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ORIGINAL RESEARCH

# Digital Competences of Pre-service Teachers in Italy and Poland

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**Abstract**
The aim of this research was to compare the level of digital competence of future pedagogical staff (students of pedagogical faculties) in Italy and Poland. The research was conducted using original measurement tools and knowledge tests. The triangulation of techniques and research tools made possible the determination of the level of knowledge of the positive and negative features of the development of the information society, as well as the proficiency and frequency of use of the most popular websites and software. The research was conducted in the first half of 2022 using stratified sampling in both countries (N = 1209, IT = 604, PL = 605). Based on the data collected, it was noted that: (1) Pre-service teachers most often use software such as word processors and presentation creation tools; (2) This group very rarely uses software to create web pages, create visual material, or edit video; (3) The least problematic software that students use are word processors and multimedia presentations; (4) Among the typical ICT mediated activities that cause problems are: searching for and installing freeware (PL), installing and configuring parental control software (PL, IT), creating websites (PL, IT), searching for freely licensed images, and identifying plagiarism (PL); (5) Polish students have more theoretical knowledge about e-risks and the possibilities of the digital world than their Italian counterparts; (6) In most domains, the Italian future teachers rate their competences higher; (7) 53.81% of the respondents in IT and 38.68% in PL received lower results in competence tests, and handling ICT in selected areas causes problems for these students; (8) Both in PL and IT the frequency of ICT use and its seamless integration are predictors for assessing the effectiveness of ICT use in education.

**Keywords** Digital literacy · Digital skills · Digital competencies · Pre-service teachers · Italy · Poland

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## 1 Introduction

Changes associated with the transformation of the information society, consisting of the intensive development of digital services, have forced the transformation of almost all sectors of human life (Wątróbski et al., 2018; Ziemba, 2019). Transformations related to computerization are also noticeable in the area of formal education, as well as in higher education (Plebańska, 2017; Ptaszek et al., 2020). The widespread computerization of education has accelerated over the last few years, generating the need to rethink the direction of the digitization of education, to equip schools with ICT, and to analyze how new media are used in school didactics (Potyrała et al., 2021). That the modern teacher should be characterized by a number of competencies that enable the implementation of effective educational and didactic activities is an indisputable issue (Tomczyk et al., 2018). Among the main competences, the importance of digital competences, i.e. the ability to effectively use software, websites, and equipment conducive to the achievement of didactic and educational goals, is more and more strongly recognized and emphasized.

Digital competences are also becoming an area of particular interest in the context of educating future teaching staff. The appropriate and responsible preparation for the teaching profession makes it necessary to think about the directions of the modernization of academic courses that enable students to work in a school that is becoming increasingly "digital". However, the realization of this general assumption requires a diagnosis of the level of the digital competence of future generations of teaching staff. Taking into account the requirements related to the irreversible digitization of education, as well as the intense discussion of the level of digital competence of students together with social expectations, the topic of digital competence is part of the current issues assigned to both media pedagogy and higher education. This article is an exploration of the level of preparation of future pedagogical staff in Poland and Italy using new ways of measuring digital competences, going beyond the simple self-evaluation that is fraught with many methodological errors (De León et al., 2021; Gui & Argentin, 2011; Pérez-Escoda & Rodríguez-Conde, 2015). This article makes it possible to compare the level of competence in two European countries and is at the same time part of the local and global trends visible in media pedagogy, which are related to the measurement of digital competence. This type of research is particularly valuable in the discussion on the level of preparation of new generations of teachers for their profession in the information society. (Guillén-Gámez et al., 2022). This text is a study that fills a gap not only in how the digital competences of future pedagogical staff are operationalized, but also allows for a comparison of the level of preparation of pedagogical students in two European countries.

## 2 Theoretical Framework and Research Overview

There are many definitions of digital competence. The term competence itself implies the ability to perform an activity. In the case of ICT, this will be the ability to use common hardware, websites, and software, and therefore the typical information and communication technologies (ICT). Digital competence is equally often identified with activities related to the ability to access, process, transmit, and store digital information (Knobel & Lankshear, 2006). Digital competences are defined depending on the context of the use of ICT. A certain set of skills and knowledge is assigned to consumers of information and digital products, while a different set is assigned to creators of digital content (Koltay,

2011). One component of digital competence is not only the simple ability to use hardware and software, but also the knowledge of how digital media affect human behaviour (Tomczyk & Potyrała, 2021). Digital competences captured in the category of skills and knowledge are also a variable set, subject to definition adjustment depending on the metric age of the users of ICT (Buckingham, 2010; Gil, 2019; Eliseo et al., 2020), membership of a particular professional group (Stošić & Stošić, 2015), and the stage of development of the information society (Leahy & Dolan, 2010; Spante et al., 2018). When looking for an answer to the question of what digital competences actually are, one should also take into account the needs that digital media literacy satisfies (Martin & Grudziecki, 2006). The needs conditioned by professional or private life create an individually tailored set of knowledge and skills that should be combined with information society services, and the operation of a particular type of hardware or software (Jasiewicz, 2018). Regardless of the disputes over the definition of digital competence, or the constant attempts related to the search for a closed list of skills and knowledge, it is these needs that are the key to establishing a basic and more "directional" way of handling ICTs.

Digital competences in this study will be adapted to the context of the research, that is, to the activities that will be undertaken by future educators in their work. Digital competence is synonymous with the terms digital skills and digital literacy, denoting the ability to use the most popular software and websites. Considering the specificity of the activities of teachers, digital competence will also be linked to the layer of knowledge about the positive and negative aspects of using digital media in educational aspects. This knowledge will concern both the safety of students and teachers (identified by the EU KIDS Online study, among others) (Kvardova et al., 2021; Pyżalski et al., 2019) and the developmental potential that new media offer. The combination of both positive and negative aspects in research conducted on digital competences is a necessity due to the preservation of methodological correctness, and the minimization of stereotypes associated with the one-sided presentation of the positive or negative impact of ICT on children and adolescents (Tomczyk, 2021b ).

There are many typologies of digital competence that focus on teachers and future teachers. The most relevant for this article include TPACK (Koehler & Mishra, 2009; Sahin, 2011), DigCompEdu (Caena & Redecker, 2019; Redecker, 2017), UNESCO (Falloon, 2020; Woo et al., 2018), NETS-T (Banister & Vannatta Reinhart, 2012; Overbaugh & Diacopoulos, 2015), and DigiLit Leicester (Fraser et al., 2013). Each of the aforementioned theoretical frameworks primarily assumes that new media literacy in education is natural and can be taken for granted. These frameworks group in different ways the areas of the application of ICT in education; however, each assumes that digital literacy is permeated with a didactic and sometimes educational layer. Familiarity with hardware and software is not an activity separate from the school reality. The aforementioned theoretical frameworks are not only popular among researchers, allowing for the construction of educational programmes for current teachers (lifelong learning) and future teachers (academic courses), but are also a starting point for discussions on how to define and measure digital competence. The richness of terminological approaches, as well as the diverse ways in which this key skill is diagnosed, force a search for solutions that universally combine the advantages of the most influential theoretical frameworks.

The digital competence of future teachers is a group of profiled digital media literacy skills in which a high level of ability to perform typical tasks related to the use of the Internet, digital hardware, and software in order to achieve the set educational and didactic goals is evident. The digital competence of future teachers therefore differs from other professional groups in the profile of the software and websites used. Therefore, the understanding of this key competence should include professional contexts, forcing the

adaptation of the general definition of digital literacy to the specific area of the use of ICT (Hall et al., 2014; Petrucco & Grion, 2015) This study assumes that digital literacy is not only the ability to use ICT in a given context, but also knowledge, including self-reflection on the impact of media on the lives of individuals and groups with a particular focus on children, young people, and their parents. A visual representation of the notion of digital literacy is presented in Fig. 1.

Not only is the issue of defining the digital competence of future educators ambiguously defined in the literature, the means of measuring this key competence are also sometimes understood in a flexible way. Nowadays, studies based on self-evaluation have risen to prominence in media pedagogy, with students of pedagogical faculties being asked to self-declare their skill level. Such studies are conducted in many countries by experts in the field of media pedagogy (Guillén-Gámez et al., 2021a, 2021b; Záhorec et al., 2019 Morante et al. 2020; Perez-Escoda and Rodriguez-Conde, 2015). The approach related to the measurement of digital competences using a methodology based on self-evaluation allows relatively easy and rapid data collection without the use of specialized measurement tools (e.g. software and hardware), and low-cost survey-based analyses. However, self-evaluation is a very inaccurate research method, burdened with a large error due to subjectivity, which makes it impossible to determine the real level of digital skills, being rather an idea about one's own skills than its real representation. It can be seen that studies based on self-evaluation have become the dominant form of measuring digital competences in this occupational group, which may raise many concerns related to obtaining real data in this key social group.

Another form of measurement is based on competence tests. An example would be the standardized tests of the European Computer Driving Licence (ECDL), which provide more precise measurement values regarding the level of skills of using the typical software found in education. However, such measurement is more time-consuming, requiring more work, the inclusion in the measurement process of properly equipped measurement laboratories, and the involvement of experts evaluating standardized tests (Tomczyk, 2021a). Each of these ways of measuring digital competence levels is burdened with certain disadvantages. Given the debate around the definition of digital

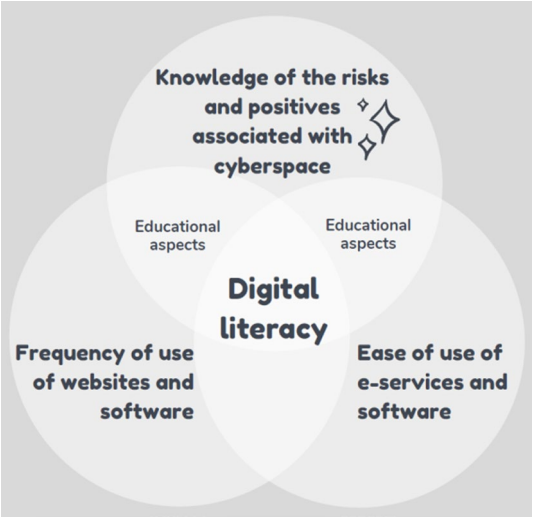



**Fig. 1** Digital competences among future teaching staff—a diagram *Source* own elaboration

competences and the methodological limitations of both methodological approaches in measuring digital competences, the subject can clearly be seen to be complex and fraught with many difficulties in terms of establishing both an unambiguous and clear theoretical framework and universal diagnostic tools.

The variety of theoretical and diagnostic approaches introduces many overinterpretations for one of the key competences (Tomczyk, 2021a). Despite the fact that digital competence is intuitively simple to define as the ability to use ICT devices, websites, and software (Çam & Kiyici, 2017), the multifaceted use of new media in education, as well as the intensity of the discussion on the directions of change and the modernization of educational programs aimed at future teachers (Anisimova, 2020), require that further research in this area is undertaken. Therefore, this text is part of the attempt to redefine the digital competence of future pedagogical cohorts (List, 2019; Ala-Mutka, 2011; Tondeur et al., 2019) and the discussion of effective measurement that minimizes the error of subjectivity.

## 3 Research Methodology

### 3.1 Object and Purpose of the Research

The aim of the research is to show the level of digital competence of future pedagogical staff in Italy and Poland. The research is comparative in nature, which is rare when the countries being compared are taken into account. Also unusual is the methodology used, based on a measurement that goes beyond the self-assessment of digital competence (Tomczyk, 2021a). The subject of the research was the declarations of pedagogical students on the frequency of use and the level of problematic use of the most typical software and websites, as well as the result of two knowledge tests on the positive and negative aspects of the development of the information society from a pedagogical aspect. The subject of analysis also considers opinions about the usefulness of the most popular educational software found in formal and non-formal education. The article considers the following research problems:

- *RQ1* What is the frequency of use of the most popular software and websites among pedagogical students in Italy and Poland?
- *RQ2* To what extent are typical ICT handling activities problematic for future teaching staff?
- *RQ3* How do students assess their skills in typical ICT-enabled activities?
- *RQ4* What is the level of knowledge among prospective teachers about the dangers of the digital world?
- *RQ5* What is the level of knowledge among future teachers about the positive aspects of the development of the information society?
- *RQ6* What is the percentage of students with high levels of digital competence in the survey sample?
- *RQ7* To what extent are digital core competences among pre-service teachers linked to predicting the use of educational software?

### 3.2 Research Tool

In the research, quantitative techniques and research tools were used, which were designed either on the basis of previous research conducted by the authors, or were completely new tools. The triangulation of research techniques and tools was dictated by the desire to find the real level of digital competences, going beyond the typical self-assessment used in most European studies. The research tool took the form of a web site. The battery of research tools consisted of the following elements:

- Frequency of use of the 9 types of most popular software and websites. The tool is a modified version of the questionnaire used in a previous study measuring digital competence among students from Visegrad countries (Eger et al., 2018). Answers regarding frequency of use were placed on a scale from 1—never to 5—very often (at least once a day). Internal consistency was IT = 0.799; PL = 0.713.
- Problematicity of using the 9 types of most popular software and websites. The tool measures experiences related to the ease or difficulty of using elementary information society software and services. The tool is a modified version of an online survey questionnaire used in previous studies (Eger et al. 2020). Responses were placed on a 5-degree Likert scale from 1—I do not use it to 5—it never causes me problems. Internal consistency for the tool was IT = 0.810; PL = 0.731.
- Performing typical activities using ICT. This part of the tool is concerned with the activities that are most often undertaken both in private and professional life. The scale consists of 16 questions, 9 of which were prepared on the basis of the e-Teacher European Computer Skills Certificate ECDL standard (Ziuziański & Furmankiewicz, 2013). The first 9 indicators covered the issues of the law, the legal and ethical use of ICT, information security, the protection of children from e-threats, the use of external devices, and the use of external educational resources. The next 7 indicators were created by referring to the DigiLit Leicester standard (Fraser et al., 2013), which covered activities related to assessing the credibility of information, creating content using a cloud-based tool, generating online forms, creating groups using an instant messenger service, identity protection, and professional development. Responses were placed on a Likert scale from: 1—I would not be able to perform this task to 5—I would perform the activity without any problem. The internal consistency for this measurement scale was IT = 0.852; PL = 0.851.
- Knowledge and skills test on phenomena assigned to the risk paradigm of media pedagogy. The test consisted of 15 original questions that were developed based on the theoretical framework of EU KIDS Online—a classification of risks associated with the use of the Internet (Livingstone et al., 2017; Pyżalski et al., 2019) Query ID="Q6" Text="Pyżalski (2019b) has been changed to Pyżalski (2019) so that this citation matches the Reference List. Please confirm that this is correct." In each question, the respondent was asked to select the one correct answer from four options. The measurement scale also included the option to select a "Don't know" response, for those with no knowledge of the topic. For each correct answer, 1 point was awarded, so the final variable built from the indicators (answers) took the value from 0—very low level of knowledge about e-risks to 15—very high level of knowledge about e-risks.
- A test of knowledge and skills concerning phenomena assigned to the opportunity paradigm of media pedagogy. The test consisted of 15 questions, which were developed on the basis of the theoretical framework of EU KIDS Online and the results of Polish research projects e.g. Impact related to cyber threat prevention (Barlinska

et al., 2019; Pyżalski, 2019). Each question had 4 answers, one of which was factually correct. Individuals unsure of their answer could select the "Don't know" option. One point was allocated for each correct answer. The lack of a correct answer or choosing the option "Don't know" resulted in the award of 0 points. Finally, the variable received values on a numerical scale from 0—no knowledge of development opportunities related to the use of new media to 15—high level of knowledge.

- The scale for evaluating the usefulness of educational software is a variable consisting of a list of the 22 most commonly used digital teaching resources found in secondary and higher education. The scale was developed independently based on a literature search (Tomczyk & Sunday Oyelere 2019; Arteaga et al., 2020), as well as our own expert experience. Responses assessing the subjective usefulness of educational software were plotted on a 5-point scale ranging from 1—very low usefulness in education to 5—very high usefulness in education. Respondents could also choose option 0—I have not dealt with this application as a pupil or student, so I cannot make an assessment. The internal consistency for this measurement scale was IT = 0.927; PL = 0.847.

The correlation for each value from the survey tool is presented below (Table 1).

### 3.3 Selection of the Research Sample

The research sample was selected in a way that allows for generalization. The sampling was conducted using data from central offices in Poland—Central Statistical Office (GUS 2020)—while in Italy—Ministero dell'Università e della Ricerca (MIUR, 2021). The research was conducted with the introduction of three strata for the two countries (the north of the country, the central part, and the south of the country). In Poland, respondents from the following universities participated in the study: the Pedagogical University in Kraków, the University of Silesia in Katowice, WSB University in Dąbrowa Górnicza, and Nicolaus Copernicus University in Toruń. In Italy the following universities were included in the study: the University of Macerata, the University of Foggia, the University of Genoa, and the University of Cagliari.

The selection of the research sample was carried out while preserving the generalizability of the results. In each country, information on the entire population was taken and then representative samples were determined by considering the confidence level, fraction size, and maximum error. Below in Table 2 the sociodemographic characteristics of the respondents surveyed from each country are presented.

### 3.4 Research Procedure

The research consisted of several stages. In the first part, the theoretical framework was analyzed, with this constituting the basis for designing the set of measurement tools. Then the research tools were designed, going beyond the standard procedure based on the self-evaluation of digital competence. The reference version of the tool was an English language document, which was later translated into the relevant national languages (Italian and Polish). Both authors of the tool approved the final version after a series of exchanges and feedback about the variables and measurement indicators. The tool in both language versions was subjected to pilot tests and linguistic correction. Subsequently, the battery of tests and tools was coded into an online form (Lime Survey UNIMC). The final version of the tool was also made available as an open access tool (Tomczyk & Fedeli, 2022). A link to the digital version of the tool was made available to students in Italy and Poland with a stratified sampling criterion based on university location. Once

**Table 1** Correlation for survey instruments

| Variable | Year of birth | | Frequency of use of the software | | Problems with the software | | Performing typical activities using ICT | | The evaluating the usefulness of educational software | | Knowledge test (risks)—points | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | IT | PL | IT | PL | IT | PL | IT | PL | IT | PL | IT | PL |
| 2. Frequency of use of the software | 0.119** | 0.035 | – | | | | | | | | | |
| 3. Problems with the software | 0.016 | −0.058 | 0.788*** | 0.760*** | – | | | | | | | |
| 4. Performing typical activities using ICT | 0.015 | −0.064 | 0.427*** | 0.469*** | 0.495*** | 0.567*** | – | | | | | |
| 5. The evaluating the usefulness of educational software | 0.128 | −0.142*** | 0.390*** | 0.372*** | 0.355*** | 0.359*** | 0.226*** | 0.296*** | – | | | |
| 6. Knowledge test (risks)—points | −0.011 | 0.148*** | 0.077 | 0.163*** | 0.115** | 0.184*** | 0.275*** | 0.345*** | 0.038 | 0.196*** | – | |
| 7. Knowledge test (chances)—points | −0.079 | −0.124** | 0.067 | 0.205*** | 0.121** | 0.250*** | 0.210*** | 0.347*** | 0.062 | 0.268*** | 0.471*** | 0.477*** |

*$p < .05$, **$p < .01$, ***$p < .001$

**Table 2** Sampling characteristics

| | Italia | Poland |
|---|---|---|
| Population pre-service teachers | 113 557 | 79 512 |
| Sampling characteristics | Confidence level = 98% (α = 0.98); Fraction size = 0.5; Maximum error = 5% | |
| Questionnaires fully completed (suitable for analysis) | 604 | 605 |
| *Gender N (%)* | | |
| Female | 516 (85.43%) | 575 (95.04%) |
| Male | 87 (14.40%) | 29 (4.79%) |
| Other | 1 (0.17%) | 1 (0.17%) |
| *Metric age (%)* | | |
| Age range | 32.16 | 25.59 |
| Standard deviation | 5.87 | 6.10 |
| *Level of study N (%)* | | |
| Bachelor's degree | 77 (12.75%) | 183 (30.25%) |
| Master`s degree | 522 (86.42%) | 419 (69.25%) |
| Doctoral | 5 (0.83%) | 3 (0.50%) |

the minimum threshold of survey return was reached, allowing the confidence level to be maintained, statistical calculations were performed in JASP and Statistica software. The research was conducted in the first half of 2022. The research procedure is presented in Fig. 2.

### 3.5 Research Ethics

The research was conducted with respect to the ethics of social science. The respondents, students of pedagogical faculties, were informed about the aim of the research. Those invited to take part were able to cease their participation in the study at any time, and that participation was completely voluntary. In the research tool, no information was collected to identify individual persons. Data about the university were not included as an independent variable (e.g. to compare the level of digital competences between particular universities, but as a feature to control the correctness of selection of layers in the research sample). The research ethics were described in the grant application, which was accepted and funded by the Polish National Agency for Academic Exchange (NAWA). Information about the purpose of the research, the research number, the funding agency, and the procedure for processing the collected data was presented in the cover letter to the research tool. The study was approved by the Ethics Committee of the University of Macerata (number: 24/01/2022).

## 4 Results

### 4.1 RQ1: The Frequency of Using the Most Popular Software and Websites Among Pedagogical Students in Italy and Poland

A comparison of the frequency of use of typical software in the two countries was made using non-parametric tests (Mann–Whitney) due to the results of Shapiro–Wilk

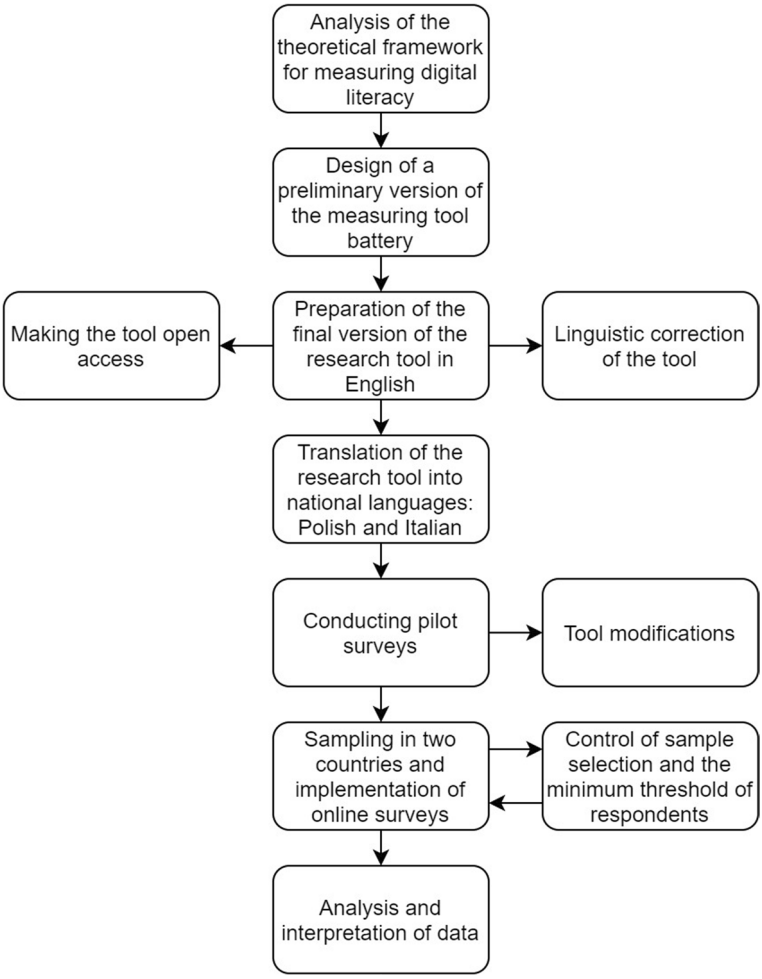



**Fig. 2** Research procedure—schematic diagram

calculations (no normal distribution). On the basis of the analyses carried out, it was noted that software for word processing, as well as for creating multimedia presentations, is used very frequently in both countries. Occasionally, future teachers use software for storing data in the cloud. Software for creating websites, handling databases, spreadsheets, or dedicated multimedia editing are rarely used. Italian students are slightly more likely to use the software listed in Table 3. Differences due to the sociodemographic variable (country) are also shown in Appendix—Section A. Tables 3, 4, 5 show the following non-parametric test data: mean; Std. Dev–standard deviation; U–number of all pairs of observations; Z-score Wilcoxon rank-sum test; *p* value–classic confidence level; and Effect size Cohen`s d.

**Table 3** Using of software—descriptive statistics

| | Mean Italy | Mean Poland | Std.Dev. Italy | Std.Dev. Poland | U | Z | *p* value | Effect size Cohen`s d |
|---|---|---|---|---|---|---|---|---|
| Word processor (e.g. Word, Writer) | 4.474 | 4.119 | 0.815 | 0.786 | 130,482 | 8.604 | 0.000 | 0.286 |
| Spreadsheet (e.g. Excel, Calc) | 2.869 | 2.230 | 1.289 | 0.966 | 130,624 | 8.581 | 0.000 | 0.285 |
| Software for creating presentations (e.g. Power Point, Impress) | 3.518 | 3.192 | 1.132 | 0.812 | 147,700 | 5.768 | 0.000 | 0.192 |
| Database software (e.g. Access, Base) | 1.767 | 1.221 | 1.021 | 0.567 | 126,591 | 9.245 | 0.000 | 0.307 |
| Software for creating visual materials (e.g. Publisher, Draw) | 1.967 | 1.433 | 1.160 | 0.816 | 134,070 | 8.013 | 0.000 | 0.266 |
| Google Drive or other cloud storage systems | 3.793 | 3.362 | 1.161 | 1.333 | 150,069 | 5.377 | 0.000 | 0.179 |
| CMS or other solutions for website creation (e.g. Joomla, WordPress) | 1.546 | 1.213 | 0.937 | 0.595 | 147,763 | 5.757 | 0.000 | 0.191 |
| Software for editing images (e.g. GIMP, Photoshop) | 2.626 | 2.071 | 1.320 | 1.073 | 139,767 | 7.074 | 0.000 | 0.235 |
| Video editing video (e.g. Lightworks, Shotcut, Filmora) | 2.050 | 1.539 | 1.181 | 0.840 | 139,339 | 7.145 | 0.000 | 0.237 |

**Table 4** Problems with typical operating software—descriptive statistics

| | Mean Italy | Mean Poland | Std.Dev. Italy | Std.Dev. Poland | U | Z | *p* value | Effect size Cohen`s d |
|---|---|---|---|---|---|---|---|---|
| Word processor (e.g. Word, Writer) | 4.553 | 4.274 | 0.685 | 0.728 | 140,170 | 7.008 | 0.000 | 0.233 |
| Spreadsheet (e.g. Excel, Calc) | 3.311 | 2.803 | 1.298 | 1.249 | 141,136 | 6.849 | 0.000 | 0.228 |
| Software for creating presentations (e.g. Power Point, Impress) | 4.048 | 4.106 | 1.062 | 0.916 | 182,397 | -0.051 | 0.959 | -0.002 |
| Database software (e.g. Access, Base) | 1.930 | 1.245 | 1.272 | 0.737 | 128,958 | 8.855 | 0.000 | 0.294 |
| Software for creating visual materials (e.g. Publisher, Draw) | 2.116 | 1.540 | 1.368 | 1.109 | 139,068 | 7.189 | 0.000 | 0.239 |
| Google Drive or other cloud storage systems | 3.929 | 3.696 | 1.130 | 1.370 | 170,716 | 1.976 | 0.048 | 0.066 |
| CMS or other solutions for website creation (e.g. Joomla, WordPress) | 1.654 | 1.256 | 1.138 | 0.773 | 150,906 | 5.239 | 0.000 | 0.174 |
| Software for editing images (e.g. GIMP, Photoshop) | 2.831 | 2.506 | 1.456 | 1.422 | 160,183 | 3.711 | 0.000 | 0.123 |
| Video editing video (e.g. Lightworks, Shotcut, Filmora) | 2.224 | 1.810 | 1.403 | 1.235 | 152,989 | 4.896 | 0.000 | 0.163 |

**Table 5** Performing typical tasks using ICT

| | Mean Italy | Mean Poland | Std.Dev. Italy | Std.Dev. Poland | U | Z | *p* value | Effect size Cohen`s d |
|---|---|---|---|---|---|---|---|---|
| I can search for and install freeware software | 4.291 | 3.195 | 1.096 | 1.513 | 99,841 | 13.652 | 0.000 | 0.454 |
| I can create a strong password for my account | 4.727 | 4.671 | 0.620 | 0.786 | 179,522 | 0.525 | 0.599 | 0.017 |
| I can update anti-virus software | 4.313 | 4.026 | 0.909 | 1.235 | 164,984 | 2.920 | 0.003 | 0.097 |
| I can install and configure parental control software | 3.611 | 3.170 | 1.338 | 1.498 | 152,405 | 4.992 | 0.000 | 0.166 |
| I can share an internet connection via smart phone (hot spot) | 4.773 | 4.597 | 0.628 | 0.904 | 167,728 | 2.468 | 0.014 | 0.082 |
| I can scan a document | 4.825 | 4.752 | 0.551 | 0.691 | 175,942 | 1.115 | 0.265 | 0.037 |
| I can load a foreign language program onto my smartphone | 4.222 | 4.481 | 1.117 | 1.127 | 149,559 | -5.461 | 0.000 | -0.181 |
| I can create a simple website where I share files | 3.243 | 2.749 | 1.305 | 1.259 | 143,366 | 6.482 | 0.000 | 0.215 |
| I can create and share a text file in the "cloud" | 4.058 | 4.025 | 1.140 | 1.237 | 181,485 | -0.202 | 0.840 | -0.007 |
| I can create an online survey and share it with other users | 3.833 | 4.060 | 1.251 | 1.246 | 159,269 | -3.862 | 0.000 | -0.128 |
| I can create a chat group in a messenger app | 4.798 | 4.919 | 0.600 | 0.397 | 167,808 | -2.455 | 0.014 | -0.082 |
| I can block the visibility of a social networking account to people outside of my friend group | 4.747 | 4.688 | 0.667 | 0.820 | 179,801 | 0.479 | 0.632 | 0.016 |
| I can find and participate in an e-learning course related to my interests | 4.785 | 4.542 | 0.546 | 0.956 | 162,274 | 3.367 | 0.001 | 0.112 |
| I can judge whether information is "fake news" | 4.445 | 3.990 | 0.844 | 1.149 | 138,058 | 7.356 | 0.000 | 0.244 |
| I can search for graphics or images under a "fair use" license | 4.028 | 3.152 | 1.136 | 1.608 | 128,540 | 8.924 | 0.000 | 0.296 |
| I can identify if text is plagiarized | 3.866 | 2.856 | 1.243 | 1.424 | 108,655 | 12.200 | 0.000 | 0.405 |

### 4.2 RQ2: Problems with Typical Software Operation Among Italian and Polish Students

The future pedagogical staff declare that they have the most difficulties in operating the software used for creating and handling databases, designing and editing visual materials, and creating web pages. The fewest students in both countries declare that they have problems with operating a word processor, as well as with operating software used to create multimedia presentations. Italian future teachers declare that they have slightly fewer problems with using software than Polish students. In terms of using software for creating multimedia presentations, there are no differences between the two samples. Descriptive statistics (percentage distribution of indicator counts) and a graphical summary of the differences are available in Appendix—Section B.

### 4.3 RQ3: Performing Typical Tasks Using ICT

In most cases the respondents declare that typical activities connected with using ICT for professional life tasks (or learning) or using new media for private activities do not cause problems. Among the activities that may, however, cause some challenges are searching for and installing freeware (PL), installing and configuring parental control software (PL, IT), creating websites (PL, IT), and searching for freely licensed images and identifying plagiarised text (PL). Differences by country were noted in the individual indicators. Descriptive statistics are presented in Table 5, and are also illustrated in Appendix—Section C (Fig. 3).

### 4.4 RQ4 and RQ5: The Level of Knowledge About Cyber Threats and the Positive Aspects of Using ICT in Education

On the basis of a knowledge test conducted in the two countries using analogous tools, it was noted that Polish students have slightly more knowledge of the positive and negative aspects related to functioning in cyberspace and the didactic aspects of use of ICT. A slightly bigger difference was found between the countries (of more than 6%) for the positive dimensions of the use of ICT in teaching and educational processes. The analyses in the two countries also showed that there was a positive (medium strength) and statistically significant correlation between the results of the tests (consisting of 30 questions: 15

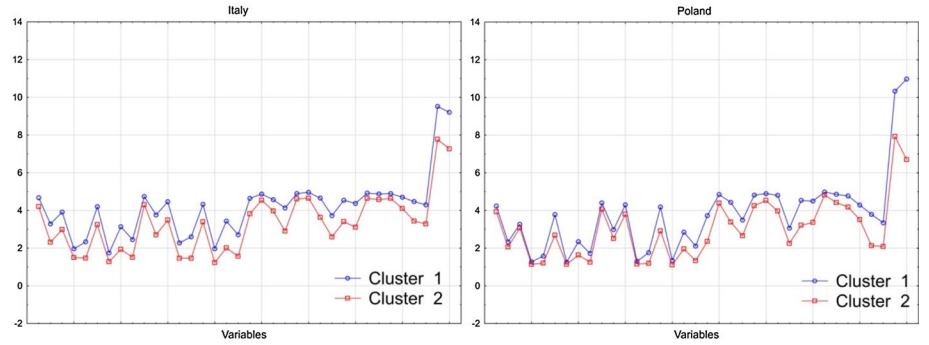



**Fig. 3** Results of k-means cluster analysis

**Table 6** Results of the knowledge test on e-threats and ICT opportunities

| | Mean Italy | Mean Poland | Std.Dev. Italy | Std.Dev. Poland | U | Z | *p* value | Effect size Cohen`s d |
|---|---|---|---|---|---|---|---|---|
| Knowledge test (risks) | 58.50% | 62.66% | 14.68 | 14.86 | 151,478 | −5.145 | 0.000 | −0.281 |
| Knowledge test (chances) | 55.87% | 62.15% | 17.04% | 20.49% | 144,464 | −6.300 | 0.000 | −0.334 |

for the issue of e-risks and 15 questions for the positive opportunities inherent in ICTs). The results of the correlation coefficient were for IT = 0.471, $p < 0.001$ and for PL = 0.477, $p < 0.001$. The results are presented in Table 6 and also in Appendix—Section D.

### 4.5 RQ6: User Groups in Poland and Italy

Based on a cluster analysis using the k-means method, two main groups were identified among the future teachers in Italy. Cluster number 1 (N = 279, 46.19%) is composed of people actively using ICT, at the same time declaring no problems with handling new media and having knowledge of the positive and negative aspects of the impact of ICT on the psychosocial functioning of young people, as well as of the teaching processes mediated by new media. Cluster 2 in Italy—red (N = 325, 53.81%) -are, in turn, people who use new media less actively, achieve lower results in knowledge tests and declare a slightly higher number of challenges with basic activities performed using ICT. In the Polish research sample, more than half of the future teaching staff (N = 371, 61.32%) belongs to cluster 1 (active users, no problems, and knowledgeable), whereas 234 students belong to the second group (38.68%). There are therefore differences of several percent between the two groups in both countries.

### 4.6 RQ7: Predicting Educational Software Use and Core Digital Competences

Digital competence, as noted in the opening section of this article, is a complex construct. ICT skills and knowledge are also mediated by profession. In the case of teachers, as well as future teaching staff, the use of educational software is of particular importance. On the basis of a multivariate analysis, the decision was made to explore the extent by which changes in the level of basic digital competences can be related to the assessment of the effectiveness of existing tools supporting teaching processes. The analyses in the two countries show that the level of basic digital competences can be a predictor for the level of evaluation of the usefulness of educational software. In particular, as the frequency of use of basic (typical) software increases and the declaration of no difficulty in using this software increases, the positive evaluation of the latest educational software increases. This is a relation common to both countries. In Poland, with decreasing metric age, the positive evaluation of educational software decreases (in Italy, the relationship is the opposite). The issue of knowledge test scores also does not allow for an unambiguous and universal prediction of the evaluation of modern educational software. A detailed analysis is presented in Table 7.

## 5 Discussion

The issue of the digital competence of future educators is a recognizable phenomenon. Among the different ways to increase the ability in this professional group to use the potential of ICT are found the permanent modernization of academic curricula (e.g., inclusion of new educational content), the implementation of international grants (Ranieri & Bruni, 2018), educational policy, and unintended circumstances (COVID pandemic). In recent years, despite the importance of the topic discussed in this article, little research has been conducted in either Poland or Italy on digital

**Table 7** Multivariate analysis of variance—dependent variable: assessing the effectiveness of using modern software in teaching

| | Italia | | | | Poland | | | |
|---|---|---|---|---|---|---|---|---|
| | Dependent Variable: The scale for evaluating the usefulness of educational software | | | | | | | |
| | β | Std.Err | t | *p* value | β | Std.Err | t | *p* value |
| Intercept | | | −2.488 | 0.013 | | | −0.411 | 0.680 |
| Year of birth ($X_1$) | 0.081 | 0.038 | 2.121 | 0.034 | −0.156 | 0.037 | −4.185 | 0.000 |
| Frequency of use of the software($X_2$) | 0.181 | 0.063 | 2.888 | 0.004 | 0.201 | 0.058 | 3.475 | 0.001 |
| Problems with the software ($X_3$) | 0.203 | 0.065 | 3.126 | 0.002 | 0.154 | 0.062 | 2.494 | 0.013 |
| Performing typical activities using ICT ($X_4$) | 0.031 | 0.045 | 0.700 | 0.484 | 0.063 | 0.047 | 1.354 | 0.176 |
| Knowledge test (risks)–points ($X_5$) | −0.109 | 0.046 | −2.357 | 0.019 | −0.030 | 0.044 | −0.685 | 0.493 |
| Knowledge test (chances)–points ($X_6$) | 0.026 | 0.045 | 0.567 | 0.571 | 0.120 | 0.044 | 2.757 | 0.006 |
| Information about model | $R = 0.396$ $R^2 = 0.157$ $F = 18.612$ $p < 0.000$ | | | | $R = 0.453$ $R^2 = 0.205$ $F = 25.853$ $p < 0.000$ | | | |
| Variance Inflation Factor (VIF) | $= 0.922 + 0.081X_1 + 0.181X_2 + 0.203X_3 + 0.031X_4 - 0.109X_5 + 0.026X_6$ | | | | $= 1.084 - 0.156X_1 + 0.201X_2 + 0.154X_3 + 0.063X_4 - 0.030X_5 + 0.120X_6$ | | | |

competence among future teaching staff. When such studies have taken place they have usually been casual analyses with unrepresentative research samples, without standardised research tools, based on each author's theoretical frameworks or studies lacking clear theoretical assumptions (Jedryczkowski, 2019; Messina & Tabone, 2013; Muscarà & Messina, 2015; Romaniuk & Łukasiewicz-Wieleba, 2020; Wobalis, 2016). Attempts to study larger samples using international theoretical frameworks or comparative studies are rare (Majewska, 2020; Eger et al., 2018). This is due to several reasons. First, there are many standards for measuring digital competence in different professional groups, including among teachers (Jabłonowska & Wiśniewska, 2021). Secondly, the dominant approach is based on relatively quick research techniques based on relatively imprecise self-evaluation (inadequate questions and inappropriate measurement scales) (Peled, 2021; Tomczyk, 2021a). The measurement tools used in this text have sought to compensate for the error of subjectivity (which is difficult to remove completely in the self-evaluation of digital competence). To this aim, tools determining the frequency of use of particular applications and the problems that arise from the same, as well as performing typical activities with the use of ICT, were used in conjunction with a knowledge test, which had been successfully employed in a similar content-based study on a group of teachers (Potyrała & Tomczyk, 2021). The use of the triangulation of research tools is also an attempt to highlight that digital skills cannot be equated with digital competence (Botturi et al., 2019; Reisoğlu et al., 2020). Merely being able to use cyberspace resources and operate typical software seamlessly is not a sufficient range of skills for future educators. Therefore, the measurement of digital competences (going beyond the basic construct

of skills) should also include the areas of knowledge and reflection about the opportunities and negative consequences associated with the use of new media.

Apart from issues related to the discussion of the different components of digital competence and how measurements should be made, this study is primarily a voice in the discussion on the preparation of new pedagogical staff in two European countries. The formation of digital competences in this group is one of the components of processes related to the modernisation of education and a challenge for higher education (Altun, 2019; Chen et al., 2010). Based on the data collected, it was noted that students preparing for their profession most often use software such as word processing and presentation creation tools. The respondents very often use software that they are familiar with from earlier educational stages. More advanced software which could also be useful in education (editing videos and photos, creating websites, operating simple databases) is not popular among this group—either in Poland or Italy. The reduction of digital skills among future teachers to very basic software included in the office suite is therefore puzzling. From the self-declarations (and the results of the correlation coefficient Table 1) the picture also emerges that lower frequency of use is associated with problems in software operation. It should additionally be emphasized that this study does not take into account the real level of skills in using the software included in the office suite. Based on data collected in Poland among the same group according to the ECDL standard (Tomczyk, 2021a), it appears that self-declarations do not correlate with real test results. For example, for the ECDL Word module, only one in five students achieved a passing grade of over 70% on the test. Therefore there are two possibilities in this regard to explain the results. Firstly, the students may be affected by The Dunning-Kruger effect (Dunning, 2011), or they may be assessing their skills through their own experience with simple word processing. This relationship calls for further research in both countries using tests that measure real-world levels of software use. It is also interesting to note the slightly higher evaluation of their own digital skills among Italian students. Prospective teachers in Italy rate their skills slightly higher than their Polish counterparts do. However, at the same time, they received slightly lower scores on tests of knowledge about the possibilities of using ICT in teaching processes and knowledge about the threats of the digital world. The declarations do not correlate with the real level of knowledge of use in the teaching profession. This relationship may be related to cultural differences in the assessment of one's own skills or the different specifications of pre-university education programs in the two countries (Sánchez et al., 2011; Volman et al., 2005).

The data collected in both countries show interesting differences and similarities in terms of typical activities performed via ICT. As noted, activities such as searching for and installing freeware, searching for freely licensed images, and recognising plagiarism are more problematic for Polish future teachers. On the other hand, installing and configuring parental control software or creating websites is a challenge in both countries. Thus, when analyzing digital competences, it is important to consider not only those simple skills that are shaped at earlier stages, but also the extensive palette of activities mapped to both the risk paradigm and the opportunity paradigm of media pedagogy (Gunes & Bahivan, 2018; Haseski, 2020). When designing theoretical frameworks, and research tools to measure digital skills and digital competences, it is important to be aware of the fluidity of the determinants associated with the digitization of education due to the intensity

and multidimensionality of the development of the information society, which impinges on the preparation of future pedagogical cohorts (Garcia-Martin & Garcia-Sanchez, 2017; Ziemba, 2019).

The cluster analysis conducted also provides interesting data which shatter the myth of homogeneity of young users in terms of the style of use of new media. It is worth noting that 53.81% of respondents in IT and 38.68% in PL scored lower in the competence tests, and report that the use of ICT in selected areas causes problems. This is a group that requires educational support in the framework of academic courses preparing for the use of ICT in teaching or general courses in using ICT. This condition may be related to differences in the quality of education at earlier educational levels or may be due to individual conditions in terms of how new media are used (Shopova, 2014; Valdmane et al., 2020).

Why is the formation of basic digital skills and digital competences (which also includes knowledge about the methodological conditions of using new media in education) so crucial in both countries? This question is rhetorical; however it is worth recalling some basic facts. Currently, there is no turning back from the process of digitalization. It is a phenomenon that improves didactics, but also brings many challenges. It is also worth noting that in both PL and IT, the frequency of use of ICT and the seamlessness of their integration, are predictors for assessing the effectiveness of ICT use in education. Therefore, strengthening one area of digital competence (e.g. software and hardware skills) strengthens future teachers' attitudes towards didactics using ICT-based solutions that are both attractive to pupils and effective in their education.

This text brings a number of practical aspects. Firstly, special attention should be paid to the real level of digital competence of future generations of teachers. This is not a homogeneous group in terms of frequency of ICT use and knowledge of the positive and negative dimensions of using new media in education. This means that, in practice, there is a need for a more precise diagnosis of the starting level of digital competences in this group, as well as changes to university education programmes, which should strengthen both baseline digital competences and teacher competences. On a practical level, attention should also be paid to skills such as selecting software, creating simple websites and assessing the reliability of information. This demand is based on the fact of the data that have been extracted, which show "weaker dimensions" of digital competences.

## 6 Research Limitations and Future Research

Measuring digital competence among future teachers is currently being carried out around the world in varying ways. Despite the different typologies, there is currently no single standardised way of measuring ICT skills in the teaching and learning dimensions (Tomczyk & Fedeli, 2022). This means that the research model proposed in the text may not fully exhaust the indicators of the intensely developing concept of digital competence. Each original tool may bring different results on the level of

digital competence. Therefore, this research is also part of the global trend of building proprietary research tools that can be used in other countries and in logitudinal studies.

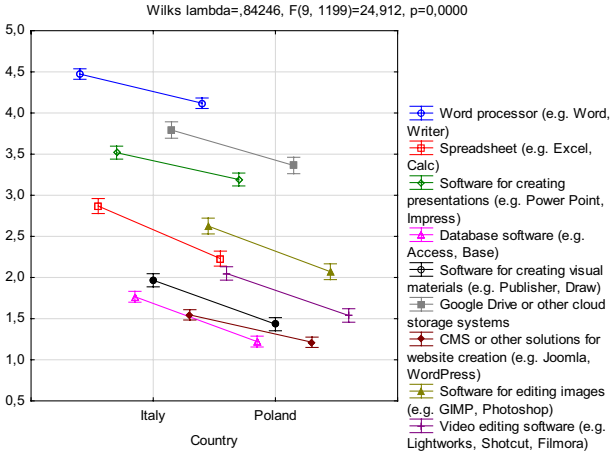
New directions of research include, first of all, the inclusion of more countries in the analysis in order to obtain a global picture of the level of preparation of future pedagogical staff to use ICT effectively in the educational and teaching perspective. Moreover, due to the intensive development of the information society, there is a need to modify the tools, taking into account the new software, websites, and IT equipment used in education.

## 7 Conclusions

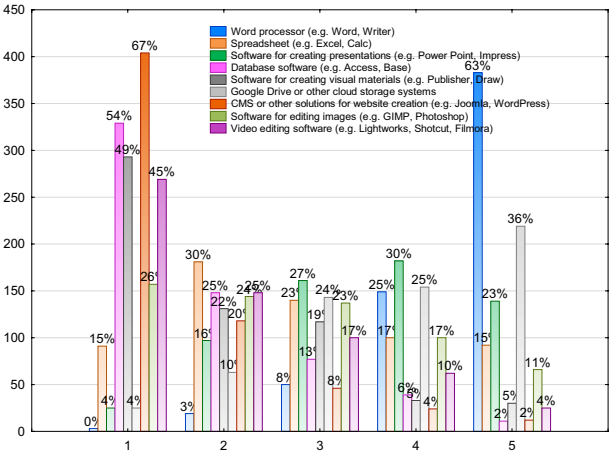
The use of ICT is undoubtedly one of the main competences of modern teachers. Both in Italy and Poland, the proficient implementation of new media in the didactic and educational process is part of the development strategies of K12 education and higher education (including teacher education at university level). The presented research results are the first stage on the way not only to comparative research, but also to providing a basis for improving programs within units that prepare staff for the teaching profession. Due to the intensive technical and social changes (e.g. related to the development of e-services) there is a need for longitudinal research with improved versions of research tools that take into account the stage of development of the information society, as well as the needs of stakeholders in education.

## Appendix

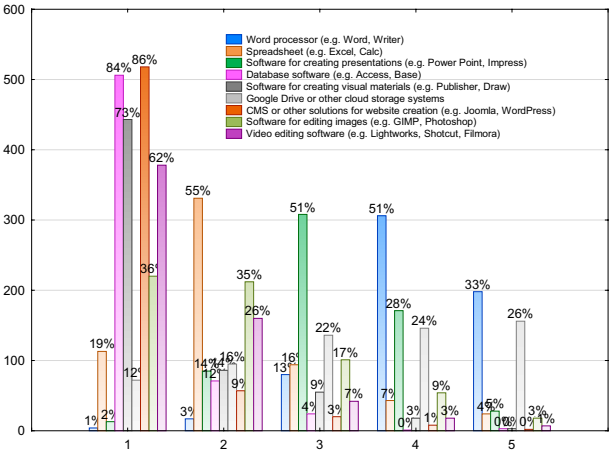
### A1: The frequency of using the most popular software and websites among pedagogical students in Italy and Poland



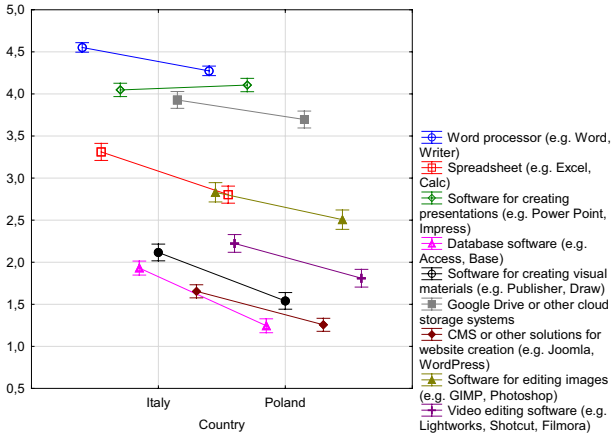
## A2: Italy the Frequency of Using the Most Popular Software and Websites Among Pedagogical Students



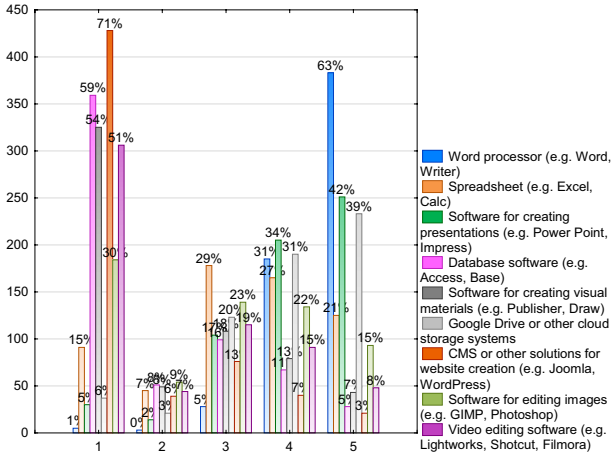

## A3: Poland the Frequency of Using the Most Popular Software and Websites Among Pedagogical Students



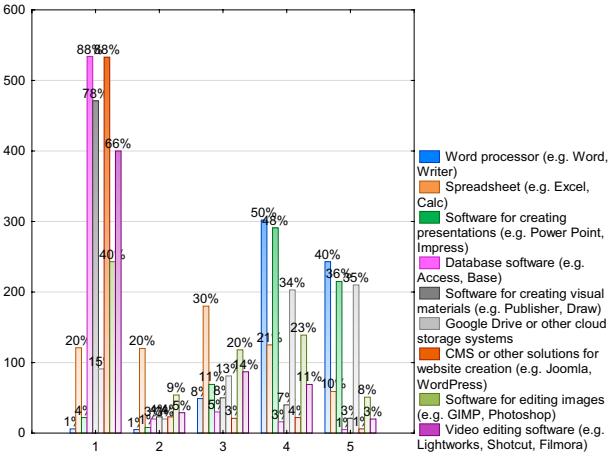
## Appendix B 1: Problems with Typical Operating Software Among Pedagogical Students in Italy and Poland



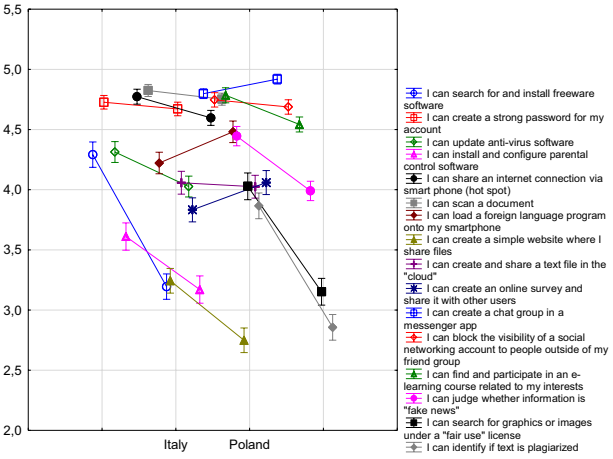

## B2: Problems with Typical Operating Software Among Pedagogical Students in Italy



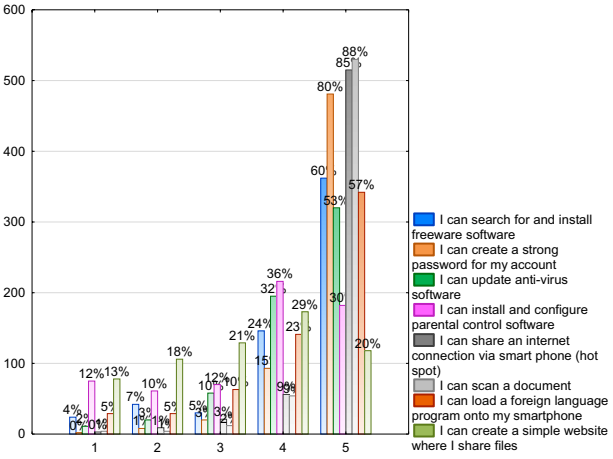
## B3: Problems with Typical Operating Software Among Pedagogical Students in Poland



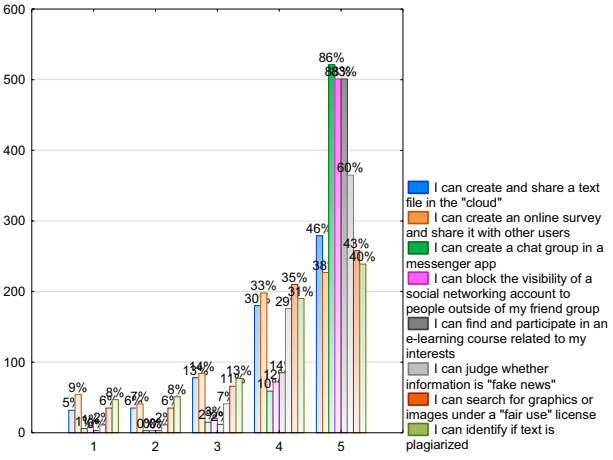

## Appendix C 1: Performing typical tasks using ICT



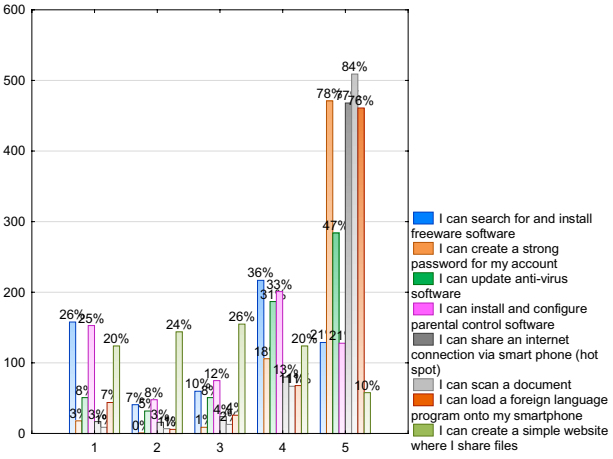
## C2: Performing Typical Tasks Using ICT in Italy (Part I)



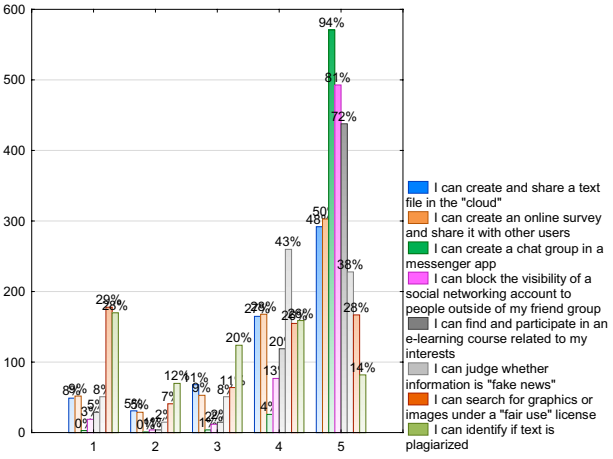

## C2: Performing Typical Tasks Using ICT in Italy (Part II)



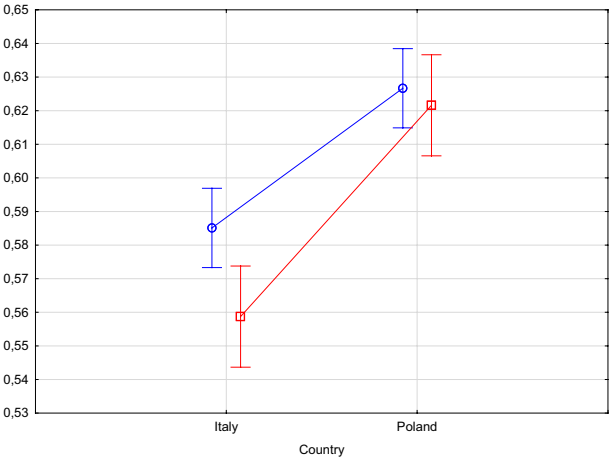
## C3: Performing Typical Tasks Using ICT in Poland (Part I)




## C3: Performing typical tasks using ICT in Poland (part II)



## Appendix D: Results of the Knowledge Test on e-Threats and ICT Opportunities

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**Data Availability** The data are fully open access at: Tomczyk, L. (2022). Digital literacy pre-service teachers Poland and Italy, Mendeley Data, v1 https://doi.org/10.17632/4gh3y28tbr.1.

## Declarations

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