During the last two decades there has been an increasing interest for ‘identity’ research in the field of mathematics education. This ‘turn’ to identity signifies a methodological, theoretical and epistemological shift towards embracing the social, cultural, historical and political underpinnings of teaching and learning mathematics. By means of discourse theory, identity work can be viewed, here, as a struggle towards articulating meaning around hegemonic and neoliberal discourses concerning school mathematics and education. The case of mathematics teaching through technology use exemplifies how teachers negotiate engagement not only with technology but with the demands of change at the societal and pedagogic axis. As a result, the present paper discusses identity work as a potential political space for teacher change in contemporary times where both school mathematics reformation and an escape from nowadays’ neoliberal crisis becomes an urgent requirement.

AN ENTRY: THE ‘TURN’ TO IDENTITY RESEARCH

Back in 1998, Anna Sierpinska and Jeremy Kilpatrick in their ICMI study based volume entitled ‘Mathematics Education as a Research Domain: A Search for Identity’ called for the need to clarify our ‘common identity’. The contribution of a number of well-known academics set up an agenda for re-considering not only goals, criteria and evaluation procedures, but also epistemologies, methodologies and ethics that designate our research and educative experiences. This ambitious endeavour concluded that despite the wish for tidying things up around ‘common’ grounds, identity in the field of mathematics education research needed to remain open due not only to its interdisciplinary theorising, but also to its locally determined field of practice. This event was an explicit expression for an urge to define our institutional identity using Gee’s (2000) words, or, the identity of our professional community of practice in Wenger’s (1998) terms. At the same time, it signified a public recognition of the inevitable impossibility in such a task when the diverse epistemological and political perspectives underpinning research in mathematics and mathematics education are seriously taken into account.

Sometime earlier, in the year 1991, Jean Lave and Etienne Wenger’s book on ‘Situated Learning: Legitimate Peripheral Participation’ argued for human learning as a participative phenomenon in local practices. This discussion was expanded by Etienne Wenger in his 1998 book on ‘Communities of practice: Learning, Meaning, and Identity’, where the notion of communities of practice as a professional organisation that manages systemic change was closely related to identity formation, learning and meaning. Although, Luria (1976) had already argued for learning as a
long transformative identity process, it was Wenger’s (1999) well cited work that captured the attention of most mathematics education researchers and mobilised the ‘identity turn’ (e.g., Boaler et al., 2000; Nasir and Cobb, 2007; Sfard & Prusak, 2005; Grootenboer & Zevenbergen, 2007; Chauraya, in press).

Identity is a contested term signifying diverse cultural historiographies, epistemological underpinnings, theoretical languages and political orientations. Diversity could range from representing the enlightenment subject (driven by rationality and logic), the socialised subject (acculturated via the institutions of family, church, school) or even the postmodern subject that exemplifies a hybrid ‘self’ (Hall, 1992). However, we could discern a mutual concern for connecting human subjectivity with knowledge and practice that have relevance for mathematics education. Questions such as; ‘who are we in a mathematical classroom, community or even society at large?’, ‘how do we identify with mathematical success and failure?’ or ‘why do we become engaged within a mathematical practice?’ can now become addressed. At first, such questions move our gaze beyond persistence on developing competencies, cultivating learning strategies and adherence towards successful performance as assigned via national curricula and international assessment standards. At a deeper level, our gaze can be attentive to how we enact, perform and narrate our relations with/in mathematical practices, activities, objects and humans. Albeit diversity, the identity turn sensitizes us towards denoting potential perils, challenges, resistances and pleasures as we strive for connectivity and transformation in our social and cultural localities. Here, I encounter identity work as a political space for mathematics educators who try to cope with demands for change – such as technology use as an integral part of mathematical activity. Taking into account how identity can be contested with diverse significations of human subjectivity, I rely on discourse theory and post-structuralism (Laclau & Mouffe, 1985/2005; Weedon, 1987) to articulate identity work as an anti-essentialist process where fragility, fragmentation and hybridity can be recognised.

**TECHNOLOGY USE, MATHEMATICS TEACHER CHANGE, IDENTITY WORK**

Current reforms worldwide place a huge emphasis on teacher change towards becoming competent technology users, able to integrate information and communication technologies in curricular areas. Dominant discourses related to education and life-long learning tend to promote digital media as facilitating knowledge building, collaboration, and creative work across schools and cultures (Loveless, 2007). As such, technology use is not viewed, merely, as developing competences (e.g. technical skills, literacies, regulating strategies) but it is viewed as primarily connected to everyday routines that dissolve into habits of work and entertainment. This move is indicative of a ‘new professionalism’ as argued by Hargreaves (1994) where teachers’ personal learning and growth is embedded within broader institutional structures. As such, teacher (and learner) development through institutional apparatuses (i.e., curriculum, classroom assessment, international
evaluation programs) including the use of ICTs that regulate individual performance becomes a ‘technology of self’ that, in Foucauldian terms, serves to govern society by governing self (Henriques et al., 1998; Popkewitz, 2004; Pais & Valero, 2012).

During the last three decades, the transformative impact of computers in mathematics education has been mainly discussed through qualitative case studies that exemplify potential learning affordances. Emphasis on technology use in mathematics curricula has mostly favored experimentations with innovative software tools purposefully designed and implemented so that to scaffold mathematical learning and advance mathematical thinking (Noss & Hoyles, 1996; Mariotti, 2002; Hershkowitz et al., 2002). Despite such influential research, technology integration in mathematics classrooms remains a huge challenge as argued in a recent study by Ruthven et al. (2004) who observe that school teachers, by and large, still do not utilize technology to deliver the mathematics curriculum. This is, perhaps, indicative of the need to broaden the discussion over mathematics teacher change and technology use to include issues of identity work as discursively situated in professional practices of teaching and training.

Trying to address in a more profound way the complex multiplicity of teacher change, Kelchtermans (2005) highlights how teachers relate personally to the structural conditions of their profession. Reform agendas that require change, have considerable emotional impact on teachers, because of the challenges they pose on self-image, self-reflection and self-reconstruction. Recent conceptualizations in the field of teacher education pay attention to identity as a socially situated construction rooted within socio-historical, cultural, political parameters with a determinative influence on teacher formation. Beijaard et al. (2000), reviewing research on teachers’ professional identity, note that inasmuch as identity is an entity of relational nature, it is unpredictable and constantly in a transition process. This implies that, while subjects construct identities collectively and in response to societal restructuring, uncertainty plays a significant role, turning identity into a shifting, unfixed, and unending entity as it involves the reconstruction of meaning over space and time. Brown and McNamara (2005), exploring how math teachers negotiate professional identity as they encounter regulative curricula reformation, denote teachers’ struggle for meaning over multiple, and often, conflicting discourses.

Through a three month teacher training course focused on introducing a small group of seven experienced teachers (two women and five men) in ways of integrating technology in mathematics teaching, we had the chance to study how teachers appropriate technology and how they weave subjectivity as part of their professional growth and change by means of small scale ethnography. Teachers live in a technology-driven society and become immersed into discourses that emphasize computer literacy. At the same time, through the training course they become acculturated to refined constructivist and socio-cultural discourses concerning investigative and experimental mathematical learning mediated by ‘appropriate’ tool-use and pedagogical design. How do teachers engage and identify with such diverse
and, at times, conflicting discourses of learning? What subject positionings do they take? How do they perform identity work as they strive to embody ‘new’ tools and pedagogies and how do they construe the ‘old’ ones? Teacher change, in this study, emerges as part of continuous efforts to reconcile personal and collective experiences and understandings of both ‘mathematics teaching’ and ‘technology use’ with societal and institutional demands of wider ‘teacher identity change’ politics. Taking into account the above, it is critical to consider how one could conceptualize teachers as subjects who are heavily engaged in identity work. This very concern entails the need to unravel further the notion of ‘identity’ itself.

IDENTITY WORK AS MEANING ARTICULATION

Identity work is not neutral. It signifies all way down historical, social, cultural, epistemological, ontological, ethical and political positions. For some, identity work is viewed as personal-social interplay and refers to the ways we narrate ourselves and how others talk about us. Personal identity is ascribed as taste, choice, belief, attitude, lifestyle or position, and is always inscribed in relation to other people, groups, communities, ethnicities, nations and sexualities. In this sense, personal or core identity in Gee’s (2000) words is linked to social identity and its associated normative rights, obligations and sanctions which, within specific collects enact behaviours, form memberships, perform rituals and generate values and emotions (Tajfel & Turner, 1986). Wenger’s (1998) model of identity formation elaborates this perspective by means of encountering three distinct modes of belonging that tend to relate personal and social dimensions of identity, namely; engagement (mutually negotiating meaning), imagination (expanding images of self) and alignment (fitting self within the broader structure). Within this perspective, the individual’s awareness of purpose, motives, goals and future directions is necessarily connected to his/her participation in specific social practices and representations. Such a view has been critiqued for assuming ‘socialisation’, ‘participation’ and ‘engagement’ as neutral processes where the individual develops rationality smoothly and where adults (parents and educators) mediate their progress and safeguard democracy (Walkerdine, 1988; Walkerdine & Lucey, 198; Henriques et al., 1984/1998).

According to the sociologist Giddens (1991), identity needs to be ultimately seen as a project where the individual has to reflexively reconcile past experiences and future aspirations. This project is based upon self-ability to construct a narrative that represents biographical continuity, where ‘self-identity is not a distinctive trait, or even a collection of traits, possessed by the individual. It is the self as reflexively understood by the person in terms of her or his biography’ (Giddens, 1991, p. 53). This perspective on identity also fails to take into account the dilemmas, the crisis and the pain involved in any attempt to account and reflect upon personal life stories as they are caught at the boundaries of ‘appropriate’ educational experiences. Today, in most western developed countries adult life is organised on short-term contracts, reduced social security funds, increased poverty and unemployment that undoubtedly affect an ever-growing population of young people who become more and more
alienated, disconnected and marginalised from mainstream educational practices. Though productive as ‘technologies of self’, notions of identity as personal ‘core’ or reflexive self ‘project’ represent heavily a neoliberal politics that assumes subject agency as linked directly to a rational learner who can be successful without cost and to an independent citizen who can choose, consume and enjoy a capitalist lifestyle. Moreover, the ‘reflective’ individual is assumed in absolute responsibility and control as providing heroic solutions to persistent social, cultural and historical problems (Walkerdine et al., 2001).

The frequent mobilization of the fictitious image of the neoliberal free, rational, autonomous and independent agent collapses when one tries to explain ‘difference’ in behavioural, affective or cognitive terms. It offers little understanding when we wish to consider seriously the complex lived experience of children and teachers in relation to mathematical practices (e.g., Walkerdine, 1998; Walshaw, 1999, 2001; Stentoft, 2007; Chronaki, 2005, 2011). Empirical evidence in such studies highlights the presence of a fractured, fragile, marginalized and resistant self who is in a continuous battle to meet institutional demands for progress, development and growth. The utopian image of being able to produce coherent narratives of a trajectory that connects linearly past, present and future experiences at any time and space and, perhaps, at any cost, conceals how personal, institutional, social, cultural, racial, gendered and other subjectivities interact whilst hegemonic and marginal discourses come at play as interpretative systems. Gill (2008) has argued that we need to develop an understanding of identity in ways that do not associate individuality and subjectivity solely with ‘inside’ or ‘interiority’. This implies that the social, cultural, political constraints upon human subjectivity should not be ignored but, instead, taken into serious consideration (Weedon, 1987).

Walkerdine was amongst the first in the field of mathematics education who opened the ‘black box’ of the relational biopolitics amongst mathematics, learners, teachers and educational politics in society (Walkerdine, 1988, 1989; Walkerdine & Lucey, 1989) and provided an elaborate critique of ‘progressive’ education (as based on mainstream notions of constructivism and educational psychology) where the ‘child’ is seen as progressing gradually from other-regulation to self-regulation, self-discipline and self-control. Leaning on poststructuralism, psychoanalysis, cultural studies and critical theory, Walkerdine has promoted a view of the subject (learner, teacher and parent) as relating actively with discourses and discursive practices and negotiating multiple and fluid meanings of self and other. In other words, people are not simply socialised but are involved in processes of subjectification where subject and society are interlinked (Davies, 1993; Weedon, 1987/2004). The notions of subject and subjectification are purposefully used so that to denote a move from the neoliberal notion of the ‘autonomous’ individual—a move that became possible through the publication of the volume ‘Changing the Subject: Psychology, social regulation and subjectivity’. In contrast to the neoliberal individual who regulates his
or her behavior and adapts in the socio-cultural context, the notion of ‘subjectivity’ embraces the subject as fragile, fragmented and relational.

Willing to move beyond the notion of identity as ‘personal core’ or ‘reflexive project’ and to embrace identity work as a process of subjectification we turn towards Laclau and Mouffe’s position of the subject as being ascribed and becoming inscribed by diverse and competing discourses. For them, subject positions that are not in visible conflict with other positions can be seen as the outcome of hegemonic regulations, whereby, alternative possibilities have been excluded and a particular discourse has been, at least temporarily, naturalized (Laclau & Mouffe, 1985/2001, pp. 47-49). Foucault’s (1993) notion of ‘discourses’ as historically, or rather genealogically, rooted attempts to construe ‘truth’ in social and cultural practices is useful here to understand how discourses seem to form a consistent totality at the experienced present, but, in fact, are part of partial fixations of meaning organized in nodal points over time and space. According to Laclau and Mouffe (1985/2005) a nodal point is defined as a privileged sign (or a key signifier) around which other signs are ordered and invested with meaning through relations in chains of signification. Through this perspective, mathematics teacher change – in the course of learning to become competent users of technology – is a relational process of articulating meaning. Articulation is a temporary fixation of discursive elements in an attempt to form connections that constitute a contingent and context-specific unity (Barker, 2006). As such, our research task, as we try to interpret identity work, is to plot how the agentive subject fabricates meaning, focuses on articulations that constitute particular positions in complex interactions and accounts for their potential effects at the socio-cultural and political levels. Meeting the above, meaning articulation, in the present study, becomes evident around chains of signification where teachers personally and collectively struggle to weave connections amongst varied elements of technology effects on mathematics at the societal and pedagogical axis. These two interrelated axes will be discussed here as core chains of articulating meaning: a) the societal: embracing the computer as a shared commodity signifying youth digital culture and consumerism, b) the pedagogical: appropriating technology based learning of mathematics as an assemblage that effects in pedagogic novelty and power redistribution. In the sections below, each one will be outlined.

**ARTICULATING THE SOCIETAL: YOUTH DIGITAL CULTURE, COMMODITIES AND CONSUMERISM**

Teachers’ involvement with technology use for mathematical learning was primarily articulated around an urge to relate with youth culture. Youth culture, affiliated with digital culture and digital youth, popularly addressed as digital natives, refers to young people who grew up and immerse into using computing technology in their everyday life (Prensky, 2001). The computer, thus, as shared commodity, becomes a way to connect with the young generation and to bridge an age generated cultural gap:
Tasos: [...] If we are disconnected from pupils [...] they wouldn’t be interested at all in what we try to pass on [...]. We will cease to be convincing. We will belong to the Paleolithic age.

Technology and youth are both seen to offer the hope and hype of society transformation – a teleological assumption of growth, progression and development (Buckingham, 2008). Young people are, often, presented, on the one hand, as the autonomous and agential ambassadors of massive cultural and technological change, and on the other hand, as uncritical consumers of digital commodities and passive users of mathematical activity. Such contradictory set of discourses denotes a wider anxiety about the changing nature of youth and childhood, the impact of technological change on social life, and, at the same time, the increasingly ‘disappearing’ but yet ‘formatting’ power of mathematics embedded in scientific and societal practices including economy and politics (James & Prout, 1990; Castells, 1998, Keitel et al., 1993; Jablonka & Gellert, 2007; Atweh et al., 2007; Chronaki, 2009, 2011).

Teachers in our study were unaware of this complexity and, instead of problematizing the presence of contradictory discourses, they resort readily to children’s enthusiasm and attraction to computers and digital media as only natural. Having experienced the secondary school mathematics culture in Greece they criticize contemporary teaching practices for the over-emphasis on drill and practice of algorithms and the training in formal proof. Teachers, worryingly, argue that this situation benefits merely a few gifted or talented students in mathematics and, by and large, results in unmotivated, uninterested and marginalised learners. Their dissatisfaction was unanimously expressed when claiming that ‘something must be done’, or ‘we cannot continue like this’. Transforming school mathematics from an entirely abstract to an experiential construction accessible to all students (and not restricted to the gifted ones) was perceived as missionary obligation. Technology, at this space and time, was mythologized as a saviour that could provide heroic solutions to such persisting needs. Petros, one of the teachers, exemplifies:

[…] In this technology lesson […] you must see them [implies the pupils]… all of them […]. Focused […] Ah, do you believe it?! […] This thing happened! This thing happened in a mathematics classroom at a vocational school.

Based on the ‘dynamic’ screen aesthetics, the computer in school mathematics is invested with broader hopes related to curricular reforms by taking pupils from inertia to activity, from boredom to creativity and from a disciplined reading of mathematical content to an experiential way of working.

However, computer use is part of a much wider cultural, industrial, commercial, social, educational and entertainment complex that involves people as operators, producers and consumers (Sheff, 1993; Lievrouw & Livingstone, 2004). In our study, the politics of appropriating technology in a society of consumers was mentioned by Tina, one of the two female teachers, as part of her observations on how some tutors
during the training course presented particular software tools as related to mathematics learning:

    [...] Reflecting on the work of last semester Txxxx (one of the tutors) referred to Fxxxx (a type of software). I get the impression that these people, without being aware of this, worked for a serious advertisement of this particular software. It is as if they were paid to advertise it.

Bauman (2007) has pointed out how modernity transforms a society of producers into a society of consumers and argues:

    In this new consumer society individuals become simultaneously the promoters of commodities and the commodities they produce. They are, at one and the same time, the merchandise and the marketer, the goods and the travelling salespeople. (p. 6)

In a similar tone, Tina problematizes the training course as a terrain for marketing educational software along with learning models (that serve to exemplify benefits and affordances for the learning of mathematics) as much needed teaching devices. Deeply concerned with identifying ways to enhance her teaching, but at the same time being cautious to an increased marketization of technology use in education, Tina turns towards deliberately questioning a neutral stance to consuming technology. Taking advantage of her expertise in informatics, Tina adopts a producer position constructing her own digital mathematics (by means of open source and free software tools) and, at the same time, she volunteers for an informal community of mathematics teachers that shares and distributes lesson plans, tools and techniques. Unlike Tina, the other teachers – claiming lack of time and expertise, experiencing restrictions due to gender and parenthood, but also acknowledging a desire to taste ‘new’ tools – positioned themselves, sometimes, as consumers who reuse commercial digital tools (as they were suggested during the training course or located in specialized web portals), and other times, as hybrid producers who amend or expand micro-worlds (e.g., in dynamic geometry or logo-like environments).

Consumerism is conceived a late attribute of modern society, of desiring and longing for goods but also as a social arrangement that coordinates systemic reproduction, social integration and stratification through forming individual and collective identities (Bauman, 2004, 2007). Tacit discourses involve teachers – and tutors in the training course – into the politics of marketing ‘new’ technologies and services for mathematical learning. Such involvement comes implicitly through engagement with theoretical and practical work in the training seminars that stress the ‘newness’ offered by specific computer hardware and software. A newness that resorts upon discourses of ‘effective’ learning design where theories, software tools and artefacts are all turned into marketable commodities. The sense of this needed ‘new’ becomes a reference to the most glamorous and recent, and this, in turn, carries the ideological fiction of ‘new’ equals ‘better’. Teachers, by and large, espoused this posture and expressed, especially at the start of the training course, eagerness to learn about ‘new’ ideas, tools and ways of doing things. For them, ‘new’ signified ‘the cutting edge’,
the avant-garde, the place for forward-thinking people to be and behave as modern designers and practitioners – perhaps a place forbidden for the so called ‘traditional’ mathematics teachers. Discourses of ‘change’ as connotations of the ‘new’ are related with a long-lasting modernist belief in social progress and development as smoothly delivered by technology use (Castells, 1996; Somekh, 2008).

**ARTICULATING THE PEDAGOGIC: TECHNOLOGY APPEAL, POWER RE-DISTRIBUTION AND MATHEMATICAL ACTIVITY**

Main discourses concerning technology use in mathematics classrooms promise potential learning gains for rigorous mathematics only at the provision that children are actively engaged with appropriate software and mathematical activity. Appropriateness has been discussed in terms of encouraging dynamic manipulation of mathematical entities on the computer screen, multiple representations of data in arithmetic, geometric and algebraic forms, as well as modelling and programming (Hershkowitz et al., 2002; Mariotti, 2000; Noss & Hoyles, 1996). The curriculum of our training course was nationally organised around such ideas and the group of teachers in this study worked meticulously so as to grasp the potential didactic and learning affordances of specific software (i.e., CAS, dynamic geometry and logo-like tools) by making direct relations to the school curriculum (see PAKE, 2007). In particular, teachers were geared towards constructing mathematical micro-worlds and designing their integration into pedagogical scenarios and lesson plans. In this way, the aforementioned discourses were re-contextualised through specific apparatuses (i.e., coursework and assessment tasks) and provided the ‘language’ for constructing and negotiating the urgent need to change current practices of mathematical teaching. Despite efforts for acculturating teachers into valuing the learning gains of specific tools they tended to prioritise technology’s impetus for pedagogic novelty. They did so by considering its appeal to children, as well as, its potential to turn the mathematics classroom culture into a more talkative, collaborative and active place.

In terms of technology’s appeal, teachers celebrated its visual, interactive and tangible characteristics and its attractiveness was constructed in direct comparison to the so-called traditional modes of chalk and talk or paper and pencil. For example, Andreas denotes computer’s magic touch:

> *This medium is more attractive, for sure. It [refers to the computer] will replace the teacher. It will help the learner... It will make him... in simple words... not bored with the endless bla, bla... even with the talking [means the need to explain using words in talk and writing] during the lesson. It is different.*

As far as the mathematics classroom culture was concerned, technology was conceived as an assemblage (i.e., computer, software, pupils, colleagues and ways of working with knowledge) that augments classroom norms and re-allocates power over humans, tools and relations. Kostas exclaims how technology serves for a
pedagogic culture where children experiment, work together and become agentive of their own learning:

*With this software children undertake the role of a researcher and what’s more this is what we need in mathematics: to activate the student in order to be able to understand … we don’t want students to continue being passive recipients […] I, finally, got enlightened as far as it concerns student collaboration and its direct relation to learning outcomes.*

Andreas, in particular, notes:

*[…] for pupils, if we can create this move for pupils. To talk. To try and try. To explain why we did such and such. They will feel it as theirs. They can make it […] The knowledge […] that will come later on. BUT, they will feel it belongs to them. They can make it […] In other words, it [mathematical knowledge] does not come from the teacher. Or, if you like, it has been validated by the machine [means the specific software tool]. I think, in this way, we win the students over. We win them back….*

Fabricating the motivated, interested, engaged, active and collaborative learner of mathematics comes along with appropriating mainstream constructivist and sociocultural discourses of technology mediated mathematical learning made available through the training course. Towards materialising this much desired shift, they articulate technology as their ally. Technology was not fabricated as a teacher substitute, but, as a teacher advocate to act out pedagogic novelty at varied layers such as representing mathematical content in multimodal genres in visual, interactive and tangible terms, capturing children’s attention, motivating them to actively engage in their learning, providing feedback and validating mathematical activity. Further, technology was expected to soothe power relations by loosening the demands for teacher authority and by mediating knowledge control.

Children’s immersion in digital worlds was woven by teachers, almost, as a chance to proselytize them into mathematical activity – an activity that leaves the young child indifferent or feared. Pedagogic novelty by means of technology attractiveness was also, here, produced on the grounds of a brutal need to change the mathematics curriculum. Enhancing the variety and appeal of classroom pedagogy was amongst the emerging themes identified by Ruthven et al. (2004) in a study on teacher’s views of computer-based teaching. Teachers referred to activities involving technology as ‘something different’, ‘making a change’, and providing ‘a change from the routine of the classroom’. It is exactly this view of ‘technology mediated pedagogic novelty as a decorative gloss’ that also entailed danger for undervaluing any chance to develop rigorous mathematical learning. All teachers in this study were heavily concerned to safeguard the view that the choice of tools and activity design could support the passage from ‘technology as decorative gloss’ to ‘technology as mediating learning’. However, it was not easy at all times. Encountering this passage was, for some teachers like opening the ‘Pandora’s box’ – a challenging, risky and uncertain endeavour.
Power re-distribution became further evident in ways of disrupting or conforming to essentialist approaches to mathematical knowledge. Specifically, Kostas draws on his work with dynamic geometry software and talks about how he experiences change as part of his relation to children in the context of mathematical activity and was described as a change from a fixed to a negotiable process. In his words:

… until now when we spoke about mathematics, we meant the fixed and hard entity that we convey as it is to the kids… we say: “that’s the way mathematics is”. “Why?” “There is no why” … In this case [means teaching with technology based tools] we can have an open procedure where we try to make them [pupils] understand how this mathematics comes along. Kids can then attribute a meaning to these [mathematical] notions.

Next to appreciation, Kostas draws reservations that became explicit when Andreas enthusiastically shared thoughts with the rest of the group; ‘I think that technology will offer the ground to move beyond the ways we currently accept mathematical proof… for example we may not accept the classical proof any more’. This comment upset Tasos, one of the teachers, who, almost furious, exclaimed ‘I disagree! This is only your personal way to view things!’ Kostas, at that moment, although a warm supporter of technology, felt that it could not be allowed to defy established conceptions of ‘mathematical proof’ and confronted Tasos by stressing: ‘…we NEED proof! The education system NEEDS it. Our society needs it!’. This event raises issues concerning identity work performed collectively by this group of teachers.

Raju (2001) points out how knowledge politics have played a serious part in how mathematics travels over time and culture and argues:

[history, a similar epistemological fissure between computational/practical Indian mathematics and formal/spiritual Western mathematics persisted for centuries, during a dialogue amongst civilizations, when texts on ‘algorismus’ and ‘infinitesimal’ calculus were imported into Europe, enhancing the ability to calculate. (p. 325)

At the same time, philosophy and sociology of science discuss technology and mathematics as interrelated in implicit ways and some have agitated technology as the black-box of mathematics (Keitel et al., 1993; Bijker & Law, 1997). They denote how late modernity – primarily through advances in information technology – renders mathematical knowledge tacit due to its embodiment in processes of producing and manufacturing techno-scientific artefacts. This results in experiencing mathematics as ‘hidden’, ‘frozen’ or ‘disappearing’ into diverse literacies of, for example, technomathematics and ethnomathematics. Neither Kostas nor Tasos have the knowledge to critically consider technology as the black box of mathematics or as part of knowledge politics dissolved over historiographies of mathematics in action. They are both not prepared to move beyond a safe conception of ‘mathematical proof’. ‘Proof’, for them, comprises competences related to hypothetical reasoning and logic central to mathematical thinking and culture – also connected with Greek educational culture. Maintaining this standpoint they resort to both professional and citizenship identities to articulate a fixation about technology use in mathematics
teaching. For them, mathematical proof is the ultimate form of any rational reasoning and an essential literacy in democratic society – a territory that technology should not touch. In other words, they argue that technology could be used for pedagogic novelty, but not for epistemological challenge. Despite the fact that nowadays mathematicians are comfortable with uncertainty as part of scientific work, school mathematics teachers, by and large, have enormous difficulty in embracing knowledge in diverse ways (see Gutiérrez, 2012). However, by the end of the training course, and as teachers were becoming increasingly comfortable with technology-use, as well as, with the idea of mathematics as also fallible, Andreas’ challenge of formal proof was re-appropriated by Tina, who commented:

*Teaching mathematics with technology make it possible not to depend so much on classical rigid mathematical proof, as we did before. Besides we already know [as part of this course] that children’s strategies for proof depend on various forms of argumentation […]*. 

This can be taken as a space where collective and discursive identity work encourages teachers to explore positions for troubling or conforming to both traditional and radical new knowledge and ideas.

**CONCLUSIONARY REMARKS**

Identity work, as a way to account for human subjectivity, is not neutral, but rather political. This becomes evident, when one is prepared to abandon a view of identity that casts self in a personal-social dichotomy. Embracing an anti-essentialist and anti-neoliberalist perspective encourages us to approach identity as contingent to socially and culturally specific productions. In consequence, identity cannot be seen primarily as a core or reflexive construction of a self-narrative, but needs to be considered as a deeply relational and discursive process of subjectification. As mathematics teachers try to cope with becoming experts in technology-use they increasingly realise the boundaries in being able to control its effects and outcomes. They also face the struggles over producing meaning around multiple and conflicting significations of hegemonic and marginal discourses. Could we, then, consider such struggle a path for identity work? If yes, could identity work become a space for negotiating societal change, including teacher change in ways that encourage us to redefine past and future experiences of success and failures as collective endeavours rooted in specific socio-political temporalities? And, if yes, could identity work entail the potentialities of a political space that can create radically different conditions for mathematics education and learning combatting nowadays’ crisis, dilemmas and dead ends?

Contextualising identity work within the specific case of a small group of mathematics teachers as meaning makers of technology use, I have tried to capture their evolving struggles for articulating diverse discourses as they strive with the socio-material contingencies of complex professional space. Findings of this empirical study indicate how teacher articulations were woven as chains of signification around the interrelated societal and pedagogical axis. Teachers’ identity
work involves the production of meaning not as self-referential individual property, but as relational – a cat’s cradle – towards locating status amongst diverse stakeholders and subject positions. Concern here is not to account for any ‘true’ meanings existing out there, but to identify how lay teachers collectively fabricate chains of meaning, and how this allows them to cope with politically grounded demands for change. I would like to stress two issues: a) intensity for change is interlinked with values and practices of a consuming society as experienced by teachers – computer, mathematics and ‘effective’ learning are all fabricated as commodities responsive to marketization politics, and b) change involves appropriation of certain discourses concerning ‘technology use’ and ‘mathematical activity’ that produce the need for pedagogic novelty but also have effects on redistributing power relations and troubling mathematical knowledge.

Concerning the first outcome, intensity for change in mathematics teaching through technology use is further articulated by teachers primarily on the basis of youth culture and market politics. It was a shared concern that mathematics learning and curriculum should be modified so that to satisfy and cater for contemporary young children’s wants, needs and values. Within this context, teachers confronted ‘technology’ and ‘mathematics’ as commodities that enforce subjects to perform specific identities as learners and professionals. Young people and teachers become, thus, a market that is heavily targeted, so that the choice, purchase and utilisation of ‘new’ technologies are already implicated in broader discourses and practices where identities as well as demands for learning and life are interlinked. The ‘threats’ of marketization and consumerism as globalized practices to education and children’s cultures, although well documented (Apple, 2004; Buckingham, 2007), are rarely considered when technology use in mathematics education is at stake. Maths teachers in this study referred to youth digital culture and questioned its potential links to a globalised marketing of educational software. Thus, technology-based mathematics education and training become heavy political arenas that serve to regulate teachers, learners and curriculum designers towards the production of ‘appropriate’ identity changes in the name of the ‘new’ mathematics teacher (see Chronaki, 2000, 2009). Vithal (2007) based on Castells (1996), argues that in the field of mathematics education, contemporary demands for technology-use can easily run into the paradox of a double process of inclusion and exclusion.

Next to these, teacher change needs to be approached as a political space for identity work performed at the core of ‘technology mediated mathematical activity’. Pedagogic novelty by means of the transformative power of technology was repeatedly argued, by teachers in this study, in the hope of an urgent reformation of school mathematics. This outcome signifies how teachers experience technology not merely as a tool, but as a complex assemblage that has vital effects on change at varied levels (Latour, 2007; Bijker & Law, 1997). Here, we witness ‘change’ to be materialised in contextual layers of pedagogic, didactic, epistemological and ontological instances that ultimately frame mathematical activity. As such ‘identity
change’ mobilised through technology-use is inscribed as a continuous move amongst possible acts and potential imageries on how mathematical activity could adopt or resist ‘change’ in concrete terms (i.e., content representation or simulation of mathematical content on screen, communicative rituals and politics of epistemology). As change comes with strain, desire for change becomes reinforced. Change, as we saw in the sections above, involves complex identity work that embodies societal and institutional demands and requires teachers to get involved in profound political choices and decisions in everyday classroom work. This becomes experienced by teachers as a fragile, fragmented, slippery and at times impossible process embodying risk and ambivalence – a process that enveloped uncertainty but also will and joy.

Addressing teacher change and identity work as a complex, multifaceted discursive process has several implications for technology integration in mathematics education. First of all, such a notion disrupts the taken for granted belief that teacher professional development in times of greater social transformation (and curricula reforms) can ever be approached as a one-size-fits-all and effective identity that teachers can easily adopt and ‘wear’. Instead, teachers in transition perform identities at local borderlands of myriad discourses and enact trajectories of non-linearity and without clear outcomes. Consequently, educational policy and official training programs aiming for transforming teaching practices, should view attempts for teacher change as identity work that involves the struggle for articulating meaning as an essential space for subject position in the high density of curriculum reform politics. Based on these findings, we further suggest, that next to training teachers in ‘instrumental’ and ‘functional’ competences in technology use, there is also a need for developing critical competences that would allow teachers to encounter ‘technology’ within wider socio-political institutions. The above are indicative of the need to create borderland spaces in teacher training programs that encourage identity work as scaffolding and dialogue for teachers who encounter technology-use. In this way, they will broaden the ‘unthinkable’ and the ‘yet-to-be-thought’ (Bernstein, 2000) and they will denaturalize and gain awareness about teaching practices. In short, safe spaces in training for teacher change will afford experimenting and performing identity work as it is – a political space.

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REFERENCES


Explore types of technology used in mathematics curricula for students aged 16-19 years old in different educational systems (within a country and internationally); Examine approaches and strategies to technology integration in curriculum design, pedagogy and assessment; Indicate issues involved in the use of technology in mathematics courses; Identify factors increasing the effectiveness of technology implementation in classroom practice; Analyse the effects of using and integrating different types of technology on the development of mathematical skills and academic achievement in mathematics... Giblin explains that through the use of technology, the students are able to detect patterns and non-verbal responses when they analyze the interviews. They are then able to create their own content based on what they learned to teach their classmates. How Teachers Can Utilize Technology to Have a Greater Impact. As an educator, you have access to millions of teachers worldwide at your fingertips. Use technology to connect with them and share ideas. Ideas and resources from others with different teaching styles, grade levels, and viewpoints are easily accessible. Our arguments for advocating the use of mathematics in politics as a resource for mathematics teaching are mainly two. Firstly, to show how mathematics is applied within the political context can have an important motivational value. There is research indicating that the study of authentic and contemporary applications of mathematics can arouse a great interest among students. Mathematics in contemporary politics could have for the students. Such examples might be easy to relate to aspects of students' daily life. However, we have other reasons to believe that the use of mathematics in politics would be interesting and motivating for mathematics students and teachers. Science, technology, engineering, and mathematics (STEM), previously science, mathematics, engineering, and technology (SMET), is a broad term used to group together these academic disciplines. This term is typically used to address an education policy or a curriculum choices in schools. It has implications for workforce development, national security concerns and immigration policy. The science in STEM typically refers to two out of the three major branches of science: natural sciences, including Working with case technology at foreign language lessons involves improving pupils' skills as a result of participation in the discussion of the problem situation. The practice of using such technology in the language classroom, as past experience shows, contributes to the activation of the learning process. It is an effective mean of formation of cognitive and language capabilities of students. Formation of professional skills with the usage of "case-study" technology should begin with simple situations that are of interest to the entire group of students and enable everyone to expr