information Communication Technology (ICT) can be integrated into the primary school curriculum, we conducted a case study in a primary school in Lugano, Switzerland. Our study was focused on the literary genre topic and the writing laboratory, which runs once a week for 2 h in each class, 1st–5th grade (Table 1).

In the laboratory, students learn how to create a story and, in accordance with the grade level, teachers establish

Table 1 An overview of the study

Year	Grade	# Students	Teacher
1	3rd	20	T 2
1	4th	18	T 1
2	3rd	20	T 3
2	4th	20	T 2
2	5th	18	T 1
3	1st	22	T 1
3	4th	20	T 3
3	5th	18	T 2
4	1st	22	T 2
4	2nd	22	T 1
4	5th	22	T 3

specific pedagogical objectives. Over the years, we therefore worked with the same three teachers (T1, T2 and T3) who taught in four different classes.

For the definition of our model, it was very important to focus on the same small group of teachers over a long period of time. In addition, it was crucial to have an overview of the activities carried out in five different grades. The longitudinal study enabled us to observe how the teachers not only explore but also challenge technology, adapt it to the curriculum, and make it a resource suitable for different educational purposes. The school is equipped with 20 desktop computers in an IT lab. Teachers are quite open to use technology and often conduct short exercises in the laboratory (e.g., asking children to browse the Web or write a short text).

The entire project is based on a methodological approach inspired by cooperative (Greenbaum and Kyng 1991) and participatory design (Schuler and Namioka 1993). Therefore, before designing a new tool for the creation and sharing of DST, we needed to analyze the current situation in the school in order to understand the school stakeholders' activities.

In accordance with this approach, the project has three main stages:

1. Analysis of existing situation in the school (they create storytelling without any digital technology support),
2. Introduction of applications and digital devices in class for DST production,
3. Design of a new DST tool.

In this paper, we focus on stages 1 and 2 by reporting the analysis of data collected during the writing laboratory, in order to provide the rationale for describing the teachers' role model.

In these two phases, we observed and analyzed the activities conducted in the writing laboratory. We involved the same three teachers over 4 years: in the first year T2 taught the 3rd grade (aged 8–9), in the second year the 4th grade (aged 9–10), in the third year the 5th grade (aged 10–11) and in the fourth year the 1st grade (aged 6–7).

4.1 Stage one

During the first year of the study, we observed the classes in a canonical situation, in which they created the story as usual (Rubegni and Paolini 2010). This stage is considered as a reference situation (Daniellou 2004), i.e., existing situations that present similar characteristics to those of the future system. During the first phase, we observed how children create narratives as they usually do (without using any digital technology) in their regular scholarly activities. The observation highlighted a few issues regarding how digital media and technology can improve the storytelling activity, for instance to enhance the emotional expression of a character, to allow synchronous collaboration on the plot and to improve the level of engagement in story creation.

The insights gathered from this stage allowed us to design the subsequent interventions in class, such as how to introduce specific applications and devices to support learning/teaching practices. The use of technology allowed us to move from storytelling to digital storytelling (DST). We recorded interesting findings regarding the general school curriculum and, more specifically, learning practices, teaching strategies, educational objectives and children's behavior when working in a group (Rubegni and Paolini 2010).

4.2 Stage two

We used the insights gathered from the first phase to plan the second one, which consists of three steps: (a) defining pedagogical objectives with teachers, (b) identifying the most appropriate digital technologies and (c) planning the activity. The first two steps—"a" and "b"—function in parallel with one feeding into the other, while the third step came subsequently, in accordance with the outcomes of the first two.

During the study, we proposed several technological solutions and devices: from desktop computers to portable devices, i.e., iPad™, from a Web-based tool to a desktop application (see Table 2). Our aim was to understand which setting was the most suitable for supporting the achievement of educational objectives in this specific context. This approach is called "technology probes" (Hutchinson et al. 2003). Each technology used in class informed the research team about the opportunities and the limits of the tools that meet the requirements, together with other data gathered through observation and interview.

Table 2 An overview of all the technologies used in the study

Year	Grade	Technology used
2	3rd	Desktop computer/Web tool: 1001story
2	4th	Desktop computer/Web tool: 1001story
2	5th	Desktop computer/Web tool: 1001story
3	1st	Desktop computer/power point
3	4th	Desktop computer/power point
3	5th	Desktop computer/power point
4	1st	Mobile/power point
4	2nd	Mobile/power point
4	5th	Mobile/power point

The outcome of this phase produced interesting insights that we used to design and develop the application in the third phase. From the data analysis, it emerged that the most suitable solutions are based on the use of portable/mobile devices. In the final phase of the project, we therefore focused on designing a solution for a mobile context.

With the introduction of digital tools, the children's work shifted from being analog (paper and pen) to being multimedia-based and interactive (power point presentation, movie and Web site). The results of the technology probes in the second phase provided the breakdown and breakthrough of digital technology in the course of school activities. The data analysis showed that the most successful activities were based on the use of portable/mobile devices, so we decided to design our system as a mobile application.

The case study is quite extensive and embraces several research questions and has therefore produced many findings and outcomes. In particular, in this paper we focus on one specific aspect of the project: the role of the teacher in introducing technology into educational practices in accordance with the institutional curriculum. In the section below, we present the methodological framework and the techniques used to collect and analyze data for investigating this research issue.

5 Methodological framework

In our study, we took a holistic perspective in order to understand the complex ecology of the school. In exploring the school as institution, we integrated a hierarchical perspective (O'Dwyer et al. 2005) with a curriculum viewpoint, so we looked at the organizational structure through a lens made of pedagogical objectives, practices and contents. Integrating a curriculum-based perspective allowed us to explore the relationships between people working in the school, the economic and social aspects of the school, and the financial and structural resources. This approach provided us with a clear picture of the school, showing the elements that were fundamental in order to plan an intervention that aims to impact on children and teacher technology-related professional development. Outcomes of the study were integrated into the guidelines described in (Rubegni and Landoni 2014), as well as in the model presented in this article.

The model was produced by elaborating data gathered by means of different techniques. Indeed, our approach is based on a mix of techniques that allow us to depict the context before and after the study, and also to make repeated observations during the writing laboratory in class. Each technique supported the elicitation of a specific aspect and enabled us to gather a rich set of data to be discussed later in the paper. Each year we interviewed our main stakeholders—teachers and children—before and after the activity in which technology was used. Contextual inquiry (Raven and Flanders 1996) was used with interviews with the teacher, Focus Groups (FG) with children, and, in addition, we collected notes from observations made during the activity in class.

The inquiry with teachers *before* the study addressed:

- Assessment of children's skills and attitude, and pupils' and teachers' technological ability,
- Identification of the technology available at school,
- Definition of the educational objectives and expectations of the storytelling activity,

While the interview *after* focused on:

- The collective and individual activity of the children,
- The learning process,
- The quality of the outcomes.

The aim of the observation was to monitor the activity in class during the writing laboratory. The researchers observed each class twice a week, for 2 h each session. The purpose was to notice:

- Breakthrough and breakdown of the artifact use for content production (pen and paper in the explorative study as well as tablet and desktop computer in the second stage),
- Activity of the children, both collectively and as individuals,
- Interaction between children and teachers.

After story creation phase, at the end of the plenary presentation, we conducted FGs with the pupils. This technique allowed us to confront each child's different perspectives and impressions regarding the storytelling.

The FG with children mainly aimed at assessing their self-perception about:

- Specific learning achievement,
- Interaction with other pupils and the teacher,
- The weak and strong points of the experience.

These techniques allowed us to depict the ecology of the school and understand the roles of its players, their interactions and how the introduction and transformation of technology impacted on their activity.

We followed a similar procedure for the analysis of the notes taken during the observation periods.

In order to understand the quality of the story, we also asked teachers to evaluate these stories using the same criteria as those used in a canonical situation. They evaluated the narrative by taking into consideration two main dimensions: the extent to which students improved their skills and the vicinity of these newly acquired skills to required levels. In the following section, we provide an overview of the various school stakeholders, starting with an overview of the context. This is quite relevant in order to understand the different relationships in the school ecology.

6 Roles of the school stakeholders

We investigated the roles of the various stakeholders in order to gain an understanding of the whole school ecosystem. The section below describes the stakeholder roles in the school practices and also mentions the involvement of these stakeholders in the research project.

6.1 Director and head teacher

The school director and head teacher were both involved at the beginning of the study and at the beginning of every school year. They represent the authority and have the power to open the school doors, facilitate contact with teachers and allow us access to the school facility. Their authorization was essential for conducting the study, as well as for gaining a better understanding of the overall context of the school. They act as formal interface with parents and are very sensitive to their reactions. The director supported the project proposed by the researchers and acted both as a stimulator toward the teachers and as a facilitator toward the parents.

6.2 Technician

Once the director gave us permission to use the facilities, the technician physically gave us access to the digital technology available in the school. We interviewed him at the beginning of the study to obtain an overview of the facilities available in the school and of the expected activity in the computer class. The technician teaches computer science in different classes and operates as a specialist in the field, helping both pupils and teachers to use the IT room in the most effective way. The role of the technician during the first 2 years of the study was quite limited, but from the third year he became fully part of the process. In particular, the technician manages the schedule and looks after the hardware and software in the informatics room. He acted as facilitator by helping teachers, researchers and pupils to resolve issues using the technology in class.

6.3 Teachers

The role of teachers in school is to define the specific objectives of their class activities and to orchestrate the activity in class.

At the beginning of the study, teachers were somewhat hesitant and afraid of being involved in such a project, as they did not have any training in using technology in their teaching. They were also reluctant to let external researchers play a role in their class, even that of observers. Finally, they were afraid of wasting time and falling behind with their schedule due to pupils being distracted by the novelty of taking part in a research project. Despite focusing explicitly on a writing laboratory at the beginning of our study, teachers subsequently started using the solutions in a transversal way across a wide range activities and scenarios.

Understanding the curriculum and the teachers' goals was fundamental in determining the best technology to use and in customizing the intervention in class. In general, teachers focused mainly on the process, rather than on the final output (e.g., the quality of the story); however, the evaluation of students' digital products was quite helpful in assessing the process. Indeed, the final contextual interview with the teachers also helped us to make sense of the observation data.

6.4 Students

Students were ready to enthusiastically embrace any novelty, especially if technology and attractive gadgets (such as iPads^{TM}) were involved. We observed the students in class, and we monitored their activity during the writing laboratory. Pupils were actively involved in the study and, as users of the technology, they play an important role. They provided spontaneous feedback during the observation in class and more explicit comments during the interviews and the FG.

At the end of each school year, we ran an FG with the entire class. The FG with children helped us to make sense of their experience in using technology in school. During the FG we prompted children to assess their own improvements, the limitations of the tools used and the successful aspects of the experience.

Children move seamlessly from analog to digital worlds (and vice versa) by combining pen and paper with multimedia. From the study, it emerged that children do not differentiate between the two worlds, being happy to use one instrumentally with the other. Thus, what is quite difficult for an adult (i.e., teacher) is quite natural for a "*native digital*" child.

6.5 Parents

Children's families are also important stakeholders. Although we did not interview the parents, we still consider them to be essential to the process, and we gathered indirect evidence of their opinion via the children and teachers. In particular, families are the first beneficiaries of the children's stories, and their appreciation is an important element for building the child's self-esteem.

Parents were formally involved when asked to sign parental consent forms. They also had an active role in keeping children motivated and focused, and, very importantly, they were the main audience and judges of the work delivered by their children. We made sure that the head teacher and teachers communicated with parents, explaining how the technology was simply part of an educational project they would administer to the pupils while continuing to adhere to the existing curriculum. Their positive reactions to presentations made by children of their work, be it a projection in a schoolroom or a Web page address to visit at home, clearly had an influence. This was reflected in the fact that permission for further years of study was granted by the head teacher and director, not to mention the impact on teachers, as even those not involved in the study became eager to be part of it. The parents are motivators toward their children as well as assessors and evaluators of the effective positive impact of the research project in improving the pupils' skills.

Considering the contribution of each stakeholder and the school workflow, we started to understand the interplay of the people in schools in more depth.

7 Findings

In the project, we applied a qualitative approach by using different methods and techniques in order to investigate the activity in detail and collect as much consistent information as possible. Our model and findings are therefore based on the analysis of the data collected following this approach. We proceeded with the content analysis of the interviews and the FG transcriptions.

We transcribed the interviews and analyzed them by highlighting the most relevant aspects regarding activities at school. The analysis was conducted through the coding of the transcription using a mixed deductive and inductive approach. We identified the most relevant themes and grouped them into categories in-line with our main research questions. In a second phase, we refined these themes and their connections in macro-categories. We then interpreted the results considering also the outcomes of the other evaluation methods used in the project, e.g., analysis of the stories created by children and considerations regarding their level of collaboration, as reported in (Rubegni and Sabiescu 2014). Indeed, the combination of the findings that emerged from these data provides us with an accurate overview of the activities carried out, and of the effect of these on the development of student skills and on teacher practices. Each method contributed to gathering data that fed the model by providing a rich overview of the school practices, student/teacher needs, and the opportunities and constraints of using technology in this setting.

Moreover, data analysis allowed us to understand the role of the teachers and how they implement the curriculum, introduce and use technology in class. The interpretation of these data stands at the basis of the creation of the model roles. We defined the teachers' roles for our model by analyzing the competences, interactions, functions and responsibilities of the teachers in the reference situation. As this is a qualitative study, a portion of discourses that we transcribed and analyzed supports our findings. However, in this paper, we will report only a few of these, which exemplify the concept.

We now report the key findings concerning the role of stakeholders as well as some evidences of the impact of technology on teaching/learning activities. These considerations link directly to the definitions of our model, and here, we are linking our teachers profiles to the most poignant quotations emerged in our interviews; these will be discussed in greater length in the next section.

7.1 Teachers helped each other in understanding how to use technology

T1: "*… my colleague did not know how to use it and I helped her and from there she took a much more positive attitude. The researchers' presence for me has been stimulating and essential in motivating me to start using this technology.*" In this extract, describing the situation at the beginning of the project, different roles among teachers are highlighted, with some being more active and others preferring to follow in their footsteps. The researcher is seen

Fig. 1 Children and teacher using mobile in a class activity

as a Manager and T1 is acting as Facilitator toward other colleagues (Fig. 1).

And again from the same teacher: "… *competencies are transferred to students and colleagues by using technological tools as naturally and normally as possible, with a positive attitude, avoiding drama.*" This quotation describes the situation during the project once some of the teachers have assumed a Manager role and how this has influenced the rest of the colleagues. It points to the importance of the attitude proactive teachers could bring and pass down to their colleagues.

T2 reinforces this concept adding: "…*technology helps us to keep focused and motivated, and enforces a positive attitude towards the storytelling task.*" This emphasizes the perception of teachers about the role technology plays in education. T2 is here speaking like a good Follower teacher with her focus steadily on the educational task (Fig. 2).

7.2 Technology engaged teachers and pupils in activities that improved their autonomy

Pupils have an active role by proposing some activities to the teachers and motivating them in using it. Indeed, in some cases they had sufficient self-confidence to become the leaders of the activity.

As reported by T3: "… *I never had to use any of the tools provided by the researchers, the children did everything by themselves.*" This extract shows very clearly how teachers could be passive in their involvement with technology as children take a leading role. A prefect description of the role of a Follower where the focus is on the educational task of letting children takes responsibility for their learning.

T3 added: "… *my pupils would also like to write their exams using their iPad™ s, they asked for that explicitly. All pupils in my class have an iPad™ at home. They feel so confident about using it that they offered to help one of their classmate's father who is involved in a project for the creation of stories."* Again, another sign of teachers giving space to children to take initiative and behave independently when using technology.

T3 explained: "… *my pupils are able to self-assess. They are equally able to understand how much they can accomplish and assess their peers too. This is a great improvement, all my pupils are good at self-assessment*."

The teachers noticed ways in which the technologies proposed improved the level of group work collaboration between the members, and activated a scaffolding process among the peers (Fig. 3).

The same teacher adds: "… *pupils have improved in their ability to listen to and understand each other, they are able to put ideas together and work on a common story*

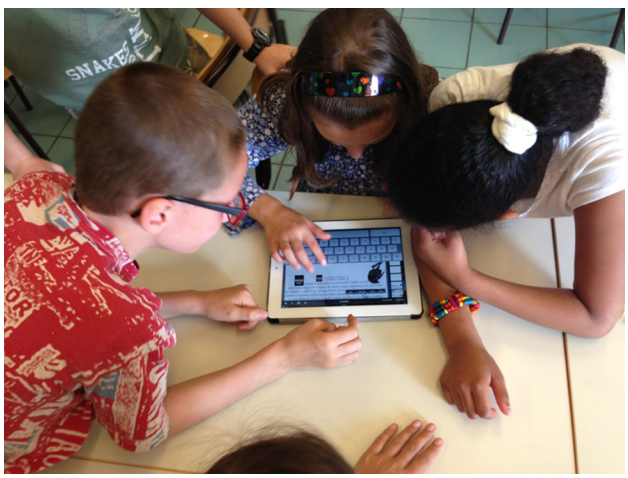

Fig. 2 Pupils collaborate in using the iPad™ in class

Fig. 3 Children split the activity into subtasks: each child has his/her own role

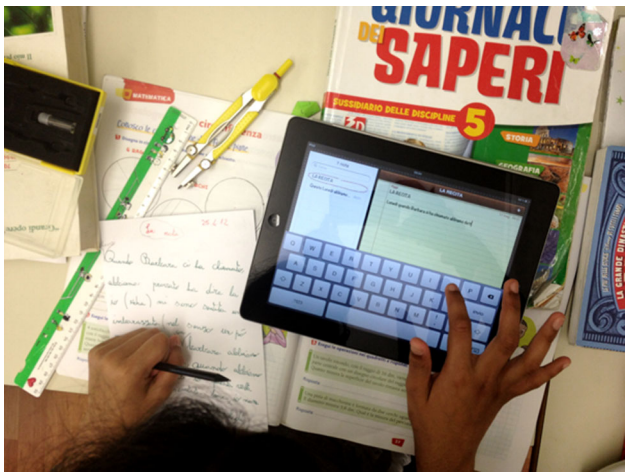

Fig. 4 Children integrate the work with pen and paper with digital resources

script. Previously they were all working in isolation now they really are a group! They get to know with whom they could work productively."

T1 considers how the practicalities of having and sharing screens add to the way pupils collaborate and notes: "*… pupils in a classroom usually compare with each other and look at what they have produced. Sharing screens helps to see, comment and eventually take inspiration from what others are doing. For children in primary school copying from each other is an important learning expedient.*" This is the comment of a Proactive teacher as she has spotted an opportunity and has then actively taken advantage of one of the side effects of introducing tablets in a classroom: a boost to collaboration (Fig. 4).

7.3 The impact of the research project and the researcher in class

The teachers considered the presence of the researcher to be a fundamental element of their activity. T3 added: "*… It has been a very stimulating experience for my pupils, as they improved their writing skills as much as they learned how to discuss and share their abilities. Having an external presence in the class pushed them to give their best and contribute to their group by understanding each other, to get inspired by each other and work together like a real group.*" During the course of the project the researcher was there to facilitate "*group activities and above all, to help in critical situations by giving out indications to pupils not only on how to use technology but also about work organization.*" T2. These sentences pave the way toward defining the role of manager as being shared by researchers and the leading teacher.

T1 summed up their feelings toward the researcher by saying: "*I like to work with you because you help me accomplish my tasks thanks to the project defined in line with your research and the technology you bring with you. Having deadlines and learning how to use new tools is stimulating for us too. That said, I only use what I need, as you have stimulated me to use new tools that I never used before I came to discover and learn new things too.*"

This is the description of a teacher acting as Facilitator.

During the study the three teachers demonstrated that they were fundamental in envisioning the use of digital technology for serving pedagogical objectives. We focus on their roles in order to build our model. In the following section, we present our model to be used for planning the introduction of DST in class.

8 The teacher role in introducing technology at school—TRiTS—model

In our study, we observed that teachers use technology for multiple purposes, from the preparation of class lessons (e.g., searching for information on a specific subject on the Internet) to conducting class activities (e.g., using the smart board to show an instructional video). From the investigation of the teachers' activities, we identified several facets that characterized their way of using the technology for teaching. Indeed, as stated in O'Dwyer "individual teacher characteristics such as constructivist beliefs, higher confidence using technology and positive beliefs about the efficacy of technology were each found to be associated with increased use of technology in the classroom" (O'Dwyer et al. 2005). Our model covers all the potential roles that teachers can play when using technology in primary school. The model was a fundamental outcome and part of the project since it allows researchers to predict problematic situations and deal with them in advance, and to study different elements in the model and their influence on the learning process and outcomes. At the same time, teachers can use the model as guidelines to understand their responsibilities and the possible implications in using those to enact the curriculum.

The model was based on the analysis of different sources:

- Data gathered throughout the 4-year case study conducted in a primary school (interviews, FGs and observation in class),
- The school curriculum,
- The literature

On the basis of the theoretical reflections and considering the insights gathered in our case study, we built a model that could describe the role of the teachers in introducing portable/mobile technology into school. TRiTS model is based on the triadic interaction of teachers,

children and technology, and on how the intersection of these components has to be addressed in the direction of producing education benefits.

The TRiTS model includes two main dimensions:

1. Level of engagement in class activity and students, from fully engaged to not engaged.
2. Level of commitment in envisioning and planning the use of digital technology to support the curriculum objective achievement, from active to passive.

In accordance with these dimensions, we conceived four different teachers' roles: Manager (MT), Proactive (PT), Facilitator (FT), and Follower (FoT) (see Fig. 1).

In this first version of TRiTS, we use teacher profiles that are extreme, stereotypical even, in order to highlight differences between them, and to help researchers make sense of these differences in unambiguous way. We are aware that real teachers do not fit these stereotypes, but are rather more likely to present a mixture of features borrowed from each of the four roles according to the situation and their level of experience. Nonetheless, while preparing a future fuzzy version of our TRiTS, where each profile will have a number of shades, and will be characterized by degrees of attributes pertaining each role, we feel that this simple "extreme" version has been useful to us in order to characterize the different reactions and expectations in play, and that other researchers will also benefit from its simplicity (Fig. 5).

The Manager (MT) has the role of leading the planning of the technology used in the class activities. With the perspective of enhancing the achievement of the educational objective, the MT uses his/her knowledge of the school curriculum and teaching practices to integrate digital artifacts and media with the traditional analogical tools.

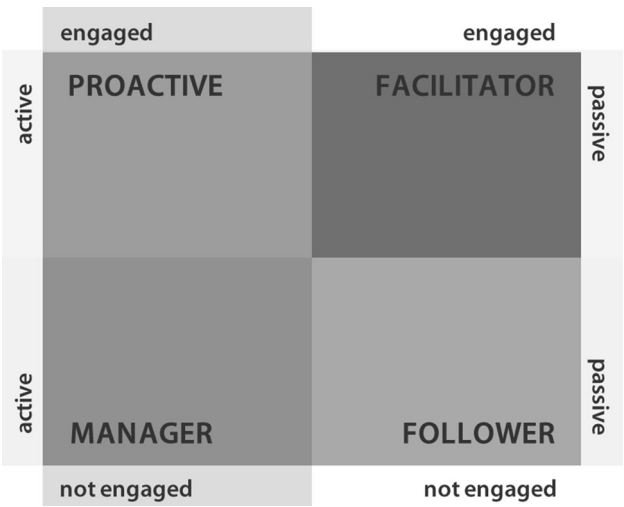

Fig. 5 Teacher roles in introducing technology at school—TRiTS—model

The MT as curriculum enactor has a deep understanding of how the program is carried out in practice, and using her/his knowledge of the human and structural resources of the school, he/she figure out the constraints and opportunities of introducing new tools and activities. Indeed, the MT role implies active interaction with the school management to define the activities as well as to coordinate/support the other teachers.

The interaction with colleagues is quite critical for the MT, especially if they lack confidence with digital technology and may feel apprehensive about introducing it in class. Indeed, part of the MT responsibilities is to support other teachers in the organization and the conduction of class activities, helping them to adapt it to the specific needs of the class. The MT is a reference point for the school management and the teachers. When the MT is engaged in class activities, her/his role changes and he/she becomes a PT.

The Proactive (PT) is active in the use of technology in class and takes the initiative on how to use the digital tools and media in the class scenarios. Indeed, the PT uses his/her creativity and experience to understand the limits and opportunities of applying digital artifacts in their class context. Bearing in mind the achievement of curriculum objectives, they collaborate with the MT to envision possible scenarios and activities in the class. The PT plays an active role in engaging with the activities in his/her class; thus, he/she can have a direct control over them and address directly problems and opportunities arising from the proposed scenario. He/she monitors how students make progress in the adoption of new technology and assesses benefits in terms of educational achievements. Students are supported in their class activities by his/her expertise, both in the curriculum objectives and in using technology. While students with a good knowledge of the topic and of the use digital technology do not need any help and can be independent, those that have weaknesses in both areas can find strong support in the PT. Thus, children feel well supported and confident in their learning path. In addition, the PT gives purposeful feedback to the MT and helps in refining the activities.

The Facilitator (FT) is aware of the possible advantages of using digital technology for achieving educational purposes, but he/she is not active in envisioning possible scenarios where new technology could support teaching and learning in a creative way. However, the FT is active in adopting the strategies defined by the MT. The FT organizes the activity in class in terms of timing and focus in educational practices and then leaves the pupils to handle it. The FT supports students without interfering with their tasks; he/she informs students of the activities, the goals, the tools and the outcome to deliver. Students take responsibility for using the technology and leading the task.

Students use their knowledge to achieve their task, while the FT is an external supporter who observes and intervenes when necessary or on demand. The FT collects feedback from the activity and provides this to the MT.

The Follower (FoT) is not active in envisioning the use of digital technology or in planning activities in class. Although the FoT executes the MT's instructions with somewhat limited personal initiative, this role is quite critical. The FoT is generally a teacher whose technological skills are not strong enough to promote or facilitate the use of new technology in teaching, but who has very valuable teaching skills.

They provide the institutional framework to the class activity by giving all the information students need to carry it out. The FoT monitors the class and gives advices according to the topic and curriculum aspects, but he/she is not engaged in the use of technology. Indeed, in this case students are the main protagonists of using digital artifacts and media. Children have more space for trying out ideas and experimenting with technology, but will not feel supported and perhaps miss out in confidence when venturing outside the educational boundaries fixed by teacher. In this case also the feedback given to the MT is quite poor.

The students perceive and gather different benefits in accordance with the engagement of the teacher in the activity in class and with his/her knowledge of the use of digital technology and media. On the one hand, teachers that are more engaged in the class activity leave less room and freedom to the students but also give more support in case of breakdown. On the other hand, children are more independent with teachers that are not engaged in class activity, but at the same time feel less supported in carrying out the task. In this case, an interesting aspect that emerged from our study concerns how students helped their peers in overcoming the difficulties.

The same teacher could perform one or more roles and, in the course of his/her career, can play different roles. In addition, the four roles are closely interconnected, and the success of educational achievements requires a high level of inter-teacher collaboration. In particular, the teachers have to discuss the introduction and use of technology collectively. Although teachers have different levels of expertise and knowledge regarding digital technology usage, they collaborate at various levels on the definition of educational objectives, the organization of activities and setup of resources. For instance, the FoTs have a passive role in planning, but they participate in the initial discussion and provide their perspective. In addition, all the teachers helped each other in case of difficulties.

This model was conceived for a Swiss school, and in order to overcome this limitation, it was later refined and tested by applying it to a Lugano primary school following the Italian-based curriculum. The Italian and Swiss programs at elementary school are quite similar, and for the part, concerning the teaching of literary genre is identical. Thus, applying TRiTS in another school was helpful as a heuristic evaluation of the model and in order to explore its applicability in other settings. We made an analysis of the Italian-based curriculum school, and we used the results to test the model. In applying the model, we tried to understand whether the expertise, the knowledge and the function of teachers corresponded to those that emerged in the previous study and portrayed in the roles of our model. We produced a detailed description of teachers' expertise and knowledge (regarding the curriculum and digital technology usage), and analyzed teachers' activities in terms of communication between peers and with students, use of resources, attention to needs and potentials of their students. Data were gathered and analyzed following the same approach of the previous case study.

From the results of this heuristic evaluation, it emerged that the Italian-based curriculum school fits the model and that the teachers match the proposed roles.

9 Conclusions

Our research aims to contribute to the current discussion about how the use of mobile/portable technology can be integrated into formal education and the school curriculum. We conceived a model called teacher role in introducing technology at school—TRiTS—that aims to explain the different roles played by teachers in the process of introducing technology into the primary school curriculum. Our case study shows how the group of three teachers was able to orchestrate the introduction of digital technology by covering different roles and complementing each other. Our model also includes students' reactions to different roles in terms of their willingness to explore further elements of the curriculum and/or the use of technology. While we cannot provide a recipe for a successful combination of roles, we feel this information could be used to guide educators when introducing technology to learners in different settings, by starting from the identification of the MTs and the organization of when and how PTs, FTs and FoTs will interact with them.

The heuristic evaluation conducted in a school following a different curriculum suggests that our model could be productively used in similar contexts outside the cultural boundaries of our specific study.

Moreover, although our model was inspired by a specific context, its theoretical background is grounded in the literature, and as such we expect that it could be used as a heuristic tool to compare the engagement of teachers in

other learning contexts with different curricula and social backgrounds.

We also believe our model could be useful for the investigation and even prediction of how the synergy between teacher and learners changes when technology is introduced.

The project is currently in its third stage, and we are designing a new tool for the creation of digital storytelling. The findings gathered from the case study have been used as requirements for the development of an iPad™ application. The app will be designed in collaboration with the teachers and assessed in two schools in Lugano.

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