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Indice

The Trialogical Learning Approach in Practices: Reflections from pedagogical cases

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Abstract

In the development of 21st century life skills, specific activity-based learning approaches could be helpful. This article describes the Trialogical Learning Approach, considered from the point of view of its interpretation and evaluation by teachers across a range of pedagogical courses. The aim of the paper is to provide both a summary of reflections on current practices and recommendations for potential enhancements to the trialogical pedagogical application. After a description of the approach, we focus on the role of pedagogical scenarios in educational design and reflective practice and, specifically, the scenarios used by teachers involved in the European project KNORK who have implemented TLA in their courses. From the content analysis of 53 pedagogical scenarios we have derived that: a) teachers were competent in designing their course following the trialogical approach prescriptions, b) teachers believed that the approach had promoted professional, collaborative and digital skills, thus satisfying their initial expectations, and c) a better management of group work and evaluation has been identified as major element requiring improvement.

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Methodological reflections about the use of the scenario as a corpus of data are discussed.

Keywords: Trialogical Learning Approach, Object-oriented learning, Mediation, Pedagogical Scenario, Teacher learning

1. Introduction

One of the main objectives of secondary education is to ensure that students acquire useful skills to achieve success not only in their studies but also in their future professional careers and life in general. These skills are defined by contextual characteristics pertinent to today's students' temporal lives: the 21st century. A comprehensive list of 21st century skills has been provided by Binkley et al. (2012) who identified ten skills grouped into four clusters: ways of thinking (e.g., creativity and innovation, critical thinking, problem solving, decision making, learning to learn and metacognition); ways of working (e.g., communication and collaboration – teamwork); tools for working (e.g., information literacy, ICT literacy), and living in the world (e.g., citizenship; life and career; personal & social responsibility). Equipped with these skills, the citizens of tomorrow should be able to solve complex problems, deal with authentic activities, innovate knowledge work practices, create and support professional networks, build new technologies, and take responsibility for the knowledge advancement in a globalized world. In this paper, we describe a theoretical model considered suitable for promoting these new ways of thinking, working and living in the world, thanks to its focus on technology-mediated collaborative work with knowledge artifacts and practices. Specifically, we will consider this model in the light of the interpretation and evaluation by teachers who have engaged with it in their pedagogical endeavors.

2. The trialogical learning approach and its theoretical foundations

The model that we present in this article uses a "trialogical" learning approach (TLA: Paavola, & Hakkarainen, 2005) (Fig.1).

Figure 1. The Trialogical Learning Approach
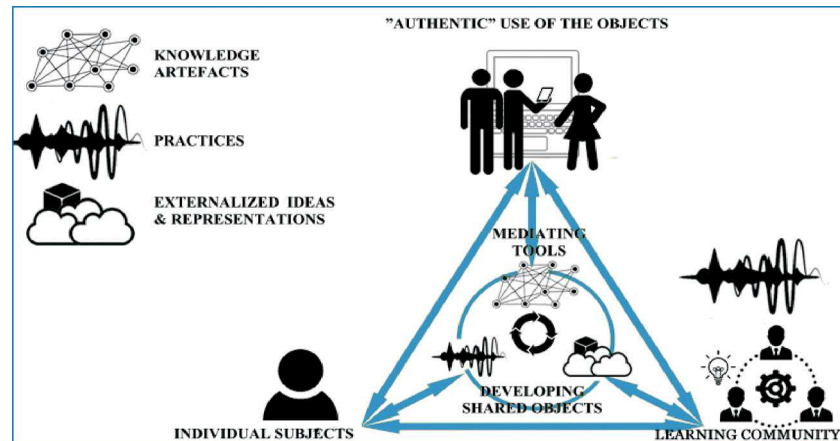
This approach integrates "monological" (with emphasis on individual knowledge and conceptual processes) and "dialogical" (with emphasis on distributed cognition and the role of social and material interactions) approaches, with a third element: the intentional processes involved in collaboratively producing knowledge artefacts that are shared and useful for the community. The acquisition and participation metaphors of learning (Sfard, 1998) are, in this approach, embedded in the knowledge creation metaphor, which, going beyond many traditional dichotomies (Paavola, Lipponen, & Hakkarainen, 2004), focus on both individual and social processes, conceptual knowledge and social practices, needed to foster collaborative creativity.

In this sense, TLA is clearly influenced by knowledge building theory (KB; Scardamalia, & Bereiter, 1994, 2003), both starting from technology-enhanced collaborative learning and both aiming to sustain students in creating knowledge artifacts together (Paavola, & Hakkarainen, 2014). Nevertheless, TLA diverges from KB for two main reasons. KB focus on the innovation of knowledge – mostly intended as conceptual artifacts or ideas –, whereas TLA extends the innovative potential to the *knowledge practices*, e.g. both "personal and social

practices related to working with knowledge" (Hakkarainen, 2009, p. 215). Moreover, though KB too could be defined as a practice-based approach – having been developed in close interaction with teacher practitioners – practices are not conceptualized (beyond knowledge building principles). As it will be clear later, by reading TLA design principles, this approach puts great emphasis on the cross-fertilization between school and community, thinking of the latter both in terms of real customers as well as of authentic challenges able to sustain the development of innovative knowledge practices (see DP1 and DP5, Tab.1). The crossing boundaries required from TLA has, indeed, a double effect: it motivates students and promote the acquisition of the skills needed in the modern knowledge work (Paavola, & Hakkarainen, 2014). That is why, Peirce's and Vygotskji's approach to human activity are more suitable to understand TLA than Popper's "world 3" (Bereiter, 2002) and its emphasis on conceptual artifacts (Paavola, & Hakkarainen, 2009).

The trialogical approach demonstrates here its strong links with the Cultural Historical Activity Theory (CHAT) (Engeström, 1987). Starting from Vygotskij's thought (1981), according to which, our experience of the world is always mediated by a tool, whether tangible or intangible, CHAT perceives knowledge as a collaborative construction mediated by cultural and social artifacts and grounded on practical activities (Cole, 1996). TLA starts from these theories – including Clark's extended mind (2010) and Peirce's semiotic pragmatism (1992) –, maintain the importance of personal learning, and then focus on the role of collaborative processes aimed to develop concrete knowledge artifacts and of the new technologies, which could mediate and sustain these processes. Thus, it favors the use of environments and tools that let individuals create, share, process, transform and organize objects of learning and that, in doing so, enable reflective transformation of knowledge practices. According to Hakkarainen (2009), these practices are more likely to appear in those contexts purposely "designed for the furtherance of innovation and knowledge" (p. 215) and identified as innovative knowledge communities. Similar practices, in fact, can only take place through technological mediation and specifically through technologies able to "transform students'

intangible ideas into digital entities that can be further articulated, shared, interlinked, and extended in long-term processes" (*ibidem*).

Table 1. The six design principles

Design Principle	Definition
DP1 Organizing activities around shared "objects"	Formative action must converge towards the realization of shared objects recognized as important and intended for actual use, beyond the individual as well as the social dimensions of learning. Shared objects are also represented by shared practices and processes
DP2 Supporting interaction between personal and social levels	It is necessary to combine individual work with that of team, considering the different needs and "exploiting" inclinations and interests.
DP3 Fostering long-term processes of knowledge advancement	This principle emphasizes the importance of providing enough time for iterative inquiry cycles and of supporting environments to let long-term processes take place, including creative re-use of previous practice and knowledge artifacts.
DP4 Emphasizing development through transformation and reflection between various forms of knowledge and practices	New ideas and practices could emerge more easily when learning involves various forms of knowledge and practices: declarative, procedural as well as tacit.
DP5 Cross fertilization of various knowledge practices across communities and institutions	Creating connections within other contexts intentionally promotes the acquisition of modes of interaction, ways of thinking and languages typical of contexts other than those of training.
DP6 Providing flexible tool mediation	Accordingly with the 21st century society, the last principle affirms the importance of providing adequate and diversified technologies, selecting those most suited to mediate collaborative activities and enhance aspects highlighted in the other design principles.

Technologies, rather than replace the teacher and / or the class-room, enrich the learning environment and allow experiences otherwise impossible, since they mediate and stimulate new ways of thinking, thus boosting our capabilities. Technologies also enhance the dialogical aspect of learning, opening the doors of the classroom to other classes, schools or environments (Campione, Brown, & Jay, 1992; Ito

et al., 2013; Scardamalia, & Bereiter, 2003). Teachers, for their part, should act as digital sages (Prensky, 2009) when organizing learning environments in which students can use their own digital dexterity to enhance their skills, while teachers and tutors assume the role of guide in the knowledge-creating activity. However, for all of this to be true and effective, deliberate and iterative efforts of transformations of teaching and learning social practices are needed. TLA does not assure these transformations, but it provides solid and well-based guidelines to follow this path, in which the possibilities of the modern digital technologies are exploited to improve education and the perspective goes from technological tools to social practice of their usage (Paavola, & Hakkarainen, 2014).

A trialogical approach is applied through six principles, the so-called design principles (Tab. 1: Hakkarainen, & Paavola, 2009; Paavola, & Hakkarainen, 2014), which guide the planning of technology based teaching and learning activities to facilitate shared efforts of working with knowledge artifacts (Paavola, Lakkala, Muukkonen, Kosonen, & Karlgren 2011). In summary, these principles highlight the main characteristics of TLA: *mediation, knowledge artifacts, knowledge practices* and *object-oriented activities* (Paavola, & Hakkarainen, 2014).

3. Educational design and educational scenarios to support TLA application

As described, the TLA revolves around collaborative construction of knowledge objects and the related innovation of knowledge practices through the use of modern technologies. To this end, it is necessary to carefully structure educational activities, using techniques and proven pedagogical strategies, sculpting them around the objectives and characteristics of the course requirements. Therefore, the importance of pedagogical design is clear, especially in the case of an articulated model such as the trialogical approach.

A pedagogical scenario (PS), as defined Pernine, & Leujeune (2006), is a planned description of learning, defined *a priori* or *a posteriori*, that outlines:

- The learning situation and the general context (how many students, involved, their age, the culture of the classroom, etc.),
- The specification of roles and activities,
- The content, the knowledge and the sources,
- The results.
  A PS may also include, as state by Peter, & Vantroys (2005):
- The sequencing of the activities,
- The learning objects,
- The tools that could be provided by different actors (researchers, teachers, students, parents, experts, etc.).

A PS promotes the use of structured activity based teaching, which enables the development of skills to be broken down into manageable chunks for the learners (Schneider, Synteta, Frété, Girardin, & Morand, 2003). In cases where the PS serves to introduce new practices, such as those advocated by the TLA, such a scenario could be understood as a "boundary object" between what normally happens in the classroom and the innovation needed to introduce collaborative learning enhanced by tools. In this sense, the scenario supports the teacher who wants to innovate their teaching. While a teacher may have their own methods, tips and tricks to aid their memory of the lesson plan and the sequence of activities to be carried out in class, some type of formalization is needed to facilitate the design process and make scenarios easy to share and modify (Ligorio, Andriessen, Baker, Knoller, & Tateo, 2009).

4. The Research

4.1. The Research Setting

In this article, we will focus on a PS used to implement TLA within the KNORK[1] project. KNORK – Promoting Knowledge Work Practices in Education – is a project funded by the European Commission under the Lifelong Learning Programme in the years 2014-2016. Its aim is to test the TLA as a device for improving knowledge work

[1] http://knork.info/website

and digital competencies in secondary and higher education, in order to create a bridge between the world of education and the world of work. The project has been promoted by the Technology in Education Research Group (TEdu) at the University of Helsinki and has included participation of educational establishments in Bulgaria, Sweden and Italy.

Trials of the TLA approach promoted by the KNORK project involved an initial period of teacher training. During the workshops, teachers received practical and theoretical training on the TLA teaching model and were invited to write a PS following a specific template, described as follows:

A. an initial section in which the main characteristics of the course (school / university, discipline, duration, number of teachers, number of students) were specified;
B. the clarification of the reasons that led to testing;
C. a double entry table with course design principles on the one hand, and implementation thereof in the other;
D. reflections about key experiences and suggestions for future implementation;
E. a design section, containing the detailed description of activities, including phases, learning objectives, preparations before the course and forms of assessment adopted.

The writing of the scenario accompanied the implementation of educational activities; during both of these processes, KNORK researchers supported the teachers. At the beginning of the course, teachers produced a first draft of the design, which was revised as the activities progressed. At the end of the course, in addition to further amendments to the scenario, teachers completed reflective evaluations of the experience. The specific construction of the design document makes it a peculiar artefact of this project. Transforming over time, initially teachers indicated how they thought they could apply the principles of the TLA; by the end of the course, they then modified this section – writing down the way in which they had concretely applied them, thus providing us with accounts that we could actually read and analyze – and reflected on how they had been able to apply them concretely.

All scenarios have been made accessible through their insertion in the Re-Use Library[2], one of the main outcomes of the project KNORK.

4.2. Research aims

The aim of this paper is to describe the way in which teachers participating in the KNORK project have interpreted the TLA and assessed the resulting learning experience. We believe that when analyzing the views of those involved in a specific learning intervention we will be able to derive valuable insights on theory and improvement of practices, following the Research-based design approach recommendations (Design-Based Research Collective, 2003; Barab, & Squire, 2004). Specifically, we draw our questions directly from the KNORK PS template and the information it provides. Therefore, following its structure, our research questions were:

1. Why did teachers decide to apply TLA in their courses?
2. How did they interpret TLA prescriptions and design the course to apply them consequently?
3. What pros and cons did they find during their TLA experience?
4. What suggestions did they have to improve future TLA applications?

4.3. Method: corpus of data and analysis

Fifty-three PSs have been collected for this study[3], corresponding to fifty-three pedagogical cases/ courses held during the KNORK project. The majority of courses took place in Italy (39.6%) and Finland (30.2%). Fewer courses were held in Bulgaria and Sweden (15.1% each).

In the table below (Tab. 2), we summarize the main characteristics of the pedagogical cases, drawn directly from the initial section of the PS templates, in which teachers had to specify the aspects of the courses they were going to implement following TLA.

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[2] http://knork.info/website/reuselibrary/
[3] The PSs collected do not correspond to the total number which have been produced during the KNORK project. However, they are the PSs fully available and accessible at the time of this study.

Table 2. An overview of the 53 KNORK pedagogical cases (percentage data)

Level	High School 37.8%	Master's degree 31.1%	Undergraduate 24.4%	Adult training[1] 6.7%
Discipline	Science 43.5%	Technology 32.3%	Humanities 24.2%	
Duration in weeks	11-16 45.3%	5-10 37.7%	> 17 17%	
N° of students	< 30 48.9%	30-60 37.8%	> 60 13.3%	
N° of teachers	1 54.3%	> 2 23.9%	2 21.7%	

[1] Health and technical domains

The majority of courses represented in the analysis were from the higher secondary school level (37.8%). Adoption of the TLA principles was most evident in science (43.5%) and technology (32.3%) courses. The duration of the courses analyzed was predominantly between 11 and 16 weeks (45.3%). Concerning the number of students, almost half of the courses (48.9%) were attended by less than 30 students, with 37.8% having between 31 and 60 participants. More than half of the courses involved delivery by a single teacher[4] (54.3%).

A qualitative analysis of the PS documents was performed. Two researchers entered the online database in which the PSs were stored and downloaded them. Specifically, two researchers performed a content analysis following the Grounded Theory principles (Glaser, & Strauss, 1967; Walker, & Myrick, 2006). This involved several cycles of looking at the data and re-defining categories for analysis. Guided by theoretical principles – which in this case are those ones derived from the TLA –, the researchers defined the categories drawing them directly from data. In line with the qualitative research approach (Smith, 2015), no aspect of the study is preliminarily determined or permanently defined: questions and answers found are then individu-

[4] Though we do not have precise statistics about teachers' experience, during data analysis we did realise a certain variability, going from 2 to 20 years of teaching.

ated as the research goes on. In particular, referring to the DPs section, our aim was to find out how, for example, teachers planned to accomplish each design principle, which strategies and techniques they adopted, and which aspect they evaluated more[5].

5. Results

5.1. Teachers' motivation to adopt the TLA

The first part of the KNORK pedagogical scenario aimed to make explicit teachers' reasons for their choice in adopting the trialogical approach. Thirty-two percent of teachers stated that their primary motivation was to promote the professional skills of students (e.g. respect of deadlines, critical reasoning, use of different instruments), with 26.8% citing a desire to improve collaborative skills. Promotion of digital skills and increased motivation and engagement were considered equally important (16.1%).

In total, approximately 75% of the motivation to engage in the TLA approach revolved around the development of skills, as can be exemplified by an excerpt from one of the scenarios:

In higher education students frequently face with challenges such as how to work effectively in groups, how to use new technologies, how to produce high quality material when submitting a group assignment and how to deal successfully with deadlines. This need is even higher for students who are in the first year of their studies and who have not worked like this before.

It seems that – somehow – teachers feel the urgency of promoting 21st century skills too. Probably their focus is more about students completing the course programme, but this alignment between recent literature (see Introduction) and "real" teachers could be a leverage to innovate teaching and learning paths.

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[5] For this reason, results about this section are not supported by percentage ranges: we derived this data from variety of ideas on how to improve TLA, not as a way to demonstrate the popularity of each proposal between teachers.

5.2. TLA Design Principles (DP) and their implementation in courses

Analysis of the PSs provided an insight into how each teacher planned to implement each of the six core principles of TLA:

DP1*. Organize activities around shared 'objects'.*

Reading the scenarios, we immediately noticed a wide variety of technological products cited in the objectives of the teaching activities. These included, but were not limited to: an interactive blog on the Italian Renaissance, an exhibition on the Holocaust, a variety of apps and games, and wikis on driving sensors and proper nutrition. Typically, however, the shared objects were intended for internal use, rather than external to the training context, as advocated by TLA. In most instances the products cited were teacher-driven proposals; however, in a few cases, class based negotiation, through various forms of brainstorming concerning the final project and/or the building process, were reported. In addition to the final learning products, intermediary reports, mind maps and/or observation forms were also cited as class learning requirements. Moreover, the courses were often characterized by a modular structure in which several sub-activities and intermediate deadlines were included. Both the intermediate product and the modular structure supported the accomplishment of TLA DP3. To achieve the final and intermediary learning objectives a variety of different activities, mostly based on small groups who worked interdependently through a distribution of tasks and roles, were evident. These activities were in compliance with TLA DP2 (see below).

DP2. *Support integration of personal and collective agency and work; arouse the individual and collective initiative.*

The second principle was evidenced by teachers taking into account the individual and social learning of their students. Students were organized through their individual commitment, personal intervention in the discussion activities or building object, the taking of specific roles (e.g. the tutor, the scenario-maker, the editor, the designer, etc.), compliance with the deadlines, and their commentary on the work of

others. Teamwork was encouraged in educational discussions, both online and in the classroom, in the creation of the finished product, in the distribution of roles and interdependent tasks, and the use of techniques pertinent to the task. Students were always divided in small work-groups from 6 to 10 members and frequently re-assembled into different groupings throughout the course. Teachers chose to adopt an evaluation strategy that took into account both the individual student and the teamwork. This was possible using ad hoc tools such as – in the Italian cases – a specific assessment protocol, developed to meet this need (Sansone, & Ligorio, 2015).

DP3. *Foster long-term processes of knowledge advancement.*

As previously stated, the courses analyzed had an average duration of approximately 15 weeks. In each of the weeks, several hours were devoted to trialogical activities. These activities supported work processes and long-term learning, in which the modular designs facilitated repetition of procedures and practices ensuring a continual review and reflection on the work completed. In many cases, such reflections were supported by the completion of "captain's logs" or final questionnaires. In addition, teachers encouraged students to share preliminary versions of objects and to offer each other feedback that was more or less structured. This process was one of the most frequently used method in the pedagogical cases analyzed. Implementation of the DP3 was also evidenced in teachers that considered and made explicit the future use of the object in their PS, and/or its application for other students or users who could start from that version to improve it or to use it as a learning base. For example, a course that sought to produce tutorials in the history of art, aimed at supporting students in the revision of the subject, was implemented as a wiki that could be improved and added to by future students.

DP4. *Emphasize development and creativity through transformation and reflection.*

To support transformation and reflection, teachers planned learning opportunities, which combined different types of knowledge in a variety of

formats. These included the use of textbooks, web pages, audio-video content and guided tutorials. Expert advice and peer discussion were also used to draw out implicit knowledge among the learners and allow them to compare their developments with scientific sources. Evidence in the PS's highlighted the use of the e-portfolio's to foster meta-cognitive reflections. Such a learning device was conceived as accompanying the activities to stimulate the self-assessment of one's own participation and contribution to the group-work. E-portfolios were also meant as a digital space in which to collect students' best artifacts – notes, report, ideas and concrete products –. To comply with this principle many teachers also introduced specific roles into their learning activities, for example, the product expert, the auditor and the external sources researcher.

DP5. *Cross-fertilization of various knowledge practices and artifacts across communities and institutions.*

Associations between education and professional environments were used frequently in courses dealing with scientific or technical learning. Development of knowledge and learning outcomes using professional tools and contexts were evident, allowing for the promotion of work-life skills of a more technical nature and nearing the students to the labor market. In other cases, expert procedures were modelled and displayed so that they could then be repeated during the educational path. This often resulted in the intervention of experts in the process of review and evaluation of the products created, if not from the beginning of the activities, but with the final commissioning of the object itself. Moreover, during the activities, groups were re-assembled to favor the transfer of knowledge practices from one group to another.

DP6. *Provide flexible tools for developing artifacts and practices.*

Analysis of the pedagogical scenarios indicated that both teachers and students used a variety of technological tools in their learning pathways. Tools, software, apps, and digital environments were used in many different ways to support the different phases and activities[6].

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[6] For a complete list, see KNORK Re-Use Library

Examples included the use of technical software (e.g. Gnu electric[7], irsim[8]), integrated learning platforms (e.g. Moodle[9]), and online walls for brainstorming (e.g. Padlet[10]).

5.3. Reflections on testing: pros and cons, and suggestions for improvement

At the end of the TLA trials, teachers reviewed and completed the pedagogical scenarios. In doing so, they explained their points of view with respect to key experiences during the courses and suggestions for improvement for future implementations of the TLA approach.

The main advantage that they attributed to the trial was that - based on their impressions - the TLA approach had promoted the development of professional, digital and collaborative skills (26.7%). The ability to motivate students and increase their participation in learning activities was also cited as a key advantage (20%). Furthermore, the TLA approach appeared to have promoted better learning in terms of understanding and knowledge construction (11.1%) and constructive interactions between teacher and students (8.9%). A smaller percentage of teachers (6.7%) reflections cited that the TLA approach had facilitated the discovery of new technologies, links between different disciplines and the integration of both theory and practice into learning.

The following excerpt from a teacher highlights some of these findings:

The main success however can be seen in the long run. Students through time learn to set up rules for their group work and undertake responsibility as a group. They gain important skills, which they can use not only for their future courses but also eventually for their future jobs.

In terms of critical aspects of the TLA trial, teachers identified group work dynamics (29%; e.g. low participation, drop-outs and conflicts that required the reorganization of the groups) as a key area of

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[7] https://www.gnu.org/software/electric/
[8] http://opencircuitdesign.com/irsim/
[9] www.moodle.org
[10] www.padlet.com

difficulty. Keeping pace with the schedule of learning activities (25.8%) and the evaluation of learning (16.1%) – in part due to the difficulty in evaluating individual contributions to the group work – were also cited. Other aspects raised concern such as technical problems (9.7%), insufficient digital skills (6.5%) and the commitment level required by the teacher in implementing the TLA approach. For instance, the need for ongoing support of students (12.9%), especially in the use of instruments and the familiarization with new work-methods.

In view of these critical points identified, teachers believed that, in the event of subsequent implementations of the TLA, it would be necessary to first improve aspects concerning the evaluation of student learning (28%). Secondly, given the identified difficulties in managing the dynamics of participation in group work, teachers called for more attention to the compositional strategies of the groups and the support of active participation (16%), for example through the introduction of a bonus/reward points scheme. The teacher's role and the planning of activities (12%), followed by aspects related to time and technological tools (8%) were also highlighted as requiring better management.

The following excerpt summarizes some of the criticisms and suggested improvements highlighted by many teachers, in particular about the scheduling (required by the new working methodology) and the role of teacher:

I myself realized that when using new ways of working enough time should be reserved for practicing the new skills; you cannot expect that students manage the new practices at once. For instance, peer evaluation should be practiced with an exercise before it is actually used in the real task. All working methods should be structured and guided, and there has to be repeated possibilities to practice and improve the skills. The teacher should not give up if students do not manage well at once, but give more guidance and instructions, and encourage students to go on.

6.Concluding remarks

Successfully cultivating 21st century skills requires a deep change in educational practices and the adoption of a specific framework. In

this paper, we have described the Trialogical Learning Approach, considered from the point of view of its interpretation and evaluation by teachers across a range of pedagogical courses of the European KNORK project. To do this, we used a cross-reading of the pedagogical scenarios written by some of the participating teachers. KNORK scenario templates provided a means of both designing learning opportunities and making evaluative reflections focused on the TLA experience to highlight critical areas and possible improvements needed. Each section of the PS templates were analyzed in order to trace the common elements recurring across the teachers and courses delivered as part of the trial.

Starting with an analysis of the reasons that prompted the teachers to adopt the trialogical approach, there emerges an alignment with the theoretical model objectives: to promote the development of those professional, collaborative and digital skills that reside under the umbrella of 21st century skills (Binkley et al., 2012; Scardamalia, Bransford, Kozma, & Quellmalz, 2012). Additionally, teachers highlighted the need to involve and strengthen the participation of their students.

In reading the scenarios, it can be seen how teachers planned to translate the individual DPs into each course (Tab. 3).

Teachers have interpreted in a diversified and – somehow – original manner each trialogical indication, adapting it to their own context and educational objectives. This emerges for both the type of object/product built, and the strategies adopted to do so. It is also evident in the tools used and the way in which collaboration practices have been favored. Considering the training and ongoing support that teachers received from KNORK researchers, it could be disputed that they were just following the experts' suggestions. We would consider this eventuality as a success. Pedagogical scenario planning and execution is unusual and very few teachers can «spontaneously do it». The majority needs adequate training and supporting environments since such designs can become very complex and costly (Schneider et al., 2003). Researchers are therefore called to help teachers in implementing such a pedagogical transformation, which we already know requires widespread commitment, institutional support and individual good will.

Table 3. Main findings about DPs application from KNORK pedagogical scenario

Design Principles (keywords)	Main findings
DP1 Shared object	• Knowledge artifacts or technological tools mainly intended for students' use • No focus nor reporting shared practices and processes • DP description including DP2 and DP3
DP2 Personal and collective agency	• Small groups • Online and classroom individual and group commitment via interdependent task and roles • Balanced evaluation
DP3 Knowledge advancement	• Modular structure • Many weeks of activities • Intermediate products and peer feedback • Captain's logs • Objects revision also from future users
DP4 Reflections and creativity	• Many knowledge formats • Expert advices • E-portfolio • Roles (e.g. product expert, auditor)
DP5 Cross-fertilization	• Use of professional tools and practices • Expert interventions as reviewers or committee • Group re-assemblement
DP6 Flexible tools	• Tools, software, apps, and digital environments • Supporting each phase and activity

On analysis of the trials, teachers' reflections indicate that the main advantage of the TLA was that it supported the development of professional, collaborative and digital skills, and that it have improved involvement and students' participation, thus meeting their initial expectations and reasons to "go trialogical".

Main criticisms of the approach cited were the dynamics linked to group work and the difficulty of managing time – both for teachers and for students. This last aspect can be attributed both to the short duration of most courses, and possibly to the unfamiliarity of the TLA and associated working methods in the classroom. Evaluation was another critical issue. The kind of activities and processes under the TLA model require different forms of evaluation from traditional learning activities, and should be able to take into account

the individual as much as the group and the products as much as the processes (Sansone, & Ligorio, 2015). Teachers felt that the area of evaluation was somewhat weak when implemented in their courses, and believed that it should be an area of improvement for them and others in subsequent experiments. It was suggested that a different system of assessment could also improve focus on teamwork.

From the scenarios, we can conclude that teachers seemed able to provide an efficient and comprehensive instructional design, which took into account all aspects of the TLA in a custom fashion for each course delivered. From the point of view of practical application, difficulties have been discovered relating to the management and evaluation of teamwork, timing and, less predominantly, to technological aspects. These insights are for us elements to take into account, particularly in the training phase of future educators. It is imperative that teachers know and experience collaborative learning strategies, are aware of evaluation protocols and can support materials for course delivery (templates, tutorials, etc.). In addition, we now also realize the importance and advantage that familiarization with multiple environments and technological tools can have in teacher education and subsequent adoption of the TLA.

Finally, from a methodological point of view, we believe the pedagogical scenarios used in the KNORK trials are valuable tools to support the design based on the TLA and to scaffold a continuous improvement of educational practices. The PSs produced as part of the KNORK project, in fact, were not only an educational design document, but they also promoted a reflection on the experience aimed at facilitating future implementation by their own or other teachers, since they provided an overview about what happened, the limitations encountered and the solutions introduced.

In our case, we read and analyzed each section of the template, without having any preconceived answer in mind, to discover personal and original TLA interpretations and evaluations from KNORK teachers. After all, the templates have been written without rigid indications about length, style, or any mandatory section sub-contents, therefore – referring to DPs section – they are not a perfectly faithful representation of what have been realized, but an approximation.

Aware of this, our aim was to take advantage of teachers' imagination and proposals in order to enrich the TLA DPs definition. Elsewhere (Ilomäki, Stefanova, Vasileva, & Lakkala, 2015; Ligorio, Sansone, & Cesareni, 2015; Ligorio, Sansone, & Amenduni, in review) different analyses on the same courses have been performed in order to collect objective data about, for instance, the actual development of 21st skills or the innovation in educational practices.

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