The present research aimed at investigating some features characterising the profile of 79 student teachers at the end of their pre-service training. Technology proficiency, TPACK and beliefs on the value of technology in teaching and learning were explored through a self-administered questionnaire. Data show the following: student teachers’ low proficiency with new or dedicated technology; some difficulties in integrating technology, pedagogy and disciplinary content, joined with the lack of modelling by Faculty; the prevalence of a functionalist/instrumental view of technology, associated with perceived benefits for teachers, and in contrast with a social/potentialistic view of technology. The results highlight the necessity to boost initial teacher training in the direction of specific/dedicated technology integration and to support Faculty in developing the integration of technology in teaching practices.

KEYWORDS: technology integration in higher education; proficiency; TPACK; beliefs; student teachers
1. Technology integration in higher education

In the context of the technology-driven knowledge society, the issue of technology integration in higher education, especially in the field of teacher education, is growing dramatically in importance. Evidence of this can be seen in the increasing number of national and international programs aimed at integrating technology into teaching (e.g., Preparing Tomorrow’s Teachers to Use Technology in the United States and Teaching Teachers for the Future in Australia), in the trends of the European formative policy dedicated to incorporating media and information literacy in teacher training curricula (e.g., Pérez Tornero, 2008), and in statistics and research demonstrating that many teachers acquire ICT knowledge and skills during their initial training and that the quantity and quality of pre-service technology experience gained during teacher education curriculum influence new teachers’ adoption of technology (e.g., Drent & Melissen, 2008; Enochson & Rizza, 2009; Eurydice, 2011).

The flourishing of research concerning technology integration in higher education has made it possible for scholars to develop theoretical models (e.g., Knezek, Christensen & Fluke, 2003; Mishra & Koehler, 2006; Tondeur et al., 2012; Wang, 2008), among which that of Kay (2006), recently further developed by Messina (2012; Messina & Rivoltella, 2012) and still “open” to modification and additions, is probably the most complete, as it systematizes the different variables found so far in the literature intervening at the institutional level and addressable to any teacher training organization.

Following the schema in Figure 1, some system variables for technology integration are represented in the upper part. Technology integration is subordinated to access, which consists in the availability of technological devices and of just-in-time support to use them, and can be enhanced by the presence of standards, national and local policies and University Centres in charge of Faculty development, refresher courses and support (e.g., Messina & Zambelli, 2008). Moreover,
technology integration should be planned considering the target needs, since the target group is the primary stakeholder in the educational process, both in present and future perspectives.

Immediately below the system variables, Figure 1 presents five sets of variables that impact on technology integration. The first set concerns the *strategies* adopted: according to Kay (2006), technology can be intended as the object of a specific course aimed at the acquisition of technical skills (single course), or its use can be comprised across the curriculum (all courses) and modulated on the basis of different subject matters of the curriculum. Technology can also be considered in its aspect of operative knowledge expressed in ‘stand-alone’ activities or in activities connected to others, e.g. workshops and seminars; but it can also be intended in its role of additional teaching and learning support, e.g. online courses, e-portfolios and case studies of technology use in specific contexts (multimedia).

The second set of variables concerns the *methods* that can be applied to integrate technology into teaching: educators should involve teacher students in problem-solving, context-based, education-aimed design (authentic tasks); they should use technology in their teaching practices (adoption) and, doing so, provide a concrete, direct example of reflective and purposive technology use (modelling).

The third set of variables deals with the *actors* of technology integration, namely teacher students, Faculty members in higher education institution and in-service teachers in schools (mentors) that help teacher students to integrate theory with field practice. Moreover, the question of leadership among actors should be considered, as it has the power to create a ‘technology integrative’ vision and policy in a given institution. Some specific staff members could be included, too, as they could work together with the leader to provide just-in-time support to Faculty in developing knowledge of pedagogical use of new technologies.

The fourth set of variables concerns the *profile* of the actors. This is one of the most complex aspects of technology integration, as it comprises different personal features: beliefs regarding (and attitudes toward) the use of technology for teaching and learning, ability and technological skills, and, from a cognitive perspective, motivational, emotive-affective and intellective aspects, among which a notable aspect regards knowledge, intended, in the light of the TPACK framework (Mishra & Koehler, 2006), as the “dynamic and transactional relationship between content, pedagogy and technology” (Koehler, Mishra & Yahya, 2007, p. 741). Due to the conceptual differences between these variables and the difficulties to define their boundaries and to control all of them together, research generally treats only few of these, without deepening the connections among them (Kay, 2006, p. 395).

The fifth group of variables refers to the *expected results* of technology integration, such as the effective use of technology for instructional purpose and the digital competence pre-service teachers develop during their training.

Last but not least, as shown at the bottom of Figure 1, all the aspects of the considered teacher-training model should be assessed and evaluated, but, as Kay (2006) reports, it still remains a critical matter.
1.1. Student teachers’ profile

Among the variables that affect the process of technology integration, according to the model of Messina and Rivoltella (2012), the set dealing with the profile of the actors becomes crucial, as individual characteristics influence, and are influenced by, technology experience (Albion & Ertmer, 2002), can shape the effective use of technology in teaching (Ertmer et al., 2012; Mumtaz, 2000) and can be changed and developed through experience and instruction (Ropp, 1999). Although the mentioned set comprises different and interrelated personal features, three variables seem to intervene in fostering technology integration: technological ability or, in particular, proficiency; technological, pedagogical and content knowledge-TPACK (Mishra & Koehler, 2006); and beliefs about the value of technology use in education. The combination of these features gives rise to what Drent and Melissen (2008, p. 197) call personal entrepreneurs: one who uses ICT innovatively in teaching practices “is characterised by a specific combination of knowledge, skills, attitudes, or competencies that are advantageous for the innovative use of ICT”. In the same direction, Christensen (2002) highlights the need to provide pre-service teacher students with technology, opportunities for technical training, technology knowledge and experience to increase technological confidence: it is “critical that teachers possess both positive attitudes and adequate computer literacy skills to successfully incorporate technology into the classroom” (Christensen, 2002, p. 412). Also Ertmer and Ottenbreit-Leftwich (2010), defining teachers as agents of change for technology integration and inquiring into the proper characteristics to leverage technology resources as meaningful pedagogical tools, study the intersection between teachers’ confidence in using ICT, their knowledge (also contemplating TPACK) and beliefs. In doing so they take into account the role of subject and school culture: “when thinking about ways to change teachers’ technology practices, we need to consider all these factors [...] during teacher education programs and during professional development programs for practicing teachers” (Ertmer & Ottenbreit-Leftwich, 2010, p. 267).

Another crucial aspect, regarding the modalities through which student teachers achieve the disposition to use technology in teaching/learning practices, is “modeling”. As Kay (2006, p. 391) states, “the modelling approach involves demonstrating how technology can be used in the classroom” and “the emphasis with modelling is to provide preservice candidates with concrete examples of how technology can be used in the classroom”. Consequently, Faculty modelling seems a powerful strategy to support teacher students in offering good examples and letting them decide to try to integrate technology in their future teaching practices.

Technology proficiency

Proficiency refers to the level of confidence a certain technological application or device is used with. Consequently, self-evaluation of proficiency refers to the extent to which each person is deemed to be able to perform a sequence of actions using the proper tools, among those available, to achieve the established goals and recognise his/her ability to do so (Georgina & Hosford, 2009). Proficiency can be investigated within an array of devices ranging from the ‘general’ technology contemplated in the European Computer Driving License (ECDL),
such as word processor, spreadsheets, presentation software, e-mail and internet, to the more ‘specific’ technologies linked to the teaching and learning sphere, such as the Interactive Whiteboard, educational or content-specific software or platforms for e-learning.

Even if the proficiency in using technological devices can be achieved “through experience and instruction” (Ropp, 1999, p.402) and is a necessary condition to introduce, experiment and maintain an accessible technological tool into teaching practices, it can not be considered a predictive factor for technology integration in teaching per se. Technology proficiency in fact seems relevant for many aspects of the teaching profession, such as lesson preparation (Argentin & Cavalli, 2010; Rivoltella, 2006), but other aspects impact teacher decisions to introduce technology into classroom activities, such as beliefs about the way the subject should be taught or skills associated with competence in managing classroom activities (Mumtaz, 2000). However, if teachers should be “pedagogically highly proficient and flexible enough to fit technology in with the varying demands of educational practices” (Tondeur et al., in press, p. 13), they need to encounter and explore a wide variety of technological devices in order to have the possibility to know and choose those which best respond to teaching contents and pedagogical aims.

Knowledge (TPACK framework)

Knowledge is another key component that influences teachers’ designing and teaching practices, and, in order to integrate content and pedagogy aspects with technology, the main theoretical reference is the TPACK framework, developed by Mishra and Koehler (2006) on the basis of Shulman’s work (1986; 1987).

As represented in Figure 2, the TPACK framework (Mishra & Koehler, 2006; 2008) is constituted by seven types of knowledge, three basic forms - content, pedagogy and technology - and their mutual integrations.

- Content Knowledge (CK) regards “knowledge about the actual subject matter that is to be learned or taught” which includes “knowledge of central facts, concepts, theories, and procedures within a given field; knowledge of explanatory frameworks that organize and connect ideas; and knowledge of the rules of evidence and proof” (Mishra & Koehler, 2006, p. 1026).

- Pedagogical Knowledge (PK) is the “deep knowledge about the processes and practices or methods of teaching and learning and how it encompasses (among other things) overall educational purposes, values and aims”. This is a generic form that “includes knowledge about techniques or methods to be used in the classroom; the nature of the target audience; and strategies for evaluating student understanding” (Mishra & Koehler, 2006, pp. 1026-1027).

- Technology Knowledge (TK) refers to knowledge about “standard technologies, such as books and chalk and blackboard, as well as more advanced technologies such as the Internet and digital video. This would involve the skills to operate particular technologies. In the case of digital technologies this would include knowledge of operating systems and computer hardware, as well the ability to use standard software tools” (Mishra & Koehler, 2008, p.4).
• **Pedagogical Content Knowledge** (PCK) includes “knowing what teaching approaches fit the content, and likewise, knowing how elements of the content can be arranged for better teaching” (Mishra & Koehler, 2006, p. 1027).

• **Technological Content Knowledge** (TCK) regards “a deep understanding of the manner in which the subject matter (or the kinds of representations that can be constructed) can be changed by the application of technology” (Mishra & Koehler, 2008, p. 7).

• **Technological Pedagogical Knowledge** (TPK) refers to the ability to use technology in a teaching and learning context, “knowing the pedagogical affordances and constraints of a range of technological tools as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies” (Mishra & Koehler, 2008, p. 9).

• **Technological Pedagogical Content Knowledge** (TPACK) represents “a specialized brand of teacher knowledge” (Mishra, Koehler & Henriksen, 2011, p. 23) constituted by “the dynamic, transactional relationship between content, pedagogy, and technology. Good teaching with technology requires understanding the mutually reinforcing relationships between all three elements taken together to develop appropriate, context specific, strategies and representations” (Koehler, Mishra & Yahya, 2007, p. 741).

Even if the framework has been widely accepted, studied and adopted, some limitations have been recently addressed to TPACK (e.g., Grahm, 2011), among which are mentioned unclear boundaries between components of the model (Cox & Graham, 2009; Archambault & Barnet, 2010); the lack of precise and shared definitions, i.e. for “new technology” (Grahm, 2011); the “parsimony” and simplicity of the model that hides a deep underlying level of complexity and excludes other important dimensions, such as teachers’ values and beliefs regarding teaching and learning (Angeli & Valanides, 2009, p. 157); and the irreversibility of the integration “transformative” process (Gess-Newsome, 2002,
p.12), a reason why teachers with solid blended knowledge domains (i.e. PCK) given by experience can encounter difficulties in considering separately their constitutive components (in our example, CK and PK). Moreover, the use of questionnaires to measure the TPACK dimensions has been criticized: since questionnaires are a means to obtain replies, the ability of the instrument to accurately represent knowledge in TPACK domains can be limited by the ability of respondents to assess their knowledge and to answer appropriately to the survey items. To overcome this limitation, additional performance-based TPACK measurement procedures are under study, such as rubrics and a discourse-analysis coding scheme (Abbitt, 2011; Graham et al., 2010; Harris et al., 2010). Finally, another fundamental problem is pointed out by Ertmer and Ottenbreit-Leftwich (2010): as technology continuously evolves, the process of technology integration into teaching is itself continuously under construction. Consequently, it becomes necessary to refer also to stable personal traits, such as beliefs that can sustain the adoption, use and adaptation of technology in teaching practices.

Beliefs

“Beliefs systems consist of an eclectic mix of rules of thumb, generalizations, opinions, values, and expectations grouped in a more or less structured way” (Hermans et al., 2008, p. 1500). According to Pajares (1992), beliefs are established during earlier experiences and become stronger over time as they are used to process subsequent experiences, and the strength or stability of a belief depends on its ‘central-peripheral dimension’ positioning (the more connections a surveyed belief has with other beliefs, the less it is likely to change): consequently, a sufficient amount of direct qualitative and successful examples of technology integration in teaching should be offered to pre-service teachers. Moreover, beliefs are strong ‘predictors of behaviours’” (Pajares, 1992): research shows that teachers are likely to plan and implement practices with technologies that reflect their beliefs (Prestidge, 2011) and, conversely, teacher beliefs can become a ‘second-order’ barrier to the integration of ICT in teaching and learning, since the ‘first-order’ barriers are those extrinsic to the teacher profile, such as lack of resources, time, access and technical support (Ertmer, 2005). Analysing the research works dealing with teacher beliefs and technology integration in education (among whom Ertmer and Ottenbreit-Leftwich, 2010; Hennessy, Ruthven & Brindley, 2005; Vannatta & Banister, 2009), the field of pedagogical beliefs concerning the integration of ICT in teaching was narrowed to beliefs regarding the value of technology use in education. It seems that teachers assign a value to technology that facilitates the achievement of significant goals: the more positive the judgment is, the keener the teachers are on using technology (Watson, 2006). Essentially, teachers seem to screen pros and cons about the use of technology into teaching and they accept to adopt a certain technology if they foresee a facilitation in achieving their established goals. In summary, research shows that “pedagogical beliefs” affect the integration of technology and are closely related to teacher knowledge (Voogt et al., 2013).
2. The research

A premise concerning the Italian context in which the research has taken place should be made. From an institutional point of view, what must be pointed out is the lack of national standards regarding teacher technological skills. The profile of teachers at the end of their pre-service training, set out in the most recent national law on teacher education (D.M. 249/2012), does not dedicate a specific section to digital competences for teachers, and the European recommendations are just mentioned. Moreover, there are few national studies that set out the actual technological assets in teacher training institutions or Faculty use of technological devices for teaching and learning purposes (Alfonsi et al., 2004).

Within this scenario, the decision to integrate technology in pre-service education seems to depend on each institution’s choice and on Faculty members’ personal initiative¹.

With the purpose to define instruments suitable to systematically investigate the profile of student teachers at the end of their pre-service training, the current research involved 79 student teachers of a north-eastern Italian university. In particular, the research was aimed at exploring:

1. student teachers’ technology proficiency, in order to identify their ability to use different kind of technologies;
2. student teachers’ TPACK, in order to identify the degree of integration among the three basic domains (CK, PK, TK) and their intersection, and the Faculty modelling role;
3. student teachers’ beliefs regarding the value of technology use in education;
4. correlation between student teachers’ knowledge, proficiency and beliefs.

Instruments and procedures

The instrument used for data collection was a paper-based, self-administered questionnaire made up of four sections. In the first section, some demographic information was required: gender, age, the kind of work teacher students discussed during the final examination² and the school subject the final work was related to, plus an e-mail contact if the participants were interested in further research.

In the second section, technology proficiency was surveyed through an 18 item scale, based on the adaptation of the Computer Software Proficiency Scale (Georgina & Hosford, 2009). Participants were required to rate their proficiency with different technologies on a five-point Likert scale (1=not proficient, 2=somewhat not proficient, 3=uncertain, 4=somewhat proficient, 5=proficient). Technologies ranged from ‘general’, such as e-mail, word processor, spreadsheets or presentation software, or ‘less diffused’, such as database, photo-retouch or ed-

¹ The aspects regarding Faculty members, surveyed simultaneously with the same research design, are not presented in this article.
² Italian law states the possibility for teacher students to choose between the discussion of a compulsory essay on their field practice, or both an essay and non-compulsory thesis.
iting software, to ‘specific’ devices, such as the interactive whiteboard or some dedicated teaching software (i.e. Scratch, Cabri géomètre).

In the third section, a 90 item scale, based on the adaptation of the Preservice Teachers’ Knowledge of Teaching and Technology (Shmidt et al., 2009), was used to survey the knowledge of student teachers. For items 1-89, participants were required to rate their level of agreement with the given statements on a five-point Likert scale (1= strongly disagree, 2=disagree, 3=neither agree nor disagree, 4= agree, 5=strongly agree).

Items 1-30 regard CK-content knowledge, i.e., knowledge inherent to the ten subjects teacher students could be teaching at school: Italian (1-3), Foreign language (4-6), Music (7-9), Arts (10-12), Gym (13-15), History (16-18), Geography (19-21), Maths (22-24), Sciences (25-27) and Technology (28-30).

Items 31-37 regard PK-pedagogical knowledge.

Items 38-43 regard TK-technological knowledge.

Items 44-53 regard PCK-pedagogical content knowledge, repeating the same item for each of the ten mentioned school subjects.

Items 54-63 regard TCK-technological content knowledge, repeating the same item for each of the ten mentioned school subjects.

Items 64-68 regard TPK-technological pedagogical knowledge.

Items 69-79 regard TPACK-technological, pedagogical and content knowledge, repeating the same item for each of the ten school subjects and surveying the respondent’s reference role to help colleagues in integrating the three basic domains of TPACK model.

Items 80-89 regard the TPACK modelling role of those Faculty members teaching the ten school subjects during the teacher training course: participants were asked to rate how much their Professor offered a model of TPACK integration during their course; for this sub-scale, another answer option was added: “I did not attended this specific course”, to avoid missing values.

Finally, item 90 consists in an open question: participants were asked to describe briefly a University lesson they attended in which content, pedagogy and technology were actually integrated, specifying context, content (topic of the lesson/lecture), technology used, adopted teaching approach and in what the integration of content, pedagogy and technology consisted. In the case where they had never attended such a lesson, teacher students were asked to answer with a “never attended” label, in order to avoid missing values.

In the fourth section, student teachers’ beliefs were surveyed through an 18 item scale, based on the adaptation of the Teacher Technology Integration Survey (Vannatta & Banister, 2009), partially retracing the cognitive attitude section of the Computer Attitude Measure (Kay, 1993). Participants were required to rate their level of agreement with the given statements regarding the role and the value of technology use in education for teachers and students on a five-point Likert scale (1= strongly disagree, 2=disagree, 3=neither agree nor disagree, 4= agree, 5=strongly agree).

After an initial questionnaire test with teacher students external to the research, tried out between the end of October and the beginning of November 2011 and aimed at verifying the unclear items, the paper-based instrument was delivered personally with pre-paid, self-addressed envelope to 106 teacher students few days before their graduation between December 2011 and February 2012. The
completed questionnaires were subsequently sent by mail to researchers, with a return rate equal to 74.5% at the beginning of March 2012.

**Participations**

The 79 student teachers who participated in the study were mainly female (94.9%; 5.1% male); 60.8% participants were 24 year old or under, being the range comprised between 22 and 46 years of age.

64.4% of participants discussed only the compulsory essay and 35.4% discussed both the essay and an optional thesis. The essay deals with teacher students’ field practice and consists of a report on their teaching experience with primary school pupils within the national curriculum subjects or in specific projects sustained by school or class team; conversely, the thesis encompasses aspects not directly ascribable to a specific subject (e.g. theoretical issue) and had to deal with a topic different from the one encountered in the previous field practice.

As shown in Table 1, the school subjects most frequently treated in the field practice by teacher students were Italian language (n=22), Sciences (n=15), Math (n=10) and Foreign language (n=9). Such a choice depended on the subject preferences of the student teachers, on the availability of mentor teacher in schools who accepted them in their classrooms and on the amount of time each subject is allotted in the school calendar (e.g. Italian language and Math have more hours of teaching than Music or Gym per week).

<table>
<thead>
<tr>
<th>Subject</th>
<th>Essay (compulsory)</th>
<th>Thesis (facultative)</th>
<th>Total (essay and thesis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italian language</td>
<td>22</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td>Foreign language</td>
<td>9</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Music</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Arts</td>
<td>7</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Gym</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>History</td>
<td>6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Geography</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Math</td>
<td>10</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Sciences</td>
<td>15</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Technology</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>12</td>
<td>14</td>
</tr>
</tbody>
</table>

**Table 1.** Distribution of teacher students’ final work according school subjects

Finally, 44.3% respondents left an e-mail account as they were available to collaborate in further research.

**2.1. Data Analysis**

Data concerning the following sections of the questionnaire were analysed using SPSS.19: descriptive analysis, factor analysis and correlations were conducted.

**Technology proficiency**

According to technology proficiency, the modal value was chosen to identify the ability of the majority of student teachers to use different kinds of technologies. Moreover, a synthetic index, obtained as the mean of the scores of the 18 items
composing the scale, was created to summarize the average of the item scores constituting the scale itself.

As shown in Table 2, the majority of teacher students felt proficient (score 5) in using institutional e-mail, search engines and word processors, and in transferring data from device to device. They felt somewhat proficient (score 4) in using browsers, spreadsheets, presentation software and tools for e-learning, in installing and removing software, and in conducting bibliographic searches. They felt uncertain (score 3) in using editing software and in teaching through social networks. They felt somewhat not proficient (score 2) in using photo-retouch software and in organizing personal on-line resources. They rated themselves not proficient (score 1) in managing databases, in using didactic software and IWB, and in creating web pages.

The participants’ synthetic index ranges from a minimum of 1.94 to a maximum of 4.44, with a mean equal to 3.25 and a standard deviation equal to .63815.

<table>
<thead>
<tr>
<th>Score 5: proficient</th>
<th>e-mail, search engine, word processor, transferring data from device to device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score 4: somewhat proficient</td>
<td>browser, spreadsheet, presentation, tools for e-learning, installing/removing software, bibliographic search</td>
</tr>
<tr>
<td>Score 3: uncertain</td>
<td>editing software, social networks for teaching</td>
</tr>
<tr>
<td>Score 2: somewhat not proficient</td>
<td>photo-retouch, organizing personal on-line resources</td>
</tr>
<tr>
<td>Score 1: not proficient</td>
<td>database, didactic software, IWB, creating web pages</td>
</tr>
</tbody>
</table>

Table 2. Student teachers’ proficiency in using different technologies (modal value)

Knowledge - TPACK

For each sub-scale of the seven sections of TPACK, the reliability was tested through Cronbach’s alpha and a synthetic index was created. As shown in Table 3, Cronbach’s coefficients range from .824 to .927.

<table>
<thead>
<tr>
<th>Sub-scale</th>
<th>Items</th>
<th>N. of items</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK</td>
<td>1-30</td>
<td>30</td>
<td>.927</td>
</tr>
<tr>
<td>PK</td>
<td>31-37</td>
<td>7</td>
<td>.824</td>
</tr>
<tr>
<td>TK</td>
<td>38-43</td>
<td>6</td>
<td>.905</td>
</tr>
<tr>
<td>PCK</td>
<td>44-53</td>
<td>10</td>
<td>.851</td>
</tr>
<tr>
<td>TCK</td>
<td>54-63</td>
<td>10</td>
<td>.905</td>
</tr>
<tr>
<td>TPK</td>
<td>64-68</td>
<td>5</td>
<td>.890</td>
</tr>
<tr>
<td>TPACK</td>
<td>69-79</td>
<td>11</td>
<td>.925</td>
</tr>
</tbody>
</table>

Table 3. Reliability of each TPACK sub-scale

The synthetic indexes representing Content Knowledge, Pedagogical Knowledge and Pedagogical Content Knowledge are those with the ‘highest’ rating (M_{PK}= 3.89, M_{PCK}= 3.88, M_{PCK}= 3.78); then Technological Knowledge (M_{TK}= 3.64) and the other knowledge domains involving the integration of technology (M_{TPK}= 3.45, M_{TCK}= 3.33, M_{TPACK}= 3.26) follow. Moreover, as shown in Table 4, the indexes of CK, PK and PCK have lower standard deviation than those concerning technology alone or integrated within other knowledge domains: student teachers seem to agree in rating their content, pedagogy and pedagogical content knowledge, but they present higher individual differences in the domains concerning technology.
Student teachers report in technology knowledge (TK) a higher value than in the domains involving the combination of technology, pedagogy or/and content (TPK, TCK and TPACK): in line with other studies (Cavalli & Argentin, 2010; Mantovani & Ferri, 2008; Rivoltella, 2006) this one highlights the tendency of teachers to be more and more ‘technological’, but also to use digital technology for private purposes, without transferring their competences in school setting and school practices with pupils.

<table>
<thead>
<tr>
<th>Sub-Scale</th>
<th>Respondents</th>
<th>Mean value</th>
<th>St. deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKtot</td>
<td>77</td>
<td>3.88</td>
<td>1.539</td>
</tr>
<tr>
<td>PKtot</td>
<td>79</td>
<td>3.89</td>
<td>1.529</td>
</tr>
<tr>
<td>TKtot</td>
<td>79</td>
<td>3.64</td>
<td>1.842</td>
</tr>
<tr>
<td>PCKtot</td>
<td>77</td>
<td>3.78</td>
<td>1.585</td>
</tr>
<tr>
<td>TCKtot</td>
<td>77</td>
<td>3.33</td>
<td>1.746</td>
</tr>
<tr>
<td>TPKtot</td>
<td>79</td>
<td>3.45</td>
<td>1.769</td>
</tr>
<tr>
<td>TPACKtot</td>
<td>78</td>
<td>3.26</td>
<td>1.751</td>
</tr>
</tbody>
</table>

Table 4. Synthetic index for each TPACK sub-scale

The Faculty modeling role in integrating content, pedagogy and technology was investigated, as modeling appears to be a powerful strategy to support teacher students in deciding to try to integrate technology in their teaching practices. In Table 5 the answers to items 80-90 are summarized: the mean scores of Faculty for ‘being a good model’ during University lessons range from 2.55 to 3.68, with a number of respondents that varies from 35 (Music is the only non compulsory subject in the curriculum) to 72. The subjects most highly rated turned out to be Arts ($M_{\text{arts}} = 3.64$), Technology ($M_{\text{tech}} = 3.59$), Geography ($M_{\text{geo}} = 3.58$) and Foreign Languages ($M_{\text{FL}} = 3.49$).

Evidence partially supporting these data is given by the student teachers’ answers to the final open question. 41.8% of respondent never attended a University lesson in which content, pedagogy and technology were effectively integrated. Participants who, conversely, attended to such kind of lesson (58.2%) mentioned mainly Arts (11.4%), Geography (11.4%), Technology (10.1%), Music (7.6%) and Foreign Language (6.3%).

<table>
<thead>
<tr>
<th>Subject</th>
<th>Respondents</th>
<th>Mean</th>
<th>St. Deviation</th>
<th>Reported examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italian language</td>
<td>72</td>
<td>2.72</td>
<td>1.313</td>
<td>None</td>
</tr>
<tr>
<td>Foreign language</td>
<td>67</td>
<td>3.49</td>
<td>1.035</td>
<td>6.3%</td>
</tr>
<tr>
<td>Music</td>
<td>35</td>
<td>3.14</td>
<td>1.375</td>
<td>7.8%</td>
</tr>
<tr>
<td>Arts</td>
<td>55</td>
<td>3.68</td>
<td>1.169</td>
<td>11.4%</td>
</tr>
<tr>
<td>Gym</td>
<td>72</td>
<td>2.79</td>
<td>1.310</td>
<td>None</td>
</tr>
<tr>
<td>History</td>
<td>71</td>
<td>2.93</td>
<td>1.345</td>
<td>5.1%</td>
</tr>
<tr>
<td>Geography</td>
<td>70</td>
<td>3.58</td>
<td>1.198</td>
<td>11.4%</td>
</tr>
<tr>
<td>Math</td>
<td>73</td>
<td>2.55</td>
<td>1.313</td>
<td>2.5%</td>
</tr>
<tr>
<td>Sciences</td>
<td>70</td>
<td>3.02</td>
<td>1.383</td>
<td>3.8%</td>
</tr>
<tr>
<td>Technology</td>
<td>68</td>
<td>3.59</td>
<td>1.225</td>
<td>10.1%</td>
</tr>
</tbody>
</table>

Table 5. Faculty modelling in content, pedagogy and technology integration

It is indicative that ‘attending’ participants indicated the context (e.g. lecture room, laboratorial setting), the subject content and the technological devices used (e.g., video projector, computer, camera, editing software, internet, web resources, wiki, chat, Moodle, Google Maps...), but encountered difficulties in
indicating the adopted teaching approaches (e.g., active methods, discussion, lecture), and never reported personal reflections about ‘what the integration of content, technology and pedagogy consisted in’: apart from the missing answers, they often described the structure of the lesson or its purpose, but rarely associating the technology used with the activity required to students.

For example:

- “Technology: The teacher divided the students into groups, assigning to each group a task. The task was written on a Power Point presentation, as well the procedures to follow for fulfilling the task. The content was presented in some handouts given to each group. Then, each group presented its work with the support of Power point, videos, cartoons, music and so on” (S. 30).

- “History: The explanation about how the teacher can use web resources such as blogs, bibliography or sites related to History, was made through an expository lesson in which the teacher copied from a Word file, and pasted in a web browser, the URL of some web resources to display its contents. The integration was aimed at learning the use of technology in the classroom” (S. 35).

- “Arts: we experimented the use of the camera to film interviews, then we used editing software and it was highlighted the possible use with pupils (group work)” (S. 46).

In general, student teachers tended to report what was done and how during the lesson; very few of them explained the purpose of using some technologies in place of other instruments, maybe more traditional, to create and represent knowledge or about the outcomes they obtained through such use.

For example:

- “Sciences: Talking about volcanoes and earthquakes, it was fundamental to verify earth movements through the vision of a short simulation video to understand more clearly the issue” (S. 92).

- “Geography: through Google Earth the teacher treated the issue of rivers and she concretely showed the difference between river delta and river estuary” (S. 97).

- “Geography: the teacher introduced and developed the issue of cartography using PC and video projector, connecting to the internet and using Google Earth and an expository approach. The analysis of paper-based maps was conducted, too” (S. 36).

On the other hand, some doubts emerge regarding the adequacy of the instrument used to collect the information required (an interview or a focus group could have been more effective) and an in-presence, prior clarification/establishment of a common terminology between researchers and respondents could have been useful (e.g. teaching approaches, technology integration...).
Beliefs

As regards beliefs, the statements on general and educational value of using technology in teaching were rated on a 5-point scale. A factor analysis, using main components extraction method and Oblimin rotation with Kaiser normalization, was conducted to detect latent, underlying dimensions. Only pure items and item-factor correlations equal to or greater than .40 in absolute value were considered. As shown in Table 6, three factors emerged, for a total explained variance equal to 65.133%.

The first factor relates to a student teachers’ functionalist/instrumental view of technology. The factor explains 50.405% of total variance, has an internal consistency index (Cronbach’s alpha) equal to .891, and is constituted by 6 items with factor loading ranging from .836 to .402. The factor score mean is 4.26 (SD=.61596): participants agree in attributing a positive value to technology in teaching, considering technologies as devices that facilitate teaching and learning.

The second factor relates to a social/potentialistic view of technology. The factor explains 7.844% of variance, has Cronbach’s alpha equal to .785, and is constituted by 3 items with factor loading ranging from .865 to .563. The factor score mean (M=4.08, SD=.71002) suggests that participants attribute a relative positive value to technology, seen in a double perspective: on the one hand, technology can enhance collaboration, creativity and active involvement especially for pupils, but also for teachers; on the other hand, technology can open new spheres of possibility, as it stimulates and encourages variety and change of practices, once again both for teachers (in terms of didactic approaches) and students (in terms of collaboration and effectiveness).

The third factor relates to perceived benefits for teachers. The factor explains 7.883% of variance, has Cronbach’s alpha equal to .866, and is constituted by 4 items with factor loading ranging from .860 to .611. The lower factor score mean (M=3.28, SD=.74114) suggests a sort of uncertainty toward the benefits of using technology (such as saving time and increasing productivity), and the ‘costs’ of its use (such as the problems posed, among which those technical, pedagogical and about classroom management).

<table>
<thead>
<tr>
<th>Item</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Teaching how to use technology is part of teaching profession</td>
<td>.836</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Technology allows the creation of materials to enhance teaching</td>
<td>.786</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Technology increases student motivation</td>
<td>.701</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Students get satisfaction using technology for learning</td>
<td>.685</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. During the lesson planning, teachers must think about how to use technology to enhance student learning</td>
<td>.584</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Technology increases the overall quality of students’ education</td>
<td>.402</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Technology allows students to work effectively and collaboratively</td>
<td>.865</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Technology stimulates the creativity of students</td>
<td>.737</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Technology encourages teachers to use more didactic approaches</td>
<td>.563</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Technology allows teachers to save time</td>
<td>.860</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Technology allows teachers to increase their productivity</td>
<td>.765</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Technology solves more problems than it poses</td>
<td>.667</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. The use of technology in the classroom is a priority</td>
<td>.511</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6. Factorial structure of the questionnaire section dealing with beliefs about technology value.
Considering the factors’ correlation, a positive correlation is found between the first factor and the third factor, namely functionalistic/instrumental view of technology and perceived benefits for teachers (r=0.478). On the contrary, the first factor and the third factor negatively correlate with the second factor, that deals with social/potentialistic view of technology (in order: r=-.445 and r=-.393).

Correlations

A significant correlation was found between proficiency synthetic index and TPACK synthetic index (r=.560): the more able teacher students feel to use technology, the more easily they integrate content, pedagogy and technology, or, in other words, the better devices and application are known, the more they could be used in versatile ways to build and represent knowledge. Other significant correlations were found between TPACK synthetic index and the first belief factor, functionalist/instrumental view of technology (r=.359,) and between TPACK synthetic index and the third belief factor, perceived benefits for teachers (r=.472). These data could confirm the nature of TPACK as a conceptual framework finalized to teaching, considering the technological component especially for uses that are allowed and the benefits that it can involve in the teaching practices themselves.

No significant correlation was found between TPACK synthetic index and the second belief factor, social/potentialistic view of technology, as teacher students seem to manifest a certain distance with respect to the social uses of new technologies.

3. Results and discussion

The current research began with the aim to define instruments suitable to systematically investigate the profile of student teachers at the end of their pre-service training. Even if technology integration involves multiple aspects, this study focused on variables concerning the profile of student teachers’, in particular their technology proficiency, knowledge and beliefs regarding the value of technology in teaching.

With regards to proficiency, participants reported a high level of confidence in using general technologies, such as email or word processing programmes, but a low level of confidence in using new or dedicated technologies, such as IWB and subject software, which could enrich their professional competencies. The emerging problems, from a perspective of improvement of pre-service teacher training, concern the need to acquire new technologies (e.g., IWB) and the need to train Faculty members, giving them the opportunity to build technology expertise together with student teachers, upgrading the curriculum of their courses in the direction of technology infusion and fostering a ‘social’ development of good practices (Georgina & Hoshford, 2009).

With regards to knowledge, referring in particular to the integration of content, pedagogy and technology presented into the TPACK framework (Mishra & Koehler, 2006), participants reported relatively ‘higher’ scores in CK-content knowledge, PK-pedagogical knowledge, PCK-pedagogical content knowledge and TK-technology knowledge, where technology was not connected to disciplinary contents,
and relatively ‘lower’ scores in integrated knowledge domains, namely TPK-technological pedagogical knowledge, TCK-technological content knowledge (in this domain can be counted the impaired aspects of proficiency with dedicated technologies), and TPACK-technological, pedagogical and content knowledge. Both ‘higher’ and ‘lower’ scores may derive from generally cautious judgments, as most of the teacher students had a limited experience of field-practice carried out during their compulsory training and generally focusing only on few school subjects, and each subject course, if attended, lasted only a short time (a semester). Caution could be also an important factor in the participants’ coherent rating of the Faculty modeling role, considering the good-model examples given by participants in the final open-ended questions. Some discrepancies seem to emerge between researchers and participants in the way of considering “technology integration”. For researchers, in fact, technology integration was intended as ‘something that is actually put into practice’ by Faculty and directly experienced by teacher students. For students, technology integration was intended also as suggestions received on ‘something that could be done in their future classrooms’, then considering again the use of technology not necessarily connected to other activities and processes designed into a systematic plan for student learning.

With regards to beliefs, three aspects emerge: a functionalist/instrumental view of technology, a socio/potentialistic view of technology and some perceived benefits for teachers implied in the use of technology. The functionalist-instrumental view of technology appears to be predominant: technologies seem still to be considered as devices that facilitate teaching, as a teaching aid or a tool (Buckingham, 2009; Lankshear & Knobel, 2008).

To conclude, while taking into account some limits of the research, such as the restricted number of involved participants and the focus on few variables even if technology integration involves multiple aspects (Messina, 2012), the results highlight the need to boost initial teacher training in the perspective of technology integration, empowering the knowledge of new, dedicated and specific content technologies (TCK) without omitting the pedagogical dimension and taking into account the fact that if teachers learn to use technology associated to specific content, they tend to transfer what they have learnt in their classrooms (Hughes, 2005; Messina & Tabone, 2011; Snoeyink & Ertmer, 2001/2002). A necessary premise is the need to support Faculty responsible for teacher training in developing the integration of technology in teaching practices, as the Faculty adoption of new technologies and their pedagogically-oriented use seem to impact positively on future teachers’ attitudes and beliefs regarding technology use in classroom practices (Brown & Warschauer, 2006; Sang et al., 2010). Moreover, the more the teachers learn to use technology associated to a specific content, the more easily they transfer what they have learnt into their classrooms; vice versa, when a learning experience is focused only on using technology for its own sake, without highlighting its applicability for achieving defined goals and in a concrete context, teachers rarely tend to incorporate it into their classroom practices (Huges, 2005; Snoeyink & Ertmer, 2001/2002).

In such direction, it is necessary to expand the research on a large-scale to obtain more generalizable indications for the still open question of technology integration in teacher education and to adopt also a qualitative approach to deepen with participants the relationships between TPACK and beliefs (Voogt et al, 2013) and, last but not least, the meaning of the terms adopted by researchers and mentioned in research instruments.
References


