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Between Awareness and Acceptance: a more mature School Teachers' Perspective on Integrated Learning one year after the pandemic outbreak

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Abstract: One year after the outbreak of the pandemic that provoked a forced and massive adoption of technology enhanced learning practices, followed by a continuous evolution of their delivery modalities (on-line learning, blended learning, parallel blended learning, hybrid learning) and, finally, by a strong commitment to come back to a "new normal", we have investigated, by mean of a survey, the evolution of: a) perceptions and perspectives of Italian school's teachers about integrated learning; b) the undergoing innovation process characterized by unprecedented features and vastness. The exploration has been conducted by integrating perspectives and factors introduced in the past by several models - TAM, UTAUT, DOI, TOE, KAM - to describe technology innovation and adoption processes. We observed a higher perceived teachers' technological and pedagogical preparation, together with a higher readiness of the schools to react to unexpected events or sudden prescriptions. A readiness that should be ascribed mainly to the quality of the management and to an increase in the level of collaboration and cohesion among the actors of the learning process, rather than to an enhancement of the technological infrastructures. Collaboration, indeed, emerges as the main peculiarity of this last year, an engine capable to foster the spread of competences and a beacon capable to guide the choice of teaching practices. The influence of contextual factors appears not relevant and that of the "perceived values" somewhat marginal. As far as the innovation process: the awareness phase developed satisfactory and, in parallel, the acceptance phase also started. The possible transition to the adoption phase appears uncertain and not easy to characterize. At the time of the survey, however, the teachers perceived, the integrated learning as a modality that could be used in the future to realize 36% of the school activities.

Keywords: smart learning ecosystems, Italian schools, Covid-19 pandemic, teachers' perception, technology innovation process, technology enhanced learning, on-line learning, blended learning, parallel blended learning, hybrid learning, integrate learning, descriptive analysis, causal network, MAETI.

1 Introduction

With the advent of the pandemic caused by Covid-19 [1], all over the world and for all learning ecosystems (schools, universities, territorial learning communities, etc.) [2], began a massive innovation process that has no equal in the history of the technological development for its speed and geographical extension.

In the past many models have been developed with the aim to describe standard processes of technology innovation and acceptance (included those occurring in educational contexts) and very recently Leoste et al. [6,18] compiled an exhaustive overview of such attempts. In particular, those involving school teachers have been described as composed by three main stages or phases: a) *awareness* (getting aware about and familiarize with a technology); b) *acceptance* (experiment with a technology in real contexts and take a decision about its relevance); c) *adoption* (the technology becomes a *need to have*) [19]. In the case of traditional technology innovation processes these stages are expected to have on average a duration that may oscillates, respectively, between few weeks and few months, one year and one year and a half, two and few years [6,18,19].

Actually, and unluckily, it is not obvious that such models could be applied to the present situation since the pandemic has activated an innovation process with unprecedented features: the process, in fact, did not concern only a small group of pioneering teachers eager to experiment a new technology, but the entire teaching staff, as well as all students and all stakeholders. In addition the awareness stage did not develop in a controlled experimental setting but took place, rather, in real contexts, side by side to the delivery of the didactic activities, often re-designed on-fly. Moreover, unlike a usual process of technology innovation, in this case the people involved did not experiment just one technology to carry out a specific didactic activity but, rather, a more or less large bouquet of technologies used in parallel, and in an integrated manner, to implement the entire set of didactic and organizational activities required by the learning processes. Finally, an additional peculiarity of the innovation process induced by the pandemic is the continuous adaptation of the "experimental" setting [7] that leads also to what we can define *integrated learning*: depending also on the specific learning ecosystems (universities, high schools, K12, etc.), the setting has been transformed from online learning in hybrid learning (i.e. alternation of online learning and face-to-face learning) or in parallel blended learning (i.e. parallel delivery of face-to-face and on-line learning); sometime also the integration of multiple settings has been adopted with the hope to identify the optimal configuration to reproduce at best the *normality*. To provide a full description of the operational context within which the innovation process has been and is still progressing it is also important to stress that, after almost six months from the outbreak of the pandemic, the process started to be influenced also by the attempt by policy makers and part of the society to push back the learning technologies to the role of tools to be activated only in case of emergency. In other words, the innovation process, and in particular the technology *acceptance* stage, was initially forced and then slowed down, instead of being continuously sustained. Because of all the above peculiarities, without performing a detailed investigation, it is not easy to figure out whether an adequate acquisition of *awareness* took place and if it has been intense enough to stimulate a switch from a *forced acceptance* to a *spontaneous and aware acceptance stage* and, as well, if it has been or will be ever capable to generate *adoption* and, in case, according to what modalities.

To perform an in-depth investigation and try to grasp the characteristics of the peculiar innovation process triggered by the pandemic one has to build up the most comprehensive framework possible and, thus, to integrate the different perspectives offered by the models developed up to now to describe the standard innovation and acceptance processes [6,18]. In particular we have considered:

• the Technology Acceptance Model (TAM) [3] that indicates the perceived usefulness and the perceived ease of use as the fundamental determinants of user acceptance;
• the Knowledge Appropriation Model (KAM) [20] that concentrates on the relation among innovation stages and collaborative social practices;
• the Technology-Organization-Environment (TOE) framework [4] that deals with factors - technological, organizational and environmental - that influence technology adoption at organizational level;
• the Unified Theory of Acceptance and Use of Technology (UTAUT) [5] that integrates several technology acceptance models, including TAM and DOI, and considers four main constructs: the performance expectancy, the effort expectancy, the social influence and the facilitating conditions;
• the Diffusion of Innovation Theory (DOI) [2] that intends to describe the spread of innovation among a given population or social systems and defines a 5 stages innovation process.

As far as we know, up to now there have not been any attempt to integrate the factors described by the above models and use the framework that could derive from it to investigate the relevance that such factors might assume in describing a massive and sudden innovation process like the one triggered by the pandemic. The study described in the following sections, thus, is not only timely but it is needed to get a better insight of the technology innovation process that is going on in all learning ecosystems since March 2020. For this reason we decided to carry on a survey that involved 293 Italian school teachers, and came one year after a similar investigation [9] conducted, on the same target, two months after the beginning of the pandemic (May 2020), i.e. at the end of the very first emergency phase.

Synthesizing, the three main goals of our study have been the following:

a) to monitor the evolution of the teachers' perceptions, keeping in mind that the survey conducted in May 2020 [9] had a narrower purpose and was designed mainly to "take a picture" of the "steady state", two months after the sudden transition from face-to-face to on-line teaching activities;
b) to investigate if the factors defined by previous models of technology innovation and acceptance processes could be relevant also to describe the innovation process triggered by the pandemic;
c) to sketch a more general model of technology innovation processes that we hope could become a reference to investigate similar issues in any complex educational setting and for any learning ecosystems.

In addition, this investigation is also intended to lay the foundation for future surveys that could be carried on to monitor the evolution of the present situation on a medium-long term (i.e. to detect the level of technology *acceptance* and *adoption* fostered by the pandemic and, as well, the possible increase in the e-maturity [10] level of the learning ecosystems).

In the following we will provide first a description of the factors taken into consideration to design the survey. After a brief description of the experimental setting, we will move on with the discussion of the results, starting with the outcomes of the descriptive analysis, that will allow us to propose a first comparison with the situation detected in May 2020. Immediately after we will describe the causal network that allowed us to put in relation the factors investigated during the survey and identify, as well, their relevance. Finally, we will sketch and discuss the Model for the Attitude to get Engaged in Technological Innovation (MAETI) [8,16] adapted to the case study investigated during this work.

2 The experimental framework

2.1 Factors relevant to technology innovation and acceptance processes

Due to the peculiarities of the process considered here, as already discussed above, we could not take any of the previous models as unique reference framework and thus we had to integrate their different perspectives with the hope to make emerge from the survey the role that might have been played by each perspective, category of factors and, as well, each single factor. Table 1 shows the outcomes of our integration efforts: the list of factors that have been considered during the present study, grouped under ten domains. Three of them refer to various aspects of the learning ecosystems: the technological setting, the organizational factors and the available level of competences. One factor domain groups what can be considered personal factors. Two additional domains contain the contextual factors, that can be separated in those accounting for environmental influences and those considering individual aspects. A large set of factors are grouped under the domain educational activities and processes. Finally, we have three domains related respectively to the perceived values of the technology based learning processes, the perceived efficacy and the perceived change that have been induced at both individual and process level. In principle each of the above group of factors, and each single factor, could potentially contribute to the outcomes listed in the second part of Table 1 that can be grouped under three categories related respectively to: the individual intentions, the future expectation about the learning process and the vision about the learning ecosystems.

Table 1: List of the factors considered in the present study, organized by domains. In the third column are listed the technology innovation and acceptance models that consider similar factors.

Factor domain	Factors considered in our investigation that may influence the innovation process	Correlated models
Learning Ecosystem: Technological setting	School Connectivity (SC); School Technological Adequacy (STA)	DOI and UTAUT

Learning Ecosystem: Organizational factors	School Reaction capacity (SRC); Adequacy of the contingency plan (ACP); Emergency Management (EM; UR in ref. 3); Operational Assistance (OA); Cohesion among colleagues (CC); Collaboration among all actors (CAA)	TAM, DOIT, UTAUT and TOE
Learning Ecosystem: Competences	Average Teachers' Technological Preparedness (ATTP; TTR in ref. 3); Average Teachers' Pedagogical Preparedness (ATPP; TPR in ref. 3)	
Personal factors	Personal Connectivity (PC); Individual Technological Adequacy (ITA); Individual Technological Preparedness (ITP); Individual Pedagogical Preparedness (IPP); Individual Innovation Propensity (IIP)	partially considered by DOI and UTAUT
Contextual factors: wider environment	Political Action (PA); Public Opinion (SI); Influence of the Prevalent Opinion in the Context (IPOC); Support by Families (SbF)	DOI and TOE
Contextual factors: individual level	Integration of Family and Didactic Commitment (IFDC); Psychological Problems (PSP);	
Educational activities/processes	Integration of Didactic Activities (IDA); Reproducibility of Classroom Dynamics (RCD); Collaborative Activities (CA); Collaborative Activities Percentage (CAP); Collaborative Activities Quality (CAQ); Communication with Students (CWS); Ability to motivate the students (AMS); Communication with Peers (CWP); Relationships with Peers (RWP); Relationships with Students (RWS); Videoconf Usage for Lesson (VUL) Videoconf Usage for Discussion (VUD); Recorded Video Usage (RVU); Forum Usage (FU); Quiz Test Usage (QTU); Dashboard Usage (DU); Didactic Material Repository Usage (DMRU); Design Activities (DA);	partially considered by KAM
Perceived changes (Individual and Process levels)	Personal Time Management Capacity (PTMC; TTMC in ref. 3); Improvement in the Feeling towards Technologies (IFT); Improvement in Technological Skills (ITS); Change in Efficacy of Didactic Activities (CEDA); Change in Didactic Activities(CDA); Change in Evaluation Modality (CEM); Influence of Strength (IoS); Influence of Weakness (IoW); Workload Increase (WI);	
Perceived values of technology based processes	Easyness of Use of the Integrated Didactic (EUID; EUOL in ref. 3); Usefulness of the Integrated Didactic (UID; UOL in ref. 3);	TAM, UTAUT, DOI and TOE

	Efficacy of Integrated didactic (EID); Usefulness of Technologies (UOT);	
Perceived efficacy	Efficacy of Use of the Integrated Didactic (EID); Change in Efficacy of the Evaluation (CEE);	TAM, DOI and TOE
Potential outcomes		
Outcomes: Learning ecosystems	School Innovation Propensity (SIP); Degree of e-Maturity (SeM);	
Outcomes: Learning processes	Extent to which School should Rely on Integrated Didactic (SRID); Sustainability of Integrated Didactic (SID); Usefulness of Education on Pedagogy of Integrated Didactic (UEPID; REDP in ref. 9); Usefulness of Education on Technologies for Integrated Didactic (UETID);	
Outcomes: Individual intentions	Intention to Use Integrated Didactic (IUID); Intention to Use Smart Organization (IUSO); Percentage of Use Integrated Didactic (PUID)	

2.2 The questionnaire and the participants

Following the outcomes of the integration effort reported in Table 1 we have designed a five-sections questionnaire presenting a total of 80 items. Section I comprises six socio-biographical background items (gender, age, school level, school curriculum and teaching subject, geographical location). Section II presents 29 items (22 questions requiring a multiple choice or numerical answer and 7 open questions or requests for explanatory comments). This section focuses on respondents' perceptions about the general operating conditions. Section III is composed of 26 items (20 questions requiring a multiple choice or numerical answer and 6 open questions or requests for explanatory comments). This section deals with the learning process and the didactic activities. Section IV presents 10 items devoted to general operating conditions (6 questions requiring a multiple choice or numerical answer and 4 open questions or requests for explanatory comments). Its focus is on changes in teachers' opinions, on personal perceptions and on repercussions on the didactic activities. Section V, finally, comprises 23 items (18 questions requiring a multiple choice or numerical answer and 5 open questions or requests for explanatory comments). This section investigates any changes in teachers' expectations for the future. The complete questionnaire is available at [11].

As for the previous survey [9], the participants were contacted mainly via announcements on social media and Facebook turned out, again, to be the most effective dissemination channel. We posted the call for participation in about 25 teachers groups on Facebook, joined by a total of about 50,000 (non-unique) members. Since our goal was to investigate the evolution of the Italian situation at about one year since the introduction of the school lockdown (March 5th, 2020), the survey was open from February 9th, 2021 to March 28th, 2021.

The survey was completed by 293 teachers (233 females, 60 males) employed in primary (65), lower secondary (52) or upper secondary (162) schools. In terms of macro-regional area distribution, 23% were from North Italy, 32% from Central Italy, and 45% from South Italy and the islands. The sample vs entire population comparison revealed an almost perfect balance in terms of gender (80% females in the sample, compared to 83% in the target population), and a slight imbalance as far as the geographical distribution is concerned (if we consider the distribution of the entire population: respectively 40%, 22% and 38% for North, Centre, and South Italy) [12]. The sample appeared to be representative of the mean population age (50.4 years vs 48.9 years) [13].

As an additional control we measured the possible fatigue effect induced by the length of the questionnaire. This turned out to be very low, with less than 4% of respondents skipping the multiple choice and numerical-answer questions, even towards the end of the survey.

3 Results

As we did in the past [8,9,16] to make emerge the teachers' feelings and opinions and the complex network of relationships connecting the factors taken in consideration during the investigation (see Table 1), we pursued multiple strategies. First, we carried out descriptive and univariate analyses (Tables 2), that allowed us to perform a comparison with the results we obtained in April 2020 (section 3.1). Then we worked out the network of relations among factors and tried to infer the direction of causality for such associations. More specifically, we used the PC algorithm [14,15] to infer the direction of causality in the graph (section 3.2). Finally, to obtain a bird's-eye view of both intensity and sign of the variables' relations, we employed the paradigm of network analysis (section 3.3).

Table 2: Outcomes of the teachers' perceptions about the factors listed in Table 1. A 10 points Likert-like scale (1-10) was used unless otherwise indicated.

Factors	**Average**	**t-test**	**Average April 2020**
Learning Ecosystems: technological settings and organizational factors			
School Connectivity SC	M = 6.19 [5.93, 6.46]	$t(291) = 5.15, p < .001$, *Cohen's d* = .30	
School Technological Adequacy STA *(TAOE in ref. 9)*	M = 6.19 [5.90, 6.47]	$t(291) = 4.80, p < .001$, *Cohen's d* = .28	M = 6.36 [6.10, 6.62]
School Innovation Propensity SIP	M = 7.28 [7.04, 7.51]	$t(289) = 15.04, p < .001$, *Cohen's d* = .88	
School Reaction Capacity SRC *(SR in ref. 9)*	M = 7.23 [7.01, 7.49]	$t(286) = 15.13, p < .001$, *Cohen's d* = .89	M = 6.23 [5.98, 6.48]
Adequacy of the Contingency Plan ACP	M = 7.52 [7.28, 7.75]	$t(290) = 16.87, p < .001$, *Cohen's d* = .99	
Emergency Management EM	M = 7,47 [7.25, 7.69]	$t(290) = 17.70, p < .001$, *Cohen's d* = 1.03	

Operational Assistance OA	M = 6.72 [6.46, 6.98]	*t*(289) = 9.27, *p* < .001, *Cohen's d* = .54	
Cohesion and collaboration among colleagues CC	M = 7,36 [7.13, 7.59]	*t*(290) = 16.07, *p* < .001, *Cohen's d* = .94	
Collaboration among all actors CAA	M = 6,96 [6.72, 7.20]	*t*(288) = 11.95, *p* < .001, *Cohen's d* = .70	
Learning Ecosystems: competences and individual factors			
Average Teachers' Technological Preparedness ATTP *(TTR in ref. 9)*	M = 6.69 [6.52, 6,85]	*t*(289) = 14.33, *p* < .001, *Cohen's d* = .84	M = 5.93 [5.72, 6.14]
Average Teachers' Pedagogical Preparedness ATPP *(TPR in ref. 9)*	M = 6.55 [6.37, 6.74]	*t*(285) = 11.29, *p* < .001, *Cohen's d* = .67	M = 5.85 [5.65, 6.05]
Personal Connectivity PC	M = 8.22 [8.05, 8.38]	*t*(290) = 32.23, *p* < .001, *Cohen's d* = 1.89	
Individual Technological Adequacy ITA	M = 8.26 [8.09, 8.43]	*t*(289) = 32.16, *p* < .001, *Cohen's d* = 1.89	
Individual Technological Preparedness ITP	M = 7.68 [7.52, 7.83]	*t*(289) = 27.48, *p* < .001, *Cohen's d* = 1.61	
Individual Pedagogical Preparedness IPP	M = 7.43 [7.52, 7.83]	*t*(289) = 27.48, *p* < .001, *Cohen's d* = 1.42	
Individual Innovation Propensity IIP	M = 8.15 [7.97, 8.34]	*t*(290) = 28.90, *p* < .001, *Cohen's d* = 1.69	
Contextual factors			
Political Action PA	M = 4.93 [4.67, 5.18]	*t(286)* = -4.93, *p* < .001, *Cohen's d* = -.26	
Societal Influence (Public Opinion) SI (-5/5)	M = -0.49 [-0.82, -0.16]	*t(290)* = -2.89, *p* = .004, *Cohen's d* = -.17	
Influence of the Prevalent Opinion in the Context IPOC	M = 0.07 [-0.17, 0.32]	*t(282)* = 0.60, *p* = .550, *Cohen's d* = .04	
Support by Families SbF	M = 5.79 [5.51, 6.07]	*t(284)* = 2.03, *p* = .043, *Cohen's d* = .12	
Integration of Family and Didactic Commitments IFDC	M = 5.42 [5.16, 5.68]	*t(288)* = -0.62, *p* = .535, *Cohen's d* = -.04	
Personal Time Management Capacity PTMC *(TTMC in ref. 9)* (scale -5, +5)	M = -1.08 [-1.40, -0.76]	*t(288)* = -6.62, *p* < .001, *Cohen's d* = -.39	M = -.43 [-.74, -.12]
Psychological Problems PSP	M = 5.19 [4,90, 5.49]	*t(277)* = -2.03, *p* = .043, *Cohen's d* = -0.12	
Educational activities/processes			
Integration of Didactic Activities IDA	M = 5.62 [5.37, 5.88]	*t(288)* = 0.95, *p* = .340, *Cohen's d* = .06	
Reproducibility of Classroom Dynamics (RCD)	M = 5.95 [5.72, 6.19]	*t*(291) = 3.79, *p* < .001, *Cohen's d* = .22	M = 5.32 [5.08, 5.57]
Design Activities DA	M = 6.32 [6.06, 6.59]	*t*(289) = 6.20, *p* < .001, *Cohen's d* = .36	
Collaborative Activities CA	M = 6.19 [5.91, 6.47]	*t*(288) = 4.83, *p* < .001, *Cohen's d* = .28	
Collaborative Activities Quality CAQ	M = 5.61 [5.35, 5.88]	*t(283)* = 0.83, *p* = .407, *Cohen's d* = .05	
Collaborative Activities Percentage CAP %	M = 50 [48, 53]	*t(287)* = 35.70, *p* < .001, *Cohen's d* = 2.10	
Communication with Students CWS	M = 6.60 [6,38, 6.83]	*t(288)* = 9.69, *p* < .001, *Cohen's d* = 0.57	
Ability to motivate the students AMS	M = 6.97 [6,79, 7.15]	*t(286)* = 15.83, *p* < .001, *Cohen's d* = 0.93	
Relationships with Peers RWP (-5/5)	M = 0.71 [0.42, 1.00]	*t(288)* = 4.84, *p* < .001, *Cohen's d* = 0.28	
Relationships with Students RWS (-5/5)	M = 0.96 [0.69, 1.24]	*t(287)* = 6.87, *p* < .001, *Cohen's d* = 0.41	

Videoconf Usage for Lectures VUL	M = 7.87 [7.61, 8.12]	*t*(289) = 18.34, *p* < .001, *Cohen's d* = 1.08	
Videoconf Usage for Discussion VUD	M = 7.22 [6.94, 7.49]	*t*(289) = 12.26, *p* < .001, *Cohen's d* = 0.72	
Recorded Video Usage RVU	M = 6.37 [6.07, 6.67]	*t*(288) = 5.68, *p* < .001, *Cohen's d* = 0.33	
Quizz/Test Usage QTU	M = 5.87 [5.55, 6.20]	*t*(289) = 2.25, *p* = .025, *Cohen's d* = 0.13	
Forum Usage FU	M = 4.33 [4.04, 4.63]	*t*(285) = -7.78, *p* < .001, *Cohen's d* = -0.46	
Dashboard Usage DU	M = 7,66 [7.38, 7.94]	*t*(291) = 1.03, *p* < .001, *Cohen's d* = 0.90	
Didactic Material Repository Usage DMRU	M = 7.54 [7.27, 7.81]	*t*(291) = 14.73, *p* < .001, *Cohen's d* = 0.86	
Perceived changes			
Improvement in the Feeling towards Technologies IFT *(IAT in ref. 9)*	M = 7.10 [6.83, 7.37]	*t*(287) = 11.73, *p* < .001, *Cohen's d* = .69	M = 6.30 [6.01, 6.59]
Improvement in Technological Skills ITS	M = 7.40 [7.16, 7.63]	*t*(287) = 15.76, *p* < .001, *Cohen's d* = .93	M = 6.88 [6.63, 7.12]
Workload Increase WI %	M = 68 [66, 71]	*t*(291) = 48.12, *p* < .001, *Cohen's d* = 2.82	M = 65 [63, 68]
Change in Didactic Activities CDA %	M = 60 [57, 62]	*t(285)* = 47.14, *p* < .001, *Cohen's d* = 2.79	
Change in Evaluation Modality CEM %	M = 52 [49, 56]	*t(284)* = 32.46, *p* < .001, *Cohen's d* = 1.92	
Influence of Strengths IoS %	M = 54 [51, 58]	*t(254)* = 32.16, *p* < .001, *Cohen's d* = 2.01	
Influence of Weaknesses IoW %	M = 62 [59, 65]	*t(255)* = 38.17, *p* < .001, *Cohen's d* = 2.39	
Perceived values			
Easiness of Use of the Integrated Didactic EUID *(EUOL in ref. 9)*	M = 0.59 [0.28, 0.90]	*t*(284) = 3.73, *p* < .001, *Cohen's d* = .22	
Usefulness of the Integrated Didactic UID *(UOL in ref. 9)*	M = 1.14 [0,84, 1.44]	*t*(284) = 7.50, *p* < .001, *Cohen's d* = .44	
Usefulness of Technologies UOT	M = 2.18 [1.94, 2.43]	*t*(287) = 17.62, *p* < .001, *Cohen's d* = 1.04	
Efficacy of the Integrated Didactic (EID)	M = 0.69 [0.37, 1.01]	*t(284)* = 4.25, *p* < .001, *Cohen's d* = 0.25	
Change in Efficacy of Didactic Activities CEDA	M = 1.37 [1.09, 1.65]	*t(284)* = 9.51, *p* < .001, *Cohen's d* = 0.56	
Change in Efficacy of the Evaluation CEE	M = 0.04 [-0.29, 0.37]	*t(280)* = 0.23, *p* = .817, *Cohen's d* = 0.01	
Potential outcomes			
Sustainability of Integrated Didactics SID *(SOE in ref. 9)*	M = 6.17 [5.91, 6.43]	*t*(283) = 5.08, *p* < .001, *Cohen's d* = .30	M = 5.17 [4.93, 5.42]
Extent to which School should Rely on Integrated Didactic <u>S</u>RID *(SROL in ref. 9)*	M = 5.12 [4.79, 5.44]	*t(285)* = -2.31, *p* = .021, *Cohen's d* = -.14	M = 5.22 [4.96, 5.48]
Usefulness of Education on Pedagogy of Integrated Didactic UEPID *(ITEDP in ref. 9 *single factor)*	M = 7.23 [6.95, 7.52]	*t*(282) = 12.02, *p* < .001, *Cohen's d* = .71	M = 8.04 * [7.81, 8.27]
Usefulness of Education on Technologies of Integrated Didactic UETID *(ITEDP in ref. 9 *single factor)*	M = 7.59 [7.31, 7.86]	*t*(281) = 14.91, *p* < .001, *Cohen's d* = .89	M = 8.04 * [7.81, 8.27]
Intention to Use Integrated Didactic IUID	M = 5.20 [4.89, 5.51]	*t(280)* = -1.91, *p* = .057, *Cohen's d* = -.11	

Intention to Use Smart Organization IUSO	M = 7.30 [7.00, 7.60]	$t(279) = 11.79$, $p < .001$, *Cohen's d* = .70	
Percentage of Use of the Integrated Didactic PUID %	M = 36 [46, 95]	$t(286) = 23.03$, $p < .001$, *Cohen's d* = 1.36	
Degree of e-Maturity (SeM)	M = 6.51 [6.27, 6.75]	$t(282) = 8.31$, $p < .001$, *Cohen's d* = .49	M = 6.36 [6.13, 6.59]

3.1 Descriptive analysis

Generalities on the technological context. After a year from the first lockdown and after the resumption of face-to-face lessons, the technological context cannot be considered to refer any longer, or no longer exclusively, to the one available at individual level (home connectivity, personal devices, etc.) but should include and actually refers mainly to the school environment. The teachers who can take advantage of an ultrawide broadband connectivity is slightly less than 9%. A broad band connectivity by mean of optical fiber is available for an additional 32% of the respondents and 4% use a satellite network. On the other hand, 33% have still to rely to an ADSL connection, while slightly more than 13% are forced to use their mobile phones to connect to internet. Most of the remaining teachers, about 10%, do not seem aware of the type of connectivity available; most of them indicate a generic Wi-Fi connection.

As far as the devices - one or more than one - with which teachers connect to internet to carry out didactic activities, 84% use a laptop, 38% a tablet, 38% a smartphone and only slightly less than 30% use a desktop. These percentages are very close to those found during the 2020 survey [9] and at that time the only allowed teaching modality was the on-line one from one's own home. Most likely this means that a large part of the teachers still use their own personal devices also at school. This assumption seems confirmed by the fact that the percentage of teachers using desktop computers has increased by only a few points from 22% [9] to almost 30%. According to this scenario, it is not surprising that the comparisons between the factors referring to school and individual technological infrastructures are largely to the advantage of the latter (see Table 2): 8.22 for *Personal Connectivity* (PC) vs. 6.19 for the *School Connectivity* (SC); 8.26 for the *Individual Technology Adequacy* (ITA) vs 6.19 for the *School technology Adequacy* (STA); 8.15 for the *Individual Innovation Propensity* (IIP) vs. 7.28 for the *School Innovation Propensity* (SIP). Nor does it seem strange that among the difficulties encountered by teachers, the limited internet bandwidth has grown from 36% [9] to almost 52%. Moreover, the difficulty in managing parallel blended teaching has been indicated by more than 46% of participants and almost 25% has pointed out the inadequacy of the school environments. Surprisingly, the difficulties in communicating with students stay, as in 2020, around 24%.

These results clearly suggest that the implementation of parallel blended learning is much more complex than that of online learning, mainly because of the infrastructural shortcomings affecting the schools.

The feeling about the learning ecosystems. With respect to a year ago - despite the critical issues related to the technological infrastructures discussed above - the feeling of teachers towards the school context has become more positive. In fact, the rating of the *School Reaction Capacity* (SRC) significantly increases from 6.23 to 7.23 and quite high ratings are reserved also for the *Emergency Management* (EM), 7.47 and for the *Adequacy of the Contingency Plan* (ACP), 7.52.

The rating for the competences available in the context also increases: the evaluation on *Average Teachers 'Technology Preparedness* (ATTP) rises from 5.93 to 6.69 and that on *Average Teachers' Pedagogical Preparedness* rises from 5.85 to 6.55. These values rise even further when teachers take into consideration the personal preparation: 7.68 for *Individual Technological Preparedness* (ITP) and 7.43 for *Individual Pedagogical Preparedness* (IPP). Finally, we observed a value of 6.72 assigned to the *Operational Assistance* (OA) which can be provided to the school.

These results seem to indicate an increase in awareness both at individual and at ecosystem level, an impression that is confirmed by the significant increase in the values of the individual *Feeling towards Technologies* (IFT), which has risen from 6.30 to 7.10, and in that of the perceived *Improvement in Technological Skills* (ITS), which has risen from 6.88 to 7.40.

It lasts still to be understood, however, whether the *awareness phase* has come to its end or it is still under development or if it continues to increase at a steady state. In parallel it also lasts to clarify if and to what extent *awareness* is converting at least into *acceptance*, if not in *adoption*.

For sure we can state that the criticalities related to the technological infrastructures, coupled with the need to implement parallel blended learning activities have prevented a significant increase of the schools' *e-maturity*, which has grown only from 6.36 [9] to 6.51.

Contextual factors. Table 2 suggests that the influence of the contextual factors on the development of the teachers' awareness has been quite scarce or, for some factors, weakly negative. We observed, in fact, a quite low rating, 4.93, assigned to the *Political Action* (PA), a rating of 5.79 assigned to the *Support by Families* (SbF) to the learning process, a rating of 0.07 (on a -5/5 scale) assigned to the *Influence of the Prevalent Opinion in the Context* (IPOC) and a rating of -0.49 (on a -5/5 scale) assigned to the influence of the public opinion (*Societal influence* - SI).

Such results are not unexpected if we consider that either the decision-makers and broad layers of the civil society have pushed and are still continuing to push for the full restoration of pre-pandemic school processes. In addition, one has also to consider that often the decisions taken during this last year have been accompanied by an attitude to denigrate on-line learning and/or hybrid learning activities, relegated to modalities to be activated only in case of emergencies.

Low ratings were detected also for the individual contextual factors: 5.42 for the ability to integrate easily *Family and Didactic Commitments* (IFDC), 5.19 for possible relevance of *Psychological Problems* (PSP) and, finally -1.08 (on a -5/5 scale) for *Personal Time Management Capacity*, with a negative increase compared to the rating observed a year ago, 0.43 [9].

This seems to indicate that the introduction of hybrid practices (parallel blended learning) has increased the difficulty in managing one's personal time, while the increase in the perceived *workload* (WI) is similar to that recorded a year ago: 68% now vs 65% in 2020 [9].

The learning processes. Teachers believe that the educational process has undergone important changes (60% *in teaching activities*, CDA, and 52% in *assessment methods*, CEM) but such changes, apparently, allowed only partially for an optimal *integration of on-line and face-to-face activities*, 5.62, and to reproduce the *classroom dynamics*, 5.95. The most popular technology appears to be the *videoconferencing* used either to deliver *video-lectures* (VUL = 7.87) and to foster and carry out *discussions* (VUD = 7.22), followed by the *dashboard* to leave notices (DU = 7.66) and the *repositories of didactic materials* (DMRU = 7.54). The teachers seem to have succeeded enough in implementing *design* (DA = 6.32) and *collaborative* (CA = 6.19) didactic activities, to *motivate the* students (AMS = 6.97) and to maintain with them a good level of communication (CWS = 6.60). Furthermore, in this year, both the *relationships with the students*, RWS = 0.96 (on a -5/5 scale), and with *colleagues/peer*, RWP = 0.71 (on a -5/5 scale), improved slightly.

These data seem to indicate that, during the last year, collaboration has assumed a greater relevance and has led, at least in part, to rethink the almost exclusively transmissive teaching approach that was implemented during the first months after the outbreak of the pandemic [9]. The diffusion and the practice with videoconferencing seem to have contributed substantially to this result.

Perceived values. So far the data presented in this section reveal, overall, a more positive picture with respect to the one that emerged two months after the lockdown. Such positive feeling seems to be confirmed also by the positive variation of the perceived values about technologies, see Table 2. On a -5/5 scale we observed: 2.18 for the *Usefulness of Technologies* (UOT); 0.59 for the *Easiness of Use of the Integrated Didactic* (EUID); 1.14 for the *Usefulness of the Integrated Didactic* (UID); 0,69 for the *Efficacy of the Integrated didactic* (EID). The only factor that does not appear to have contributed is the *Change in Efficacy of the Evaluation*, 0.04 (CEE).

According to many models of technology innovation and acceptance (see Table1 and refs. 2-5,18, 20) a positive perception of the values associated to technologies has to be considered an essential pre-condition to develop acceptance and possibly adoption. For sure, at this stage, we can state that such positive feeling has contributed to the development of a more mature and positive point of view with respect to technologies. The rethinking of the didactic methods mentioned above, thus, could also be interpreted as an indication of an incipient phase of acceptance. The consolidation of this phase, however, depends on many factors and many of these - such as political decisions - may easily counterbalance the more positive attitude achieved by the teachers who in one year had the opportunity to experience both potentialities and criticalities of technologies and of the integrated teaching.

A vision about the future. The landscape that emerges from the survey is, likely, still an evolving one and the future does not seem yet fully predictable, as it can be deduced from the values taken by the factors relating to future intentions. The positive value of SID is not enough to determine a high value of the factor *Extent to which School should Rely on Integrated Didactic* (SRID), 5.12, and of *the Intention to Use the Integrated Didactic in the future* (IUSO), 5.20. Despite of that, the *Percentage of Use of the Integrated Didactic* (PUID) is not at all negligible and stands at 36% (i.e. more than a third of the didactic activities).

On the other hand, the *Intention to Use the technologies to support a Smart Organization* (IUSO) of the school is much more convinced, 7.30.

The feeling of *Usefulness of Education on Pedagogy of Integrated Didactic* (UEPID), 7.23, and *Usefulness of Education on Technologies of Integrated Didactic* UETID, 7.59, remains quite high, although the ratings are significantly lower than the 8.04 recorded a year ago.

To conclude, the overall impression is that the effects generated by the undergoing innovation process will fully emerge only in one or more years after the current investigation and that may also strongly depend on many concurrent and still evolving factors.

3.2 Causal discovery

The search for the causal relations returned the picture of fig. 1. It looks like a reasonable one although, as in previous investigations [8,9,16], it should be interpreted as a tentative one due to the limited number of respondents that causes both the observation of few isolated factors and the impossibility to identify the direction of all the relations.

Let's analyze different aspects and zones of Fig. 1.

Organizational aspects. Both the ability to manage the emergency (EM) and the propensity of the context for innovation (SIP) contribute to the school's ability to react to events (SRC) which, as one could expect, involves the adequacy of the emergency contingency plan (ACP). All this without neglecting the contribution provided by the available digital competences, either in terms of operational assistance (OA) and of technological preparedness of the teachers (ATTP). This is an area that, as seen in the previous section, triggers an overall positive feeling in the teachers, despite the criticalities related to the technological infrastructures.

Digital maturity. The school's propensity for innovation (SIP) is related, as one could expect, to the level of digital maturity, or e-maturity, of the school (SeM). To the definition of the latter also contribute the technological adequacy of the infrastructure (STA) and the quality of the connectivity (SC). According to Tab. 2, this is an area that presents critical issues.

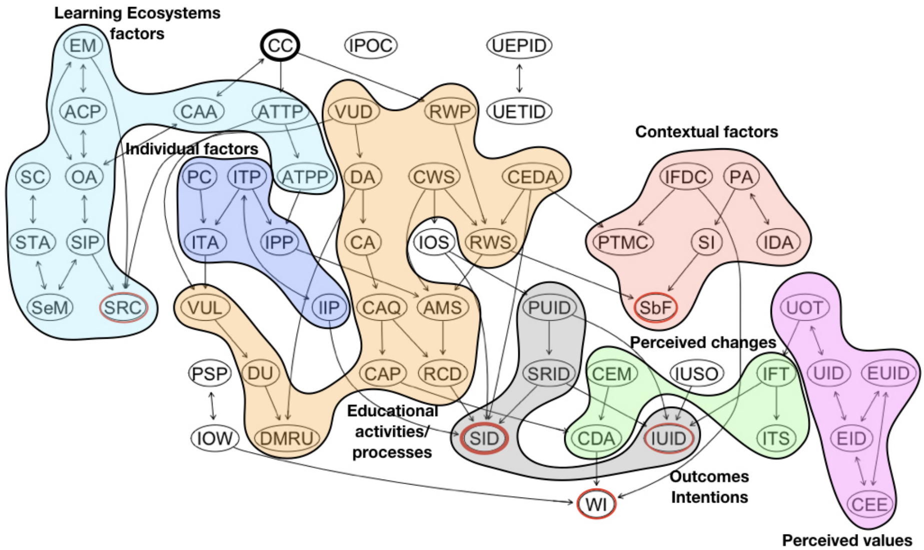

Fig. 1: Causal structure of the main factors considered in this study. Red ovals identify local an main terminals of the causal network. A ticker black oval identifies the main starting element of the causal network.

Relevance of collaboration and the educative process. The level of collaboration and cohesion between colleagues (CC) appears to be the basis for the interaction between peers (RWP) and the collaboration between all the actors in the school context (AAC), but it is also related to the level of operational assistance (OA). Furthermore, CC seems fundamental in determining the average level of technological preparedness of teachers (ATTP) which, incidentally, is considered preliminary to the pedagogical one (ATPP). The causal relationship of CDA with collaborative activities (CA) is activated through the percentage (CAP) and the quality (CAQ) of the latter. Design activities (DA), and the use of videoconferencing for discussion purposes (VUD) are also causally related and this also may imply the implementation of collaborative practices.

It is worth noting that the quality of the collaborative activities, CAQ, is also able to influence the ability to reproduce classroom dynamics (RCD), a connecting element capable to influence the sustainability of the integrated didactic (SID).

As also written in section 3.1, the relevance assumed by collaborative activities is partially unexpected if we consider the predominance of transmissive practices detected two months after the outbreak of the pandemic [9].

Individual technological equipment. The connectivity and adequacy of the individual technological equipment are related only to the possibility of using videoconferences to hold lessons, an activity that also affects the use of bulletin boards and of archives of didactic materials. The use of the latter is also influenced by the implementation of design activities.

Role of personal factors. As might be expected, individual time management (PTMC) depends on the ability to integrate family and educational/didactic commitments (IFDC). Furthermore, the latter also influences the perception of workload increase (WI). WI is also reasonably connected to the percentage of variation in teaching and evaluation activities which obviously required a greater teachers' commitment. Finally, the increase in WI is also the result of the perceived weaknesses (IOW) of both process and technologies. IOW is partly related also to psychological problems.

Factors that determine the future intention of using integrated didactic. The perception of usefulness (UID) and ease of use (EUID) of the integrated didactic are linked to the perception of the effectiveness of this teaching modality (EID), also in terms of evaluation (EEC). However, one has to underline that the direction of these causal relationships could not be defined. Very similar is the situation for the usefulness of technologies (UOT). The latter also influences the feeling of teachers with technologies (IFT) which in turn influences the perception of increased skills (ITS) and the opinion on how much one would like to use integrated didactic (IUID) in the future. It is worth noting that the area that we can define TAM [3] is only one of the components that influence IUID. In fact, IUID represents one of the main terminals of the causal chain and is directly influenced both by the desire for a smarter organizational approach within the school (IUSO) and by the opinion on how much the school should relay in the future on integrated didactic (SRID). The latter, in turn, is influenced by the perception of the strengths of this practice (IOS) and the ability to communicate with students (CWS). IUID, therefore, seem to be partially influenced by the change in the perception of values but, much more, by the perceptions of a greater individual effectiveness and by the individual intentions (reflected also on organizational aspects).

Sustainability of integrated Didactic. As might be expected, another factor that acts as main terminal of the causal network is the sustainability of the integrated didactic (SID). The following factors contribute to determine the opinion on SID:
- the pedagogical preparedness of the participants to the survey (IPP) through the ability to motivate students (AMS), and their technological preparedness (ITP) through the individual propensity for innovation (IIP);
- the possibility of reproducing the class dynamics (RCD);
- the perception of change in the effectiveness of the teaching process (CEDA) that - either directly that through the mediation the ability to interact (RWS) and motivate (AMS) students - leads also to the reproduction of the class dynamics RCD);
- the perceived strengths (IOS) of the integrated didactic;
- the individual opinion on how much the school should rely in the future on integrated didactic, SRID.

Need for continuous training. The relevance of pedagogical training on integrated didactic goes hand in hand with the technological one, but during this study it was not possible to identify other connections between these two and other factors taken into consideration.

Role of contextual factors. They do not seem to play a particularly relevant role within the causal network and give rise to a causal chain that has its terminal in the support to the educational process by the families (SbF) which, according to Table 2, is a critical issue. Participants seem to believe that the political action (PA) is able to influence the public opinion (SI) and, therefore, the support of families (SbF) which, on the other hand, seems also to be influenced by the type of relationships that are established with students (RWS). The latter, in turn, seems to be determined by the ability to communicate with students (CWS) and, as well, by the perception of change in the effectiveness of the didactic (CEDA).

The influence of opinion prevailing in the school context (IPOC) does not seem to influence the opinion of the teachers in any way.

3.3 Intensity of the relationships

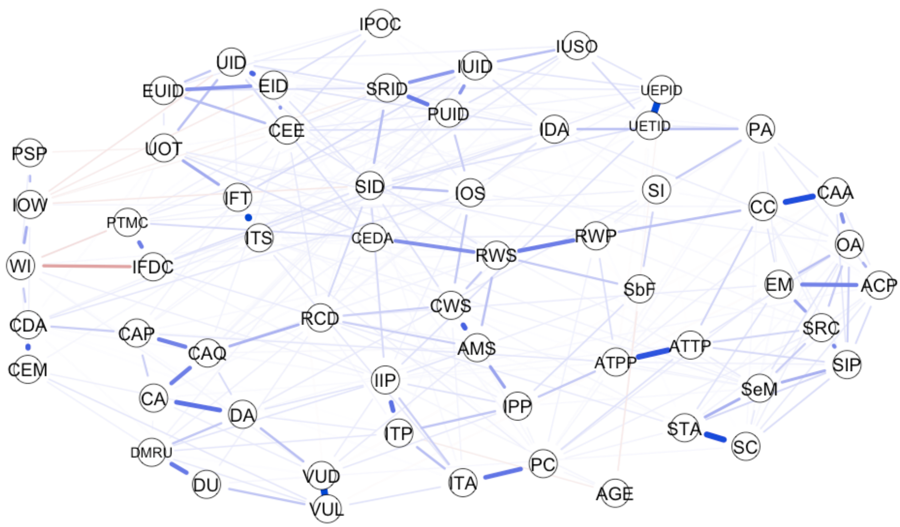

Fig. 2: LASSO-regularized partialized network of the main factors considered in this study

Network analysis offers useful tools for visualizing complex webs of variable relationships; these include the plotting of least absolute shrinkage and selection operator (LASSO) regularized partial correlation networks [17]. Partial correlations measure the degree of association between two variables after controlling for all other variables being considered; as such, they are a useful measure of direct association. Using LASSO regularization further aids in the interpretability of the network by only visualizing relatively strong associations and setting to 0 all of weaker associations.

Fig. 2 shows the intensity and the sign of the associations and thus provides us with the possibility of weighting the relevance of the relationships that emerged from the causal network. It can be noted, for example, that the ability to better manage family and school commitments (IFDC) anti-correlates (red link) to the perception of workload increase (WI), while it is positively correlated (blue link) to the ability to organize one's own time (PTMC). Fig. 2 also shows the existence of weaker relationships which, for example, put in relation the influence of the prevailing opinions in the operative context (IPOC) with the usefulness and effectiveness of the use of the integrated didactic (UID/EID); their intensity, however, is not sufficient to make any causal relationship emerge. The same applies to the usefulness of training that seems related to the intention to use integrated didactic and to the expectation about a smart organization of the learning ecosystem.

4 The block representation and the comparison between causal networks

4.1 Block representation of the causal network

Fig. 3 shows a block representation of the causal network that represents a tentative sketch of the Model for Attitude to get Engaged in Technological Innovation (MAETI) [16] for the present case study dedicated to the Italian school system, seen through the teachers' lens. In such block representation the factors that can be considered terminal - local or global - of the causal chains are highlighted (thicker frames) and are shown the relationships that connect blocks of factors.

As already highlighted in section 3.2, contextual factors are only relevant for two local terminals of the network: the family involvement and the perceived increase of the working load. The reactivity and the e-maturity of the school are two additional local terminals of the network. Both depend on the technological setting and the organizational factors, through the innovation propensity. The former, as one could expect, depends directly also on the level of collaboration that can be considered the main initial terminal of the causal network. It influences the level of competences and the educational process. The latter, together with the individual innovation propensity and future intentions/expectations determine the perceived sustainability that act as main terminal of the causal network. The perceived values, as suggested also by previous investigation of the peculiar technology innovation process considered here [8], determine the future intention at individual level. The latter, however, can be considered an additional local terminal. In any case, the perceived values seem to play a side role with respect to the main flow of the causal network.

4.2 Comparison between causal networks

In the survey carried out a year ago – actually a much more limited one - the ability of the school to react determined, together with the technological context (infrastructures and skills), the digital maturity of the school and the latter, in turn, the ability to reproduce class dynamics and finally the sustainability of the process and, as well, future intentions (also in terms of training). In the current, more specialized, analysis digital maturity still depends on the technological context but the ability to react no longer appears to be a precondition but, rather, a terminal of the organizational capacity and of the collaboration between all the players of the educational process. The achievable level of skills seems also determined by the ability to collaborate.

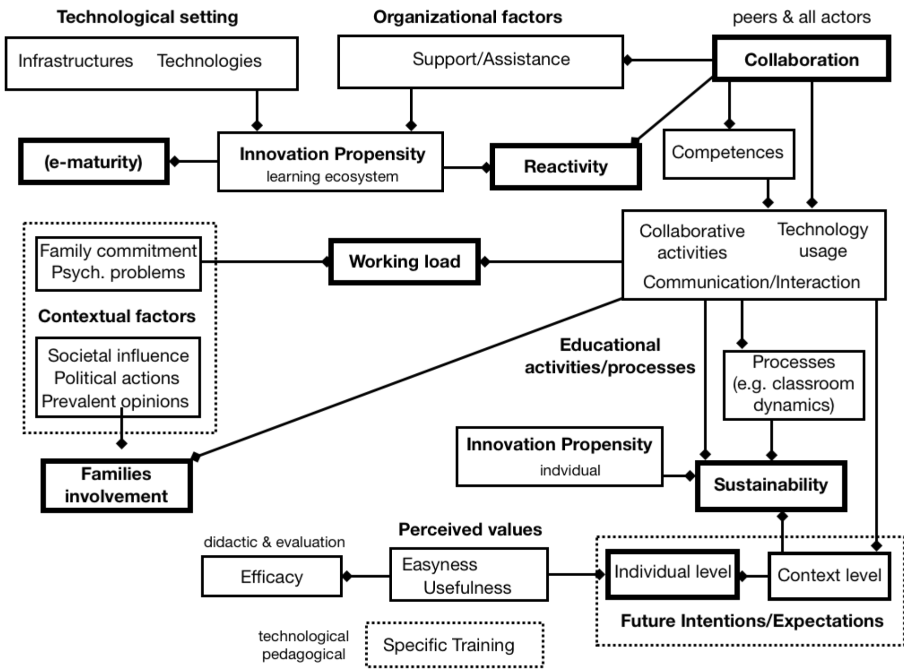

Fig. 3: A sketch of a tentative Model for Attitude to get Engaged in Technological Innovation (MAETI) for the present case study.

Future expectations about the context influenced personal intentions, already in the previous analysis. The perception of greater technological competence was linked to a perception of a generic change in the educational process while now it seems connected to the perception of the usefulness of technologies.

Training is still considered important, as the interrelation between technological and pedagogical aspects, but it assumes an absolute value and it no longer appears to be a factor connected to future individual intentions.

Overall, we can state that the transformations observed in comparing the causal networks obtained from the two surveys carried out one year apart, can be ascribed on one hand to a more detailed design of the present survey (use of a larger and more complete set of variables) and on the other hand to a more mature teachers' perception of the integrated didactic.

5 Final considerations and conclusions

The outcomes of this survey, described and discussed in the previous sections, show an evolving picture with respect to the survey carried out two months after the pandemic outbreak. After one year, schools are perceived as more capable to face readily and effectively to unforeseen events, such as a resurgence of the pandemic or the continuous adaptation to the prescriptions provided by the policy makers. This feeling seems determined mainly by a good perception of the school's organization and management, as well as by the establishment of a stronger collaboration either among peers and with all actors participating in the educational process. On the other hand, the opinion about the schools' technological infrastructures is less positive, especially when compared to personal equipment. As it emerged from the discussion, this feeling was largely determined by the schools' difficulty to deliver hybrid processes (parallel blended teaching/learning). Such modality was perceived as more difficult to manage with respect to online teaching that could be "more comfortably" delivered from one's home, and this despite the increase in teachers' skills. As far as the latter, it is interesting to remark that those who responded to the survey think to have a higher level of competence than the average of their colleagues. This could indicate that the most active subjects on social networks are also those most willing to invest their efforts in the use of new technologies. Despite that, there is no question that a generalized increase in the teachers' competences occurred and that there is room for improving the schools' technological infrastructures (e.g. ultra-wide bandwidth connectivity and WI-FI access, diffusion of the BYOD approach, creation of specialized laboratories). The latter will be fundamental for a possible future development of the *adoption stage*.

Considering the outcomes of this survey we feel comfortable enough to state that the *awareness stage* of the technology innovation process has fully developed, as evidenced by the block representation of the causal network, see fig. 3. The opinion of the teachers, in fact, is no longer affected by emergency conditions, but derives from a year of field work and reflection on the relevance of the various factors investigated during the present survey. A year that made emerge a more mature teachers' opinion capable to determine local branches and terminals of the causal network, alongside a main stream that starts from collaboration and ends in the sustainability of the process. Over one year time - in a reasonable, although somewhat unexpected way, given the tendency towards individualism that characterizes this age - collaboration has assumed a considerable importance either at organizational level and with respect to the definition and delivery of didactic activities. Such factors and as well the characteristics of the didactic process, according to the causal network, are the factors that contribute most to determine the future intentions and the perception of sustainability of the integrated didactic. The maturity of the teachers' vision is high enough to relegate to a side effect the influence of contextual factors (e.g. public opinion, political decisions), of which, by the way, they do not seem to have a particularly positive opinion.

In our opinion, this more mature, and perhaps more lucid, vision of the integrated didactic points out for the onset of an *acceptance stage* in which technologies no longer scare. For many teachers, although not for all, technologies are no longer just a support to respond to emergencies, they are expected to be used in at least 36% of educational activities and thus to become part of technology enhanced educational processes based on collaboration.

How much this vision could be consolidated over time is not at all obvious and it is difficult to predict, given the will of many politicians and large sections of public opinion to foster a return to a very traditional face-to-face didactic, heritage of the "factory" model of education. The phase of consolidation would require not only investments and optimized approaches for the use of schools' and individuals' technological infrastructures but also a commitment to rethink pedagogical approaches and teaching strategies, as well as a systemic investment in the engagement of all stakeholders in a continuous experimentation.

For sure, it is very important to follow up on the monitoring action to verify whether in the years to come the school will be able to support - and to what extent - a system transformation that goes beyond the commitment of a limited, albeit continuously growing and increasingly aware, number of teachers.

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