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DISTRIBUTED TPACK WHAT KIND OF TEACHERS DOES IT WORK FOR?

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Technology at school can be either integrated as an everyday support to normal, curricular activities or as a trigger for special projects. Drawing on the distributed cognition theory, the distributed TPACK (Technology, Pedagogy and Content Knowledge) model (Di Blas et al., 2014) claims that, at least in the latter case, the knowledge required does not reside in just the teacher's head but is rather distributed within a complex system of resources that includes students, colleagues, relatives, experts, the internet, etc.
After introducing the distributed interpretation of the TPACK model, this paper focuses on the profile of the teachers who "enact" it within their classroom, based on data from a large case-study with digital storytelling at school. Results are quite surprising: most of the teachers are quite aged, with more than 20 years of teaching experience, with a background in humanities rather than science; many admit a poor command of Technology Knowledge. Yet, they succeed: benefits for their students are substantial,

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over a wide spectrum. What lesson can be drawn? That contrary to what may be expected, PK and not TK is probably the issue when introducing technology at school, at least in the case of special projects.

1 Introduction

Technology at school can be either integrated as an everyday support to normal activities or as a trigger for special projects that somehow "protrude" with respect to the curriculum (Di Blas, 2013). This paper presents the results of a research that investigated the teachers' TPACK (Mishra & Koehler, 2006) within this latter kind of activities. Data gathered in the frame of a large-scale case-study with digital storytelling at school not only confirm prior findings about the distributed nature of TPACK (Di Blas *et al.*, 2014) but also shed a surprising light on the profiles of the teachers who enact it. TPACK appears as distributed among a system of resources orchestrated by teachers who are neither young nor "tech-nerds", but rather experts in Pedagogical Knowledge.

2 State of the art

2.1 The TPACK model

The TPACK (Technology, Pedagogy and Content) model was first introduced by Matthew Koehler and Punya Mishra in 2005 (Mishra & Koehler, *op. cit.*) and then further developed over the years (see for example Mishra & Koehler, 2006; Koehler *et al.*, 2014). The model explains what kinds of knowledge a teacher needs in order to effectively teach with technology, at the intersection of three main knowledge domains: those of Technology, Pedagogy and Content. It builds upon a previous model by Lee Shulman that focused on the intersection between Pedagogy and Content Knowledge: the PCK model (Shulman, 1986). The TPACK model has met large consensus and it would be beyond the scope of this contribution to describe all the different interpretations and applications it went through. At the time of writing, more than 740 papers are referenced in the TPACK community website (http://tpack.org) and the founding paper (Mishra & Koehler, 2006) has been quoted more than 3700 times.

2.2 The distributed cognition theory

The main thesis of the distributed cognition theory is that cognition is not confined within a single individual's head but it is distributed in the environment (Hutchins, 1995; 2001). When someone accomplishes a task, she is conditioned by the opportunities offered by the context she is operating in, and the other individuals and tools she can rely upon: e.g., it is very different to solve a complex calculation with or without a calculator (Hewitt & Scardamalia,

1998). The distributed cognition theory acknowledges that:

> …it is more appropriate to consider cognition (and intelligence) as a property of the whole system within which the individual functions rather than as something limited by the skin or skull (Karasavvidis, 2002, p. 14).

The elements of a system interact with each other towards a common goal, like a whole crew, from the captain to the ship's boy, cooperate to navigate the ship properly (Kim & Reeves, 2007). Some studies apply the distributed cognition theory to interpret what happens when technology is introduced in the classroom (Angeli, 2008; Steketee, 2006). Technology is recognized as one of the resources in which cognition is located (Salomon, 1993; Pea, 1993).

2.3 TPACK as distributed

The distributed nature of TPACK was first introduced by (Di Blas *et al.*, 2014). Basically, distributed TPACK claims that when teaching with technology the knowledge required does not reside in just the teacher's head but is rather distributed within a complex system of resources that includes students, colleagues, relatives, experts, the internet, etc., well beyond the classroom's walls (Di Blas & Paolini, 2013).

Previous studies had already highlighted the distributed nature of TK, CK and PK in working groups: (Koehler *et al.*, 2007), for example, perform a quantitative analysis of mails, official documents and reports by a group of educational technology experts in charge of designing a master course, demonstrating that the three Ks are distributed among those who participate in the discussion.

A similar view on TPACK as "shared" (or "distributed") has been taken also by (Phillips, 2013; Phillips & Kohler, 2016) and (Jones *et al.*, 2015): all these authors investigate the influence of the context in terms of a system of resources in the development of the teachers' TPACK.

3 The case-study

In order to ground the distributed and dynamic TPACK theory, a study was conducted within the frame of a digital storytelling competition to which thousands of students took part in year 2014-15. The competition is named "PoliCultura" and began in 2006, aimed at groups of students (preferably whole classes), under one or more teachers' guidance (www.policultura.it). Participants are asked to create a digital interactive "story" (in broad sense) about a subject of their choice: favourite subjects are school outings; visits to cultural institutions; local traditions, history, art and famous characters; any school

subject, often quite creatively reinterpreted (for example, in the form of a TV show or of a documentary): this step outside the classroom's walls often implies external resources, as it will be shown below. The activity typically lasts two months and requires an effort of 2-3 hours per week at school plus additional hours at home. Classes from any kind of schools or level can take part, from pre-school to high-school. At the end of the school year, the best works receive an award and all the works are published online (Di Blas & Paolini, 2013). Figure 1 shows an example of story by an Italian high-school class: on the left, the visual communication can be seen (which can take the form of a slide-show or a video); on the right, the story's "chapters", among which the user can freely choose, are displayed.

Fig. 1 - Example of a "story" by a high-school class, about Roman culinary traditions.

PoliCultura is a typical example of "special" activity, in all respects: from the point of view of Technological Knowledge (TK), it requires learning how to use an authoring tool for creating the digital stories plus additional tools for audio editing, image editing, video editing etc. From the point of view of PedagogicalKnowledge, it implies orchestrating a complex activity mixing up brainstorming moments with the whole class, group work, individual contributions, review sessions of the work, integration of external contributions and "helpers", etc. Eventually, from the point of view of Content Knowledge, teachers always deal with something connected with the curriculum though with an element of novelty and research.

4 Methodology

In order to investigate the distributed nature of TPACK, both quantitative and qualitative data were collected (during school year 2014-15): all participating teachers were administered a survey, at the beginning and at the end of the experience; moreover, 120 teachers were interviewed via skype, following a semi-structured interview schema. The interviews' transcripts were refined into unabridged versions; then, the most prominent features of each interview were extracted into "schemas", in order to facilitate the work of the researchers.

Both the surveys and the interviews covered the following aspects: the context in which the experience took place (what kind of school, what kind of class, the students' average performance, the social, economic and cultural environment); the "implementation" of the experience (organization and main steps); the results (educational benefits); an overall assessment (positive, negative). A set of questions explicitly investigated the TPACK required to run the experience, as we will see in details in the next paragraph.

5 Results

In this section, the main results from the surveys are presented, backed up by quotes from the interviews. 435 teachers answered to the surveys while 120 teachers were interviewed.

5.1 The teachers' profile

Of the 435 teachers who answered the surveys, 14,6% were from pre-school, 29,4% from primary school, 25,8% from secondary school and 28,2 from high-school (plus 1,9% of "mixed" teachers). Most of the teachers were quite aged: 69.9% were older than 46 (with 64.8% between 46 and 60 and 5.1% aged over 60). Accordingly, 57.7% of the teachers more boasted than 20 years of experience.

Table 1
TEACHERS' AGE

	Percentages
Less than 30 years	1.4%
Between 30 and 45	28.7%
Between 46 and 60	**64.8%**
More than 60	5.1%

Humanities teachers (43,1%) outnumbered math and science teachers (29,9%); 27% taught "other" subjects.

A significant number of teachers admitted having a poor command of technology at the beginning of the experience: table 2 reports teachers' self-assessment of their confidence with TK prior to the experience with digital storytelling. The scale is from 1 to 5, where 5 means "very confident" (Table 2). Together with a majority of teachers who feel confident in using technology, as may be expected, a quite significant number of teachers admits their low TK.

Table 2
TEACHERS' (PRIOR) CONFIDENCE WITH TK

Very limited	Limited	Sufficient	Good	Very good	Aver.
1.9%	**10.9%**	**29.3%**	47.9%	10.0%	3.53%

After profiling the teachers, the surveys moved on to investigate the TPACK needed within the frame of the experience with digital storytelling for both teachers and students, as well as how much external help was needed. Tables from 3 to 5 show the increase in all Ks after the experience. The scale is from 1 (not at all) to 5 (a lot).

Table 3
INCREASE IN TECHNOLOGY KNOWLEDGE

	1	2	3	4	5	Aver.
Increase in TK for the teacher, after the experience	0.5%	1.7%	14.9%	46.4%	36.5%	**4.17**
Increase in TK for the students, after the exp.	1.2%	3.7%	21.3%	48.6%	25.1%	**3.93**
Need for external help	32.3%	23.8%	15.4%	22.8%	5.7%	**2.46**

A high-school teacher says:

> I had to be humble. I could not step into the classroom and say 'I know it all'; instead, I had to say 'folks, this time we have to cooperate' […] thus it was the students who performed most of the technical tasks.

A primary-school teacher says:

> Since no colleague was willing to cooperate, I selected the two most tech-savvy kids in the classroom to record the audios. They were dubbed 'the technicians' and you could see how proud they were… they walked one meter above the floor.

Table 4
INCREASE IN CONTENT KNOWLEDGE

	1	2	3	4	5	Aver.
Increase in CK for the teacher, after the experience	1.5%	5.0%	18.4%	43.5%	31.6%	**3.99**
Increase in CK for the students, after the experience	0.5%	0.5%	7.2%	51.7%	40.0%	**4.30**
Need for external help	18.6%	18.4%	24.1%	27.5%	11.4%	**2,95**

Primary school teacher says:

> The narrative's content went beyond what is strictly curricular […] Students found content through various technologies: search engines, eBooks, educational software…

Table 5
INCREASE IN PEDAGOGY KNOWLEDGE

	1	2	3	4	5	Aver.
Increase in PK for the teacher, after the experience	0.5%	0.7%	14.4%	53.1%	31.3%	**4.14**
Increase in PK for the students, after the exp.	0.2%	0.2%	6.7%	48.6%	44.2%	**4,36**
Need for external help	18.6%	18.4%	24.1%	27.5%	11.4%	**2,95**

A high-school teacher says:

> Taking part in PoliCultura was quite a challenge, since differently with respect to everyday activities, within this project you are not in full command of all the aspects and therefore you literally do not know where you will end up, and how! Therefore this experience contributed to my professional development not only since I learnt how to use a new Soft-Ware but also, and most important, since I learnt a new way of dealing with my students and a new form of teaching strategy.

The acknowledged increase on all Ks (by all the "actors" within the experience: i.e., both teachers and students) as well as the prominent role played by external helpers clearly show that teachers were not in full command of the Ks required to run the educational experience and the distributed as well as dynamic nature of TPACK.

5.2 Effectiveness of the experience

The reader may now wonder: but was the experience "successful"? teachers "made it", but did students learn? The answer is positive. As largely reported in other publications (see for example Di Blas, 2016b), students (can) achieve a large number of benefits, many of which corresponding to the much sought-after 21st century skills (www.p21.org). Here are some brief data, again from the surveys: on a scale from 1 to 5, the "increased understanding of the subject dealt with" was rated 4.32, the "enhanced curiosity towards the subject dealt with" was rated 4.41, creativity was rated 4.34, team-work was rated 4.04… A quote by a middle school teacher conveys the idea of the benefits the activity can generate:

> All the students committed to the work: 15 hours during school hours, three more times at home. Even the less proficient found a reason to be involved. Many unexpected talents emerged, which in the curricular activities do not have a chance to stand out: for example, in music and technology. Moreover, a peer-to-peer learning process took place, with the most brilliant students literally dragging the others. Thus, the experience was genuinely positive: not only did they learn about the subject of the narrative, but also the relationship among the students and between the students and the teacher has improved. All the students have become more responsible and are scoring better in the other school subjects: their self-esteem has improved and they are proud of what they can do.

Overall, results thus show that teachers who "dare" to face an educational experience where they are not in full command of all the required Ks, counting upon resources in their environment, give vent to a positive process of knowledge-flows, opening up the doors of their classroom to include external helpers and sources. The increase in PK, which could seem strange for quite experienced teachers, may be explained by the novelty of the pedagogical implementation.

Conclusions

This paper presented data from a large-case study with digital storytelling at school: a "special" activity with technology. Data confirm prior findings on the distributed nature of TPACK, showing that teachers tend to count upon a quite sophisticated system of resources that include the students but also other colleagues, relatives, local experts, as well as the internet. This applies to TK and CK especially, while in the case of PK teachers seem to rely upon themselves: they acknowledge an improvement, but apparently they reach it

through self-training. Moreover, data show that the teachers who successfully run these complex experiences are quite aged and with a poor technological knowledge, contrary to what may be expected.

What lessons can we draw? First of all, that teachers do not need to be trained on TK *per se* but rather on how to manage activities where TK is involved. Data show that teachers can handle technology-based activities by orchestrating the system of resources they are immersed in, rather than by learning themselves all the technical details. On the other hand, it is apparent that a strong PK rather than TK is the pre-requisite to success: teachers need to be able to organize the students' work, as it unfolds, even facing unusual settings and situations. The consequences on the teachers' training are evident: teachers should be trained in view of a flexible adoption of the ever-changing technological tools for education and they should also acquire project-management skills.

Future work includes investigating the difference between special activities and every-day activities with technology: can teachers still afford being poorly equipped with TK? Do CK and PK change? Are the front runners still the "seasoned" teachers or do youngsters take the lead?

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