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Digital Innovation in Education: Occupational Stress and Attitude toward Change among Schoolteachers

Mirella Ferrari, Giulia Mura, Davide Diamantini*

"Riccardo Massa" Department of Human Sciences for Education, University of Milano, Bicocca, Milan, Italy
*Corresponding author: giulia.mura@unimib.it

Abstract The introduction of ICT into the school context is driving change in the education system, and teachers, whether willingly or otherwise, are among the main actors in this process. The study of organizational change and innovation suggests a number of variables whose impact must be analysed if we are to understand how the outcomes of digital innovation in schools may be optimized. In this paper, we evaluate the experience of a large sample of teachers (420 completed questionnaires) who had been involved in a digital innovation programme for schools. More specifically, we measured the impact of personal and contextual variables on the participants' attitude to digital change, identifying a pattern of interaction. While some variables, such as age and perceived ICT expertise, influenced both positive and negative attitudes to change, others had a more specific impact: For example, commitment to the organization mainly encouraged positive attitudes towards the digital innovation project, while negative attitudes to digital change were also associated with negative self-perceived work/life balance.

Keywords: *school innovation, organizational change, resistance to change, school digitalization, work stress*

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1. Introduction

There can be little doubt that the Internet, smartphones, and new communication technologies are widely used by young people [1,2]. In Europe, the number of young Internet users is constantly on the rise, thanks to the spread of devices such as smartphones and tablets. A recent study by the EU kids online network found that 43% of European teenagers aged between 15 and 16 years used a smartphone to access Internet [3]. The increasing ubiquity and dissemination of mobile technology devices among young people has prompted reflection on the part of educators, but also in society more generally as well as at the academic level, concerning whether and how these devices should be incorporated into educational practice. In a survey conducted in the US in 2012, 48% of parents stated their belief that mobile devices could contribute to their children's extra-curricular learning, while 62% would have been willing to purchase a mobile device for their children to use at school [4].

Ever-increasing levels of access to online information and interaction have altered the educational scene, forcing - in a certain sense - teachers and educators to adapt their teaching programs and strategies accordingly, but in the absence of clear guidelines or standards for doing so [5].

In this paper, we contribute to the debate on the complex interaction of social and personal variables in the unfolding of innovation processes in education, by analysing a case study conducted with the schools of three towns.

In the first section, we provide an overview of the current distribution of ICT in general and in the educational sector more specifically, identifying both drives to innovate and opposing drives to maintain the status quo.

In the second section, we review the factors that come into play in organizational processes of innovation, with a specific focus on educational institutions.

In the third section, we briefly outline the principles underpinning the University of Milano-Bicocca's Distretto Digitale [Digital District] project, whose aim is to foster deep-level innovation within the participating school districts.

In the fourth section, we present data collected in the course of the project, highlighting the most significant findings.

Finally, we conclude by summarizing the role played by each of the social and individual factors we examined in fostering technological innovation in the school setting.

2. ICT and the Need for Educational Innovation

Early analyses of the impact of introducing ICT into the educational system suggest mixed results: outcomes have been unclear or contradictory, and frequently major investment in new technologies has been followed by minimal changes in teaching practices and underutilisation of the newly acquired resources. The research to date indicates that use of ICT is often sporadic, superficial, and more frequently deployed to reinforce traditional practices that to introduce deep change into the curriculum [6,7].

Hence, the urgent need for innovation in schools is at odds with a de facto lack of belief in technology as a true agent of change. Numerous scholars are currently exploring and assessing the digital transition in schools, from a variety of disciplinary perspectives, including those of educational science [8], sociology [9] and computer science [10].

Drawing out the many relevant aspects of this complex theme requires a multidimensional approach that recognizes the complexity of contemporary society and sets out to investigate the forms, instruments and - importantly - the goals associated with technological innovation in schools. A theme of this kind demands setting aside one-dimensional and deterministic perspectives [11] in order to explore both individual action and institutional functioning and their interaction in the school setting.

There is a well-established view that education has a key role to play in shaping the relationship between individuals and technologies. Introducing new technological media into schools should encourage an educational approach whose focus is the person, fostering inclusiveness and learning about the world, while emphasizing the individual, with his or her characteristics, uniqueness, and originality. This is because digital media themselves push users in this direction, offering a wide range of tools, learning opportunities, and innovative teaching styles that lend themselves to "customization" [12].

At the international level, a number of schemes have been put in place to monitor the spread of technologies in educational contexts, one of which is The Survey of Schools: ICT in Education [13], carried out on behalf of the European Commission with over 190,000 respondents in 31 European nations, and offering a detailed description of trends in technological educational innovation in Europe. At the time of this study, laptops, tablets, and notebooks were only beginning to be widely used in educational settings in many of the countries surveyed. School principals and teachers complained that there was a shortage of digital equipment in schools, especially IWBs and laptops. Many students still made too little use of ICT; teachers used digital media to communicate with parents or to measure the students' learning, but rarely deployed them creatively to develop innovative content or to prepare interactive lessons. Digital resources, training exercises on dedicated platforms, on-line tests, quizzes, and simulations are still rarely used in the classroom. Nevertheless, teachers are well-disposed towards ICT, viewing digitally-mediated learning as a positive development.

Participation in teacher professional development programmes on the use of ICT was rarely obligatory. There appeared to be a gap between teachers' interest in receiving training and the effective opportunity for them to use digital technology in their educational practice, with the result that many of them used ICT in their free time. Students reported feeling confident in their digital competence and were making increasing use of ICT across the various countries involved in the survey.

In general, digital technology was reported to impact positively on learning, despite the low level of access to ICT still characterizing a number of EU countries. The use of digital technologies requires competence on the part of teachers as well as ICT infrastructure: thus, in schools with digitally competent teachers, the students were more inclined to express positive opinions about the use of ICT for teaching and learning purposes.

Only 40% of the students taking part in the survey viewed their teachers as well-trained in the use of ICT, rating them as "digitally confident and supportive teachers". In Europe, not all EU countries had formally adopted the Digital Agenda: unfortunately, Italy - along with Croatia, Austria and Greece - had not yet taken steps to implement it systematically. One of the survey's main findings was the discrepancy between the presence of ICT infrastructure in the classroom and the availability of "digitally supportive teachers" (ibid.). The outcomes of the survey suggest the value of adopting a sociological perspective that is sensitive to teachers' experience on the ground if we are to fully analyse and address the factors currently hindering the use of digital technologies in teaching and learning. Overall, there is an urgent need to improve teachers' levels of digital competence.

3. Innovation in Schools

When it comes to innovation, both in schools and in large organizations more generally, the key underlying processes may be interpreted as technological, political, or cultural [14]: these alternative perspectives are also reflected in different strands of empirical research on the dynamics of innovation.

Concerning the origin of processes of innovation, scholars have suggested that the global diffusion of ideas about desirable new policy directions gives rise to a "menu of possible policies", whose effective adoption is then conditioned by policy selection mechanisms at the national and/or local levels [15].

The current Italian schools system has seen a recent major drive to digitize teaching and administrative practices, and thereby to concretely address "the need to promote innovation in complex organizations such as schools" [16]. However, the forms and modes of use of digital technologies adopted in schools are still relatively unpredictable. ICT tools are often deployed in ways that were not intended by their creators: typically, they are incorporated into existing institutional practices and reflect aspects of social relations in the specific setting. Thus, both the use of ICT in schools and the educational innovation deriving from it may be viewed as "socially molded" [17].

Studies on the outcomes of innovation processes in institutions have long explored the factors that can contribute to overcoming the strong "resistance to change" characterizing organizational contexts [18]. Processes of innovation in schools, as in any other type of organization, always meet a certain degree of resistance, but can also elicit positive reactions: reactions to change are not necessarily either wholly positive or wholly negative [19].

Factors that have been identified as playing a role in the reception of change include: macro-variables such as economic patterns or cultural norms; national innovation policies [20]; context-related variables, such as initiatives on the part of local authorities and school principals [21], the way that the school is organized and run, or the way that information about change is communicated [22], the extent to which the different actors in the educational system have been engaged in the innovation process [23];

and, finally, personal variables characterizing the stakeholders. For example, teachers can act as "institutional agents" of change [24] but their reactions are influenced by personal variables, such as optimism, self-control, and self-esteem [25].

A further line of enquiry has investigated individuals' intrinsic motivation, together with the appeal of the innovation (based on the variety of skills involved and task demands) and its meaningfulness for the individual, as key variables shaping processes of innovation in work settings [26,27]. Each individual represents a node of knowledge and creativity that can only be fully expressed when interconnected with others within a relational network.

Another key factor in innovative processes is the atmosphere in the workplace [28]: a positive atmosphere may be generated by ensuring constant interaction and sharing of experience among colleagues.

Several authors [29] have attributed communities of practice with a crucial role in stimulating teachers to make better and more consolidated use of educational technologies. Schools crucially require a culture of sharing in order to optimize their educational work and create virtual communities and communities of practice among teachers, and not only as an educational strategy to be deployed with students [30]. The construction of a community of practice will help teachers, offering them the opportunity to share problems, decisions, processes, and products in collaborative environments that encourage the spread of good teaching practices [31].

4. The "Digital School Districts" Project

The research presented below was conducted as part of the University of Milano-Bicocca's "Digital School Districts" project, in three of the participating towns in the Milan Metropolitan Area (Rho Pero, and Carugate). These towns share a basic set of socio-economic characteristics: a medium-low per capita income (about 33% less than that of Milan) and relatively high percentages of non-national residents, ranging from 8 % in Carugate to 15% in Rho [32].

Between them, the three centres of population have six istituti comprensivi (small groups of state-run infant, primary and lower secondary schools under a single board of management and head teacher) - one in Pero, one in Carugate, and four in Rho -, which are attended by about 6,000 students and staffed by over 800 teachers.

In 2013, the digital competence and infrastructure in place in these schools was grossly inadequate with respect to the growing demand for digitalization, at both the administrative and educational levels. None of the participating groups of schools had Wi-Fi and their Internet connections were slow. For this reason, the local town councils decided to join the Digital School Districts project being launched by the University of Milano-Bicocca with the goal of helping school districts to engage their schools in a collective process of technological innovation and management of governance. The project was initiated in 2014 with the devising of a plan for updating the participating schools' ICT infrastructure. The plan was subsequently implemented, and a further series of concrete steps undertaken. Although participation in the project was voluntary, the fact that the Italian Education Ministry had already placed an obligation on schools to attain digitalization by 2016 made the need for action in this area even more evident.

More specifically, the project included the complete digitalisation of all school infrastructures, the design of a long-term professional development programme for the entire teaching staff focused on innovative teaching strategies, and the promotion of new models of governance by involving all the stakeholders (teachers; school management; parents; local town council; educational, technological and strategy development partners) in the subsequent phases of planning and dissemination. The introduction of models of shared governance, a strategy that was chosen to consolidate the actors' sense of community [33], necessarily required the implementation of a capacity building programme, designed to reinforce stakeholders ability to fulfil key functions, solve problems, define and achieve objectives, and grasp the need for change [34]. The project management model was therefore based on the creation of communities of practice, understood as "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly. The members of a community of practice [...] develop a shared repertoire of resources: experiences, stories, tools, ways of addressing recurring problems" [35].

5. Materials and Methods

The research data analysed in this article is drawn from questionnaires that were administered during an intermediate stage in the professional development programme undertaken by the teachers in the towns of Rho Pero, and Carugate as part of the Digital Districts project. In other words, it concerns teachers in a setting in which digital innovation was already being strongly encouraged, and profound - though as yet unassimilated - change was already well under way.

The sample (Table 1) comprised 420 nursery (6%), primary (61%), lower secondary (32%) and upper secondary (1%) school teachers, mainly women (89% of respondents), whose average age was quite high. Indeed, only 25% of respondents were under 40 years of age, with the remaining 75% aged between 41 and 66 years. Respondents held a school-leaving diploma in 48.5% and a university degree in 51.5% of cases; some 63% taught humanistic and 37% scientific subjects.

Table 1. Sample demographig data

		Frequency	Valid %
Sex	Male	43	11
	Female	351	89
Age	20-29	8	2,4
	30-39	66	19,7
	40-49	107	31,8
	50-59	108	32,2
	60+	46	13,8
Education	Diploma	190	48,5
	Degree	202	51,5
Employement	Nursery	26	6,6
	Primary	241	60,9
	Lower secondary	126	31,8
	Upper secondary	3	,8
Subject	Humanistic	158	63,5
	Scientific	91	36,5

The questionnaire, administered using a paper and pencil method and compiled anonymously and on a voluntary basis, consisted of closed items which participants were required to rate on Likert scales.

A set of items devised ad hoc for the project [36] were used to gather information about teachers' self-perceived levels of digital competence and modes of using digital technologies, for both personal and professional purposes.

A further set of items drawn from the ASSET stress measure [28] was adopted to assess the work atmosphere in the school. These questionnaire items formed four subscales measuring four potential stress factors:

- work-life balance
- work relationships
- work pressure
- commitment to work

All statements were rated on a scale Likert that went from 1 (strongly disagree) to 5 (strongly agree).

Participants' attitude to the specific change under study here was assessed by asking them to complete the widely validated "Attitude Toward Change" scale [37] in relation to an ad hoc scenario [38] describing the implementation of digital innovation in the school.

Again, participants were invited to use a 5-point Likert scale to indicate their level of agreement with statements that either represented the change in a positive light (e.g., This change will probably enable me to work better) or a negative one (e.g., I do not like this innovation project).

6. Results

6.1. Digital Competence

The teachers' self-evaluations of their level of digital competence were generally positive, with only 21% of respondents describing their skills as "barely adequate" or "inadequate", while 52% rated their skills as "fair" and 27% as "good". Email was used at home by 90% of the sample, and at school by 52% of respondents. Internet was used privately by 92% and at school by 71%. Those who used Internet were most likely to avail of it to: look up information for school purposes (94.5%); look up information for personal use (90.2%); look up resources for their individual professional development (81,2%); look up resources for educational projects (80.2%). Some 84% of respondents used WhatsApp or another instant messaging service, while 51% had an account on a social networking site such as Facebook.

Concerning their use of digital technology in the classroom, most teachers reported drawing on it often (40%) or sometimes (36%), with a smaller proportion claiming to deploy it always (11%), rarely (8%), or never (5%). The most popular digital tools were IWBs (77%), software for creating presentations and mobile devices (both used by 42%), the CD Roms supplied with textbooks (36%) and word-processing applications (32%). Only 25% of respondents had not attended training courses on the introduction of ICT into schools over the previous two years.

On the whole, we might say that this sample was not yet digitally expert but was computer literate, with most participants have incorporated technology into their daily lives, outside of the work context certainly but also at school.

6.2. Occupational Stress and Attitude to Change

Overall (see Table 2), the teachers in the sample were satisfied with their work relationships and emotionally attached to their work. They tended to be less positive about the level of commitment demanded by their role in terms of time and work demands: they were especially dissatisfied about the number of hours worked and the limited control that they had over many aspects of their work. They viewed the impact of technology on the performance of their duties as moderately negative.

Table 2. Means and standard deviations for scores on the ASSET scale items

	Mean	SD
Work life balance		
I often have to work unsocial hours e.g. weekends, shift work, etc.	3.4	2.1
The technology in my job has overloaded me	3.2	1.9
My work interferes with my home and personal life	3.1	1.9
I work longer hours than I choose or want to	4.1	2.0
Work relationships		
I feel isolated at work e.g. working on my own or lack of social support from others	1.8	1.4
My relationships with colleagues are poor	1.6	1.3
My ideas or suggestions about my job are not taken into account	2.3	1.6
My work is dull and repetitive	1.5	1.1
I do not receive the support from others (boss/colleagues) that I would like	2.7	1.7
Overload		
I do not have enough time to do my job as well as I would like	3.2	1.9
I am not adequately trained to do many aspects of my job	2.9	1.7
I do not have the proper equipment or resources to do my job	2.6	1.7
I have little control over many aspects of my job	4.5	2.2
Commitment to the organization		
This school deserves my full interest and loyalty	4.7	1.7
Lack of work opportunities at other places is one of the most important reasons behind my remaining at this school.	1.6	1.3
I would not leave this school because I feel a sense of duty towards the people in it	4.4	2.0
I feel strong loyalty and a strong sense of belonging to this school	2.6	1.6
It is very difficult for me to imagine leaving this school, even though, in part, I would like to	3.2	2.1

Table 3. Means and standard deviations for scores on the Attitude to Change scale

	Mean	SD
Positive attitude		
I am happy at the prospect of this change.	4.2	1.8
The majority of my colleagues will benefit from this innovation program.	3.8	1.7
I think that the changes arising from this innovation program will be stimulating.	4.6	1.7
I will probably be able to suggest new approaches to my colleagues.	3.6	1.7
This change will probably enable me to work better.	4.4	1.7
I am willing to do everything I can to support this process of change	4.7	1.6
I believe that this innovation program can contribute to improving unsatisfactory work situations.	3.8	1.7
Negative attitude		
I find it difficult to accept new things.	2.8	1.7
I do not like this innovation program.	2.4	1.7
I think that the changes connected with this innovation program will be frustrating.	2.5	1.7
Most of the time changes at work are irritating.	2.7	1.6
I think that I will be reluctant to put the new ideas connected with this innovation program into practice.	2.5	1.6
I am afraid that this change may create more problems than it solves.	2.9	1.6
I am concerned that this change may cause problems for me.	2.6	1.6
It is difficult to predict whether this change will lead to positive outcomes.	3.8	1.7

In general (see Table 3), the teachers displayed a positive attitude towards the implementation of digital innovation projects in their school. This change was seen as stimulating and they expressed a high level of commitment to it. Nonetheless, there was still a degree of uncertainty with respect to the outcomes.

Hence, the "Positive Attitude" subscale comprised seven items (Cronbach's alpha = .859), and the "Negative Attitude" subscale eight items (Cronbach's alpha = .830).

6.3. The correlations

Correlational analyses were conducted to investigate the relationship between positive and negative attitudes to change and the other variables in the research design. With respect to participants' socio-demographic characteristics, only age was moderately correlated with each of the two subscales of change. Specifically, it was negatively correlated (Kendall's tau b = -,167; sig > .000) with positive attitudes to change and positively correlated with negative attitudes. Gender, highest academic qualification, level of schooling taught, and subject area were not in any way correlated with teachers' reception of change (Table 4).

Next, we analysed the correlations between participants' attitudes to change and their self-evaluated digital competence and perceptions of their work environment (Table 5). Of the five variables investigated, only two were correlated with positive attitudes to digital innovation in the school context. Specifically, both commitment to the school (Kendall's tau b = .363; sig >.000) and self-perceived digital competency (Kendall's tau b = .217; sig > .000) were strongly positively correlated with positive reception of change.

Vice versa, negative attitudes to innovation were most strongly correlated with self-perceived digital competence (Kendall's tau b = -0,319; sig > ,000), (more negative self-evaluations were associated with greater hostility towards change), followed by work-life imbalance (Kendall's tau b = .245; sig > ,000), and, although to a far lesser extent, self-perceived levels of work pressure (Kendall's tau b = ,107; sig > ,000).

Table 4. Socio-demographic characteristics and attitude toward change

	Age		Gender		Highest Academic Qualification		Level of School Taught		Subject	
	Tau b	Sig.	$\chi 2$	Sig	Tau b	Sig	Tau b	Sig.	Tau b	Sig.
Pos. Att.	-.167	.000	non-sig.		non-sig.		non-sig.		non-sig.	
Neg. Att.	.168	.000	non-sig.		non-sig.		non-sig.		non-sig.	

Table 5. Self-evaluated digital competence, ASSET scores and attitudes toward change

	Self-Evaluated Digital Competence		Work Relationships Factor		Work-Life Balance Factor		Commitment to Work Factor		Work Pressure Factor	
	Tau b	Sig.	Tau b	Sig.	Tau b	Sig.	Tau b	Sig.	Tau b	Sig.
Pos. Att.	0.217	.000	non-sig.		non-sig.		0.363	.000	non-sig.	
Neg. Att.	-0.319	.000	0.156	.000	0.245	0	non-sig.		0.107	0.012

7. Discussion

There was a high rate of ICT usage among the teachers in this study, especially where the more basic functions of digital technologies are concerned, and this was the case both at home and at school (partly thanks to the early phases of the Digital Districts project, which had already been implemented prior to the collection of this data). These teachers were already digitally literate and perceive themselves as relatively competent in the deployment of digital resources.

With respect to a hypothetical scenario envisaging further digital innovation in their schools, they displayed a mainly open-minded and positive attitude. They obtained lower, albeit significant, scores for resistance to change.

A number of variables were found to be correlated with a positive attitude to change. The most important is commitment to one's work: the stronger teachers' emotional bonds with their schools, the more they anticipate that the proposed change will have a positive impact. The same trend was observed in relation to self-evaluated digital competence: greater confidence in their own digital abilities was associated with more positive ratings of the described innovation project. Finally, although to a lesser extent, positive attitude towards change was negatively correlated: the younger teachers were more likely to view the proposed innovation in a positive light.

Negative attitudes to change on the other hand were most closely associated with self-evaluated digital competence: negative assessment of their own resources and capacity to assimilate digital tools was strongly correlated with negative expectations concerning the outcomes of the hypothetical innovation program. A second correlate of negative outlooks on change was work/life balance: those who perceived their work as particularly invasive and as undermining their private lives were also more pessimistic about the prospects for digital innovation. Weaker correlations were found with both age (conversely to the earlier finding that younger teachers are more likely to report positive attitudes to change, older teachers are more likely to be negative about it) and perceived work relationships (the more they are perceived as unsatisfactory, more digital innovation is also viewed negatively).

8. Conclusions

Numerous studies have shown that the outcome of innovation processes is shaped by a complex interaction between social and individual factors. In education, in addition to studies on the impact of different styles of school management and leadership [39,40], scholars are increasingly exploring interaction among peers as a crucial step in the reception of change. For example, [41] focused on teacher communities, conceptualizing them as peer groups in which, as a function of different levels of innovation vs socialization, cohesion vs diversity, and cognitive and normative convergence vs divergence among members, institutional reform will take a greater or lesser hold yielding a variety of outcomes.

The teachers in the current case study displayed an ambivalent attitude towards the prospect of a digital innovation program in their schools, with enthusiasm for anticipated benefits flanked by a certain amount of distrust and concern. This situation is perfectly in keeping with the findings of existing research presented earlier in this paper.

Our analyses brought to light the impact of a set of individual and social factors on positive acceptance of and resistance to change. Among the individual factors studied, perceived digital competence was found to play a positive role, suggesting that it is crucial to provide teachers with training in digital skills, in keeping with theories that frame individual competence as critical to motivation [42]. With regard to social factors, a more complex pattern of interdependent processes [43] was identified: while on the one hand, their commitment to their work fuelled teachers' motivation to engage with change, their perceptions of an excessive work-load and unsatisfactory relationships with colleagues and (especially) superiors fostered mistrust and negativity. The key concept underpinning the project in our case study was to create a community spanning the schools in a district and other institutions and stakeholders in the local area. However, implementation of this framework sometimes came up against the individual factors identified in the present analysis .

Thus, intervention to support digital innovation processes in schools must simultaneously target multiple levels, strengthening teachers' social networks and acting on shared community values with a view to fostering a level of commitment that goes beyond loyalty to one's community of practice only [44].

Further research should investigate the development of effective strategies to support the fruitful interaction among the various stakeholders of the education system, identifying the key elements able to spark the interest of each subject in a common project. Moreover, the impact of different actions aiming at reducing negative attitude to change in general, and to digital innovation specifically, should be addressed.

Statement of Competing Interests

Authors have no competing interests.

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