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This volume represents the proceedings of the Workshops co-located with the 16th International Conference on ICT in Education, Research, and Industrial Applications, held in Kharkiv, Ukraine, in October 2020. It comprises 101 contributed papers that were carefully peer-reviewed and selected from 233 submissions for the five workshops: RMSEBT, TheRMIT, ITER, 3L-Person, CoSinE, MROL. The volume is structured in six parts, each presenting the contributions for a particular workshop. The topical scope of the volume is aligned with the thematic tracks of ICTERI 2020: (I) Advances in ICT Research; (II) Information Systems: Technology and Applications; (III) Academia/Industry ICT Cooperation; and (IV) ICT in Education.

Preface

In these extraordinary and challenging times, it is our great pleasure to present you the proceedings of the Workshops co-located with ICTERI 2020, the sixteenth edition of the International Conference on Information and Communication Technologies in Education, Research, and Industrial Applications, held in Kharkiv (Ukraine) on October 5-10, 2020. This year's edition focused on research advances, information systems technologies and applications, business/academic applications of Information and Communication Technologies. Emphasis was also placed on the role of ICT in Education. These aspects of ICT research, development, technology transfer, and use in real world cases remain vibrant for both the academic and industrial communities. Overall, ICTERI 2020, including the Workshops, was focused on the four thematic tracks reflecting these research fields: (i) ICT research advances, (ii) information systems technologies and applications, (iii) academic and industry cooperation in respect to Information and Communication Technologies, and, more relevant than ever, (iv) the role of ICT in Education.

This volume is structured in six parts, each presenting the contributions to a particular workshop:

Part I: RMSEBT Workshop is the fourth workshop Rigorous Methods in Software Engineering and Blockchain Technologies. The workshop was organized by Vladimir Peschanenko, Mykola Nikitchenko, and Yulia Tarasich. The workshop dedicated to rigorous methods which are used in different fields of software engineering: rigorous methods for specification, verification and optimization of software, rigorous methods for different kinds of software analysis (modeling, business rule extraction etc), software testing which based on rigorous methods (model based testing, white box testing and so on), re-engineering problems (model extraction from source code, language migration etc), DLT architecture development, modeling and verification of token economies, detected of smart contracts vulnerability.

Part II: TheRMIT Workshop is the sixth workshop on Theory of Reliability and Markov Modelling for Information Technologies. The workshop was organized by Vyacheslav Kharchenko. The workshop dedicated to overcoming a gap between researchers of mathematical methods for reliability, safety, security and dependability as a whole, on the one side, and engineers who develop critical systems, auditors who assess and assure dependability during life cycle stages, on the other side.

Part III: ITER Workshop is the eighth workshop on Information Technologies in Economic Research. The workshop was organized by Vitaliy Kobets, Tetiana Paientko, and Alessio Maria Braccini. The workshop intended for providing a meeting point for intensive scientific exchange among researchers and experts from computer science, business computing and information system areas in emerging technologies interested in a focused look into IT in economic research related to the design, development, implementation, use and management of emerging technologies, real-world business applications and the move to a digital economy.

Part IV: 3L-Person Workshop is the fifth workshop on Professional Retraining and Life-Long Learning using ICT. The workshop was organized by Oleksandr Burov and Svitlana Lytvynova. 3L-Person Workshop intended for providing for evaluating new and emerging technologies in education, learning environments and methods that have

to satisfy life-long learning of a person (from school age to retirement), professional training and retraining in view of the person-oriented approach. It covers such topics as an adaptive learning strategy and design, day-to-day support for individual's learning, life-long learning of individuals, learning at the workplace, learning with emerging ICT that provide remote collaboration, learning/training process of individuals with special needs, ICT in education safety and security, recommendation regards vocational retraining and/or further carrier etc.

Part V: CoSinE Workshop is the eighth workshop in memory of Illia O. Teplytskyi on Computer Simulation in Education. The workshop was organized by Arnold Kiv, Serhiy Semerikov, Vladimir Soloviev, and Andrii Striuk. CoSinE Workshop is a regular peer-reviewed workshop co-located with ICTERI focusing on theory and practice of computer simulation in education. CoSinE puts special emphasis on real-world applications of computer simulation in education. Therefore, all contributors are strongly encouraged to demonstrate how and for what purpose the proposed solutions are to be used. Examples could be taken from case studies involving new tools and/or methodological approaches in education, experimental studies with usable learning applications, or surveys revealing new modelling tools in educational research and practice.

Part VI: MROL Worksop is the fourth workshop on Methods, Resources and Technologies for Open Learning and Research. The workshop is organized by Hennadiy Kravtsov and Mariya Shyshkina. MROL Workshop intended for benchmarking the state of the art and defining the future prospects of the open systems of higher education design and development, with the focus on the most valuable trends, methods, tools and technologies driving the innovative development of educational environment. It focuses also on the learner' competencies needed for the open educational and research systems development including higher responsibility, collaborative skills, leadership, creative thinking, taking the problem in general and others are to be considered and explored.

Overall, ICTERI 2020 workshops attracted 223 paper submissions. Out of these submissions, the organizers have accepted 101 high quality and most interesting papers. So, the average acceptance rate was of 43,3 percent.

This volume would not appear without the support of many people. First of all, we would like to thank all the authors who submitted papers to the workshops of ICTERI 2020 and thus demonstrated their interest in the research problems within their scope. We are very grateful to the members of the Program Committees for providing timely and thorough reviews and, also, for being cooperative in doing additional review work. We would like to thank the local organizers of the conference whose devotion and efficiency made the constellation of ICTERI 2020 workshops a very interesting and effective scientific forum.

October 2020 — Oleksandr Sokolov, Grygoriy Zholtkevych, Vitaliy Yakovyna, Yulia Tarasich, Vyacheslav Kharchenko, Vitaliy Kobets, Olexandr Burov, Serhiy Semerikov, Hennadiy Kravtsov

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Part III: 8th International Workshop Information Technology in Economic Research (ITER 2020)

The Digital Capabilities Model of University Teachers in the Educational Activities Context

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Abstract. The article analyses the views of researchers on digital literacy. It describes the meaning of the concept of digital capability. The authors summarize the common European standards and frameworks for teaching and evaluating digital capability. A model of the digital faculty of a university teacher based on the Jisc framework is described. It is adapted by the authors to the conditions of study at Ternopil Volodymyr Hnatiuk National Pedagogical University (Ukraine). The article describes and analyses the author's` research on measuring digital capabilities of the teachers. The criteria and indicators for measuring the digital faculty of a university teacher are revealed. Methods of research using methods of mathematical statistics are described. The authors identified and explained the correlations between individual distractors for each element of the framework. Some survey results were paradoxical, so a new study is needed. Based on this research, the authors have developed a program to improve the skills of teachers and their lifelong learning.

Keywords: model, digital capability, research, Pedagogical University, teacher's profile.

1 Introduction

Today, people need digital capabilities, digital well-being to live, learn and work effectively with modern ICT technologies. Accordingly, scientists create many models to adapt individual digital capabilities to real life and meet human needs. These models define new requirements, tasks, and opportunities. All of them are realized through the digitalization of modern society.

Nowadays, the question is, "What does it mean to be digital capable?" The answer depends on the individual and the organization in which he or she works or studies. Different organizations demonstrate different approaches to building both individual and organizational digital capabilities. The issue of digital ability at a deployment ICT technologies period is one of the most relevant and little studied issues. Research into both the personal digital ability of teachers and educational institutions as a whole is

now relevant. In general, the digital capability of the education industry is an integral part of the nationwide digital capability system, which is also characterized by many interconnected aspects.

The **purpose** of this article is to study the digital capacity model of teachers and its implementation at the Ternopil Volodymyr Hnatiuk National Pedagogical University (TNPU).

2 The theoretical basis of research

The concept of digital literacy was preceded by the concept of digital capability. It has been widely studied in the 1990s [4]. It includes information, computer, network and media literacies. Modern researchers often define digital literacy as the ability to use modern digital technologies effectively and safely in work, study, professional and personal development. For over 20 years, the concept of “digital literacy” is constantly transforming.

P. Gilster defined digital literacy as the ability to understand and use information in a variety of formats from many sources. He highlighted four key competences of digital literacy: knowledge collections, content assessment, Internet search and navigation [12]. C. Pool studied the development of critical thinking in the Internet age [23].

In today's context, digital literacy is often viewed by researchers as a minimal skill set. These skills will allow the user to work effectively with software or to perform information retrieval tasks. This definition is functional. It identifies the basic skills needed to perform basic operations [7].

Specialists in the US Educational Testing Service have defined digital literacy as the ability to effectively use digital technologies, communications and networks to operate in the information society and solve important information problems. Scientists have included components in digital literacy such as the ability to use digital technology for research, evaluation and transmission of information. In addition, they noted that a digitally competent person should have an understanding of ethical and legal issues related to access and use of information [17]. This means that a person can communicate and interact with others, achieve economic success, and actively participate in social communities and collaborate on the Internet. That is, this approach states that digital literacy has become a skill that people need to process information and personal development [20].

A. Burn and J. Durran explored the concepts of digital literacy through the development of modern content forming technologies, digital economy competencies and digital skills in frameworks of teaching disciplines. In their view, the most significant feature of digital literacy is the combination of "information" with "media literacy." Scientists have found that users often have difficulty in distinguishing between these concepts [8].

Some theoretical schools have commented on the term "literacy". Their scientists believed that literacy was what usually happens at the beginning of the educational process. The problem for these researchers was to replace the term "literacy" with a

broader one. This new concept should describe common digital practices, not just complex skills. This is how the term "digital literacy" was replaced by the term "digital capability".

A. Bartlett-Bragg says that digital capability is not just about ICT competencies. It exists at the intersection of people and technology, work and learning [4]. Therefore, nowadays, scientists are studying both personal and collective digital abilities.

Digital capabilities have been identified in the works of E. Bennett, S. Folley and H. Beetham [6], [5]. In particular, researchers compared professional teaching identity with their digital ability. Professional identity has also often been the subject of research. E. Bennett, S. Folley explored digitally capable teachers. These specialists showed confidence, readiness for research, resistance to failures. Scientists concluded that these characteristics defined teachers as successful practitioners, and were not determined solely by their technical skills. T. Owens described combining both identities and analysed learning experiences in the context of digital capabilities [22]. Specialists and teachers who were able to work in digital mode were studied in his work.

Digital capability is the term used to describe the digital practices that people and organizations need. Such practices in the modern world are necessary for the successful operation of the individual and the good functioning of the business. By 2015, scientists had learned that creating a person's identity in the digital space, engaging it in the digital space, and performing digital activities provide many opportunities [22]. At the same time, these opportunities contribute too many threats. Researchers had concluded on the importance of building functional digital skills in the context of personal well-being, awareness of the integrity of the individual in the digital space [21].

Therefore, the concepts of "digital literacy" and "digital capability" are not completely synonymous. Digital literacy is a minimum set of skills for assessing the information it uses to gain knowledge and solve problems. Digital capability is a systematic activity aimed at prospering people and organizations in the modern world and ensuring their information security.

In this regard, the strategic solution was the creation of a digital capacity framework. These digital frames are most useful for activities such as:

- combining people 's digital abilities;
- embedding digital ability into specific subject areas;
- mapping of digital experience of personnel with different roles;
- structuring professional development;
- assessment of digital ability level.

Depth of digital ability may vary. One of the most advanced is the EU's digital competency assessment system. It includes a number of institutions, indicators and programs. There are currently pan-European standards for teaching and evaluating digital capability such as:

- International Computer Driving Licence (ECDL/ICDL). Its certificates are valid in almost all European countries. The organization accredits exam centres - companies, schools, non-governmental organizations that conduct exams based on franchising.

The curriculum consists of 18 modules at three levels: basic, intermediate and advanced [14].

- Digital Competence Framework for citizens (DigComp). It was created by the Joint Research Centre of the European Commission. The latest version of this framework provides for eight skill levels. Based on this, educational organizations can create a basic digital capability course [9].
- The Digital Economy and Society Index (DESI). It allows comparing European countries by indicator of digital skills, however is not suitable for certification of skills, training or research [24].
- The European Certification of Informatics Professionals (EUCIP). The frame is aimed at computer scientists. It is used by vocational education institutions to develop and certify training programs [25].
- The European e-Competence Framework (eCF). The framework has the status of an official European standard for ICT professionals. It contains 40 competencies applicable in the workplace. Suitable for use by corporations, small and medium-sized enterprises, educational institutions [26].
- The Jisc Framework. It focuses on emerging digital realities and provides an overall map of digital capability development at both basic and advanced levels. The Jisc framework was developed with the involvement of stakeholders. It is now the global benchmark for digital capability. It provides various examples of digital practices, tools and resources [11].

To create a model for our university's digital faculty and further research, we chose the Jisc framework. In addition, we used the models previously developed by us [3], [2]. The Jisc framework describes digital capability as a tool for the prosperity of educational institutions in the digital world. It offers a way of thinking about how teachers and students can successfully operate in a digitalized society.

The Jisc framework distinguishes between organizational and individual capacity. The concept of individual digital ability interprets learning as an individual result of a person, his or her effort and realization of individual opportunities. But learning must at the same time be a product of a supportive context. This happens when a person is in a supportive environment, has the necessary resources, and cooperates with the right people [13]. And the university should be responsible for providing that context. [15]. What it means to be capable of digital technology depends on each person. This depends on individual requirements, subject matter specialization, and career choices, personal and other factors.

The Individual Digital Capability Framework contains six predefined elements:

- ICT Proficiency (functional skills).
- Information, data and media literacies (critical use).
- Digital creation, problem solving and innovation (creative production).
- Digital communication, collaboration and partnership (participation).
- Digital learning and development (development).
- Digital identity and wellbeing (self-actualising).

The Jisc framework has created a series of role profiles that look at six elements of digital capability in the context of different roles. The main ones are the teacher's and the researcher's profile. Each profile demonstrates how new practices emerge and how teachers can use their own digital skills in different aspects of their professional role.

Let's take a closer look at the elements of the Jisc framework.

There are different views about *ICT Proficiency* being included as a separate element of the Jisc framework. However, all scholars agree that ICT knowledge is the basis for developing all other capabilities [16].

In the *Information, data and media literacies* element, "information literacy" and "media literacy" are aligned. There are two different discourses here, one focused on information and management. It applies to library science and digital technologies. The second discourse concerns the understanding of digital media related to communications and media research. The boundaries between data literacy and information literacy are difficult to define. Scientists and teachers have the notion that "data" is the basis of research and accountability, and "information" is the result of a secondary analysis. Therefore, information, media and data literacy are considered as separate but closely related elements of digital capability. According to them, operations such as critical use, analysis, evaluation are applied. For example, actions on the proper use of digital data and information may be generalized to the concepts of "critical use of information" or "critical thinking".

The element of *Digital creation, problem solving and innovation* covers the many ways in which teachers generate original ideas and results. For example, teachers are often innovative practitioners. The element of Digital creation, problem solving and innovation was expanded by the authors of the framework. This was done to make it more inclusive of "innovation" and other forms of creativity. Original thinking is central both to researchers who need to generate new ideas and to teachers who are developing in the professional digital space. Teachers can be innovators both in their organizational activities and in specialized subject areas. The focus is on the use of digital technologies to develop and disseminate ideas and practices. This element includes creativity and innovation as separate but related opportunities. They can be described as "creative production".

The element of *Digital communication, collaboration and partnership*, reflects the fact that many aspects of social and cultural life are now online. The authors of the framework believe that this aspect of digital capability needs to be defined more broadly. The practical aspects of citizenship belong to this element. But the development and expression of personal values through civic activity can be seen as an aspect of identity. Even though critical use and creative production can be done through digital tools, participation can only take place with respect to other people. This activity is usually mediated through computer networks. The element Digital communication, collaboration and partnership summarizes these elements.

The element of *Digital learning and development includes planning*, reflection and all aspects of self-development in the digital environment. The university's teachers are responsible for the education of future generations. The framework describes the digital opportunities for organizing the educational process. There are now specialized training and assessment systems. They involve the use of special learning support applications

(e.g., quizzes, animations, virtual worlds) and more general learning support applications (such as tools for writing, discussing, collaborating, commenting, feedback).

The element of *Digital identity and wellbeing* is quite important. Therefore, the authors of the framework added it as a separate component. However, it is sometimes associated with "digital identity". If the digital capability of the Jisc framework expresses "what I can do", then digital identity and well-being answers the question of "who am I when I do it". In the process of actualizing oneself as a digital personality, one or more manifestations of digital identity, digital participation styles, values, and a critical stance on digital ability develop.

As a result, if digital identity is at the apex of the pyramid of digital capability development, and ICT knowledge is at its core, then other elements are examples of existing digital practices.

3 Experimental study

Based on this framework, we have created a digital capabilities model of university teacher. It provides an opportunity to implement the Jisc framework in the local context of Ukrainian higher education teaching practice. Our next step was to bring this model closer to existing role definitions and standards. We have modified the Jisc model based on professional Ukrainian standards for teaching staff and for researchers. This was done because teachers in universities combine both roles [18], [19], [10], [1].

In 2018-2019, we conducted an experimental study. Its purpose was to study the digital capability of TNPU teachers. During the research we used a set of research methods, such as analysis of scientific and educational-methodological literature, official documents of the European Union, models of development of digital capabilities of the leading universities in the world and the government of Ukraine. They became the theoretical basis for solving the problem. We also used empirical methods such as surveys and surveys of university teachers. This gave us an opportunity to find out the attitude of teachers to the problem of developing their digital capabilities. We used the methods of mathematical statistics to process the data obtained, analyse and interpret the study results.

The study was conducted during the following stages:

1. Study of the studies that explored the digital capabilities of university teachers. Analysis of models of development of digital capabilities and choose the most appropriate framework.
2. Adaptation of the chosen model taking into account the specifics of the functioning of our university.
3. Choice of experimental research methods. We have created a self-assessment questionnaire by teachers of their own digital capabilities. The strategy of this study was to use an online survey.
4. Statistical processing of experimental data and interpretation of the results.

We have created a self-assessment questionnaire for teachers of their own digital capabilities. We have created a self-assessment questionnaire for teachers of their own

digital capabilities. The questionnaire contained 58 questions. They have been grouped into five sections according to the elements of the Jisc framework (see Table 1). We considered the sample as unrepresentative.

Table 1. The structure of the author's model of digital capabilities

Element	Group of Distractor	Code and Description of Distractor
Digital proficiency	*Digital proficiency*	DProf1 – use ICT devices, software and services
		DProf2 – using subject-specialist ICT devices
		DProf3 – stay up to date with digital technologies as they evolve
	Digital productivity	DProd1 – work with software to achieve teaching and assessment tasks
		DProd2 – use digital tools to work productively and efficiently
		DProd3 – use institutional ICT systems for teaching, assessment
		DProd4 – adapt ICT systems, applications to suit personal needs
Information, data and media literacies	*Information literacy*	IL1 – find, evaluate, manage, share digital content for learning
		IL2 – support learners in their use of content, including academic, professional and open content
		IL3 – interpret information for academic and professional purposes
		IL4 – know the rules of copyright and plagiarism and alternatives
	Data literacy	DL1 – collate, manage, access and use digital data in the medias
		DL2 – record learner-related data in digital systems as required
		DL3 – manage personal data securely
	Media literacy	ML1 – critically read and interpret messages from digital media
		ML2 – support learners in their use of digital media
		ML3 – choose and use media resources suitable to students' needs
		ML4 – know the rules of digital copyright and alternatives
Digital creation, problem-solving and innovation	*Digital creation*	DCr1 – edit, remix, repurpose digital media to meet learning needs
		DCr2 – produce digital materials to communicate learning content
		DCr3 – design digital tests, quizzes and assessment tasks
		DCr4 – design digital activities for different teaching contexts
	Digital research and problem solving	DR1 – collect, understand and use evaluation teaching/learning data
		DR2 – use the outcomes of digital scholarship as learning resources
	Digital innovation	DIn1 – investigate and implement new approaches to teaching
		DIn2 – identify problems and challenges in digital learning
Digital communication,	*Digital communication*	DCom1 – use digital communications to support learning
		DCom2 – communicate ideas in accordance with different cultural
		DCom3 – consider the communication needs of learners

collaboration and participation	*Digital collaboration*	DCom4 – support learners to communicate effectively
		DCom5 – respect others in public communications
		DCol1 – participate in digital teams and working groups
		DCol2 – collaborate effectively in digital spaces
		DCol3 – support learners to collaborate using shared digital tools
	Digital participation	DP1 – participate in digital networks with learners and teachers
		DP2 – share learning and teaching materials, educational resources
		DP3 – facilitate learning groups and networks
		DP4 – behave safely and ethically in networking situations
Digital learning and development	*Digital learning*	DL1 – use digital networks to undertake professional development
		DL2 – identify and take up opportunities for professional development in digital learning, teaching and assessment
		DL3 – reflect on personal practices with technology
	Digital teaching practices	DTP1 – design and plan courses of study to include digital issues
		DTP2 – use digital tools to plan, design and review courses
		DTP3 – design and plan digital learning and assessment activities
		DTP4 – adapt teaching in response to feedback from learners collected
		DTP5 – facilitate learning in digital settings
		DTP6 – use digital technologies to support in-class learning
		DTP7 – use digital tools to record learning events/data
		DTP8 – work with other professionals
		DTP9 – use digital tools in support of assessment
		DTP10 – design assessment activities to demonstrate digital capabilities
Digital identity and well-being	*Digital identity*	DId1 – develop a positive digital identity as an educator
		DId2 – collate and curate professional materials
	Digital wellbeing	DW1 – look after personal health, safety, relationships and balance
		DW2 – act with respect for the health of others and natural environment
		DW3 – participate in digital safety and cyber-bullying initiatives
		DW4 – ensure equality of access to digital opportunity
		DW5 – balance digital with real-world interactions appropriately

Through the online form we interviewed 96 teachers from all TNPU faculties. Since the questionnaire contained many questions, we did not put any time limits for filling it out. Teachers were asked to give a self-assessment of the level of development of their own digital capabilities. The general form of the following question was used: "Please rate your digital capability ..."? Assessments were conducted on a four-point Likert-like scale ranging from 0 points (no digital capability) to 3 points (high digital

capability). For example, one of the questions on the questionnaire was: "Please evaluate your own level of use of training ICT devices, systems, tools and services."

The use of this method allowed obtaining quantitative data of respondents' self-esteem. In our study, a sequential rating scale was used to express respondents' level of digital ability development. However, the use of the Likert scale in the study had shortcomings such as the avoidance of respondents' maximum or minimum scores, the presentation of not sufficiently candid estimates, the irregularity of the interval scale. Therefore, when formulating the questionnaire, we met the following requirements:

- use of unipolar rating scales in all matters;
- removal of neutral response;
- avoid formulating questions in a negative form;
- concise explanation of questions in the form of simple sentences.

The questions are focused on measuring the latent variable. In our study, this variable is the measure of digital capabilities. The respondent's assessment of each of the statements of the questionnaire can be considered as a function of the general latent factor. Therefore, we considered that a greater positive assessment of a respondent's assertion corresponds to a higher level of development of his or her digital capabilities.

We have created a spreadsheet to process the results. It contained all the data received from the respondents. Since the questionnaire contained a large number of questions, here is a snippet of this table for the items "Digital proficiency" and "Information, data and media literacies" (see Table 2):

Table 2. Self-assessment data for the element "*Digital proficiency*"

	Digital proficiency						
Respondent's number	*Digital proficiency*			*Digital productivity*			
	DProf1	*DProf2*	*DProf3*	*DProd1*	*DProd2*	*DProd3*	*DProd4*
1	3	2	1	1	1	2	0
2	2	1	1	2	2	3	1
3	2	1	0	1	1	1	0
4	1	1	0	0	0	1	0
…	…	…	…	…	…	…	…
96	2	2	1	3	3	3	2

The full survey table can be downloaded from the link https://drive.google.com/open?id=1DTMjy5W6w5P5dHUPC3Yc6auRmJ1l0QSE

We summed up all the distractors of each element group by the teacher's scores. The obtained total score allowed to determine the total assessment of the respondents to the studied distractor.

Figures 1-3 contain a graphical representation of the results obtained:

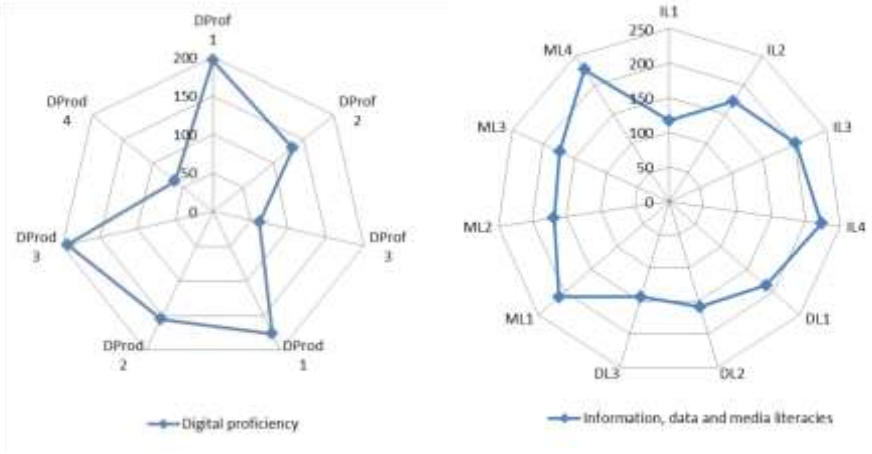

Fig. 1. Summative teachers` assessments of the elements "Digital proficiency" and "Information, data and media literacies"

Figure 1 shows that in the "Digital proficiency" element, teachers rated their own digital capabilities most highly, such as "Use ICT devices, software and services" (Dprof1) and "Use institutional ICT systems for teaching, assessment" (Dprod3). Therefore, it can be considered that teachers have good knowledge of office software and university training services. In addition, "Stay up to date with digital technologies as they evolve" (Drof3) and "adapt ICT systems, applications to suit personal needs" (Drod4) distractors were rated quite low. Therefore, it can be concluded that teachers are not yet ready to select specialized software and adapt it to their own professional needs.

In the element "Information, data and media literature," the possibilities concerning copyright and related rights (IL4, ML4) and critical assessment of information (ML1) were most highly appreciated.

Based on the analysis of the element "Digital creation, problem-solving and innovation" (see Fig. 2), we concluded that teachers are not ready to use innovations, create new digital learning resources and solve related problems. At the same time, teachers find themselves competent enough to design digital tests, quizzes and assessment tasks (Dcr3 distractor). Among the items of the "Digital Communication and Cooperation element" the distractor "Participating in digital networks and social media relevant" (DP1), as expected, received the highest score.

We were surprised by the low score of the "Consider the communication and access needs of different learners" (DCom3 distractor). In particular, in the face of modern challenges, these digital capabilities need improvement and refinement. Therefore, we can say that the explanation for this phenomenon requires a separate study.

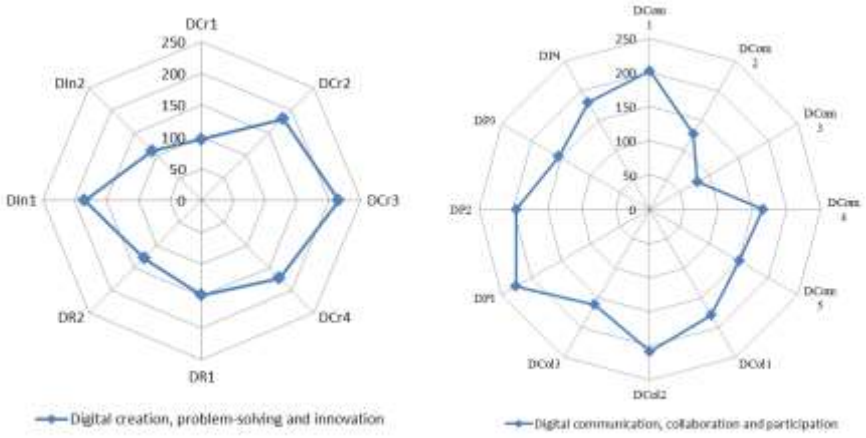

Fig. 2. Summative teachers` assessments of the elements "Digital creation, problem-solving and innovation" and "Digital communication, collaboration and participation"

Most evaluations of Digital Learning and Development and Digital Identity and Well-being distractors may be considered acceptable (see Fig. 3). DL3 distractor is negatively distinguished from this distribution. This means that TNPU lecturers do not think too often about methods of personal learning, teaching and assessment using ICT technologies.

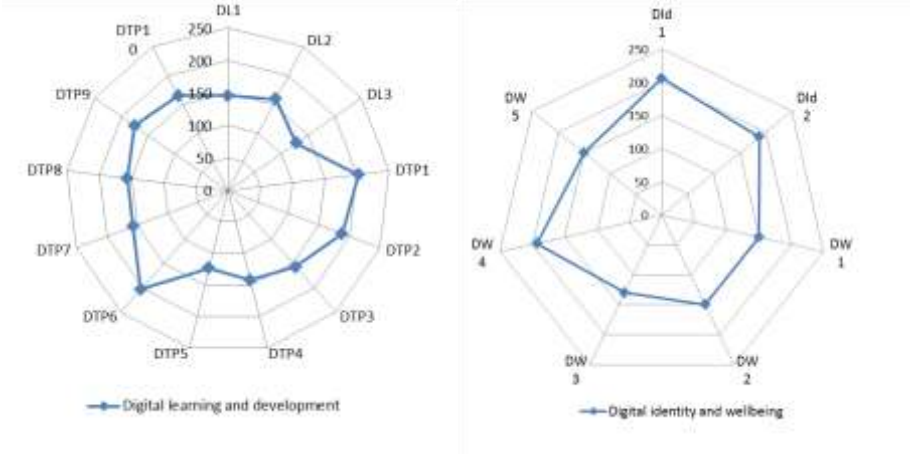

Fig. 3. Summative teachers` assessments of the elements "Digital learning and development" and "Digital identity and wellbeing"

The processing and analysis of the results of the study involved the use of the Likert scale and the Spearman rank correlation coefficient. The result of this use was to detect the existence of correlation relationships between individual distractors for each framework element. At this stage of the study, we built tables to calculate the Spearman rank correlation coefficients.

The following table presents the results of the calculation of the DProf1 distractor.

Table 3. Calculation of the correlation coefficient for the DProf1 distractor

Respon-dent's Number	Respon-dent's Sum	DProf1	DProf1-Sum	Rank1 (DProf1)	Rank2 (DProf1-Sum)	Rank1-Rank2	(Rank1-Rank2)^2
1	10	3	7	12,5	59,5	-47	2209
2	12	2	10	51	29	22	484
3	6	2	4	51	88	-37	1369
4	3	1	2	86,5	93	-6,5	42,25
…							
96	16	2	14	51	5	46	2116
Total	977	196	781	4656	4656	0	88313,5

Let's explain some of the column headers in the Table 3:

1. Respondent's Sum – the sum of the points of all distractors from the Digital proficiency element;
2. DProf1-Sum – the difference between the distractor score (DProf1 column) and the sum from item 1 (Respondent's Sum column);
3. Rank1 – the rank (taking into account the correction coefficient for the associated ranks) of the respondent score among the scores of all teachers;
4. Rank2 – the rank of difference (DProf1-Sum) obtained in paragraph 2.

Similarly, we calculated the data in all tables according to all 58 distractors of the questionnaire. Spearman's rank correlation coefficient was calculated for each distractor by the formula:

$$r_s = \frac{6\sum_{i=1}^{n}(Rank_1 - Rank_2)^2}{n(n^2-1)} \qquad (1)$$

where r_s is Spearman's rank correlation coefficient, Rank1-Rank2 is the rank difference, n = 96 is the number of rank pairs (number of respondents).

The values of all obtained correlation coefficients are shown in table 4:

Table 4. The values of the correlation coefficients for all distractors

Distractor	r_s	Distractor	r_s	Distractor	r_s
DProf1	0,4	DCr1	0,72	DL1	0,48
DProf2	0,33	DCr2	0,73	DL2	0,54
DProf3	0,34	DCr3	0,61	DL3	0,44
DProd1	0,68	DCr4	0,72	DTP1	0,83
DProd2	0,74	DR1	0,24	DTP2	0,81
DProd3	0,69	DR2	0,22	DTP3	0,89

DProd4	0,69	DIn1	0,24	DTP4	0,82
IL1	0,45	DIn2	0,23	DTP5	0,82
IL2	0,46	DCom1	0,58	DTP6	0,81
IL3	0,43	DCom2	0,53	DTP7	0,89
IL4	0,49	DCom3	0,5	DTP8	0,89
DL1	0,41	DCom4	0,49	DTP9	0,84
DL2	0,44	DCom5	0,45	DTP10	0,87
DL3	0,35	DCol1	0,36	DId1	0,45
ML1	0,46	DCol2	0,3	DId2	0,43
ML2	0,5	DCol3	0,33	DW1	0,89
ML3	0,48	DP1	0,48	DW2	0,89
ML4	0,45	DP2	0,54	DW3	0,81
		DP3	0,44	DW4	0,71
		DP4	0,53	DW5	0,89

We interpreted the results based on the Cheddock Scale [27]. The limits of the correlation coefficients obtained allow us to estimate the close relationship between the distractors inside the element. Therefore, according to the Cheddock scale, we have determined the following coefficient limits:

- 0,1-0,3 – weak connection;
- 0,3-0,5 – moderate relationship;
- 0,5-0,7 – average connection;
- 0,7-0,9 – strong bond;
- 0,9-0,99 – very strong relationship.

A graphical representation of the obtained correlation coefficients for all 58 distractors is shown in figure 4.

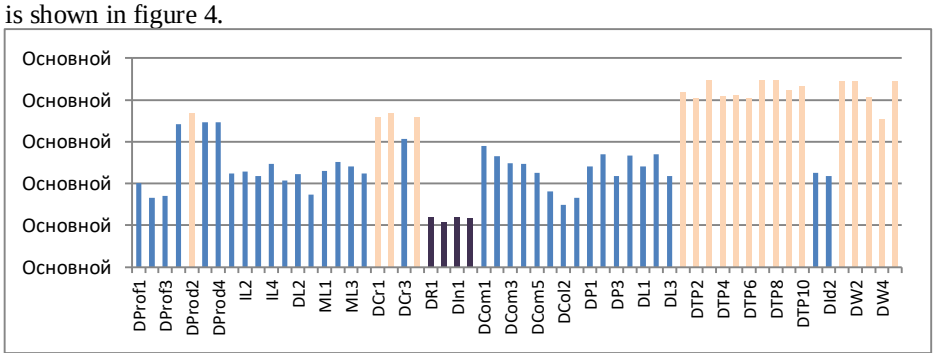

Fig. 4. Diagram of obtained Spearman's correlation coefficients

In the diagram, distractors with low correlation coefficients are coloured dark. Colours corresponding to high r_s distributors have a light colour.

The diagram shows that there is a strong link between all distractors in elements such as "Digital teaching practices" and "Digital wellbeing". This means that the distractors of these elements are selected and identified as correctly as possible. A similar situation with the "Digital creation element".

Unfortunately, the questionnaire contained 4 distractors with low correlation coefficient – DR1, DR2, DIn1, and DIn2. They all belong to the element of "Digital creation, problem-solving and innovation". It can be assumed that the distractors of this element relate to scientific activity. Therefore, we can assume that teachers believe that their own functional skills as a scientist are not as advanced as teaching.

Recalling that some of these distributors had a low overall sum, it could be concluded that such a questionnaire should be adjusted for further research. All other distractors of the questionnaire generally correlate quite well within their elements. This indicates that the questionnaire has sufficient quality and validity.

4 Conclusions

The paper analyses the views of researchers on digital literacy. On this basis, the content of the concept of digital capability is revealed. Digital capability consists of skills, knowledge and understanding. They allow critical, creative and secure use of digital technologies. It is about cultural and social awareness and functional skills of the individual. It is also important to know when digital technologies are appropriate and useful for the task and when not.

The term "digital capability" is associated with such frameworks as UCISA and Jisc. According to these models, digital literacy is made up of elements. These items help to define how the term is used to evaluate teachers' digital ability.

The Jisc framework has become a methodological basis for the study digital capabilities of the university's teachers. It is mainly intended for the evaluation of individual professional development. In this study, the digital capability model was tested in the context of teachers` educational and research activities.

An important role in the development of digital capability is the systematic use of ICT-technologies in the educational process. The digital capability is closely related to the professional activity of the teacher. Digital abilities are closely related to the professional activities of the teacher. It involves the use of modern digital technologies, efficient delivery of knowledge, involving students in practical activities, organization of monitoring and evaluation of academic achievements. Compliance with these requirements ensures the development of students' digital capabilities.

Questionnaire was used to develop approaches to assessing the digital capabilities of teachers and collecting relevant data. The questionnaire was created on the basis of the Likert scale. The correlation within the elements was verified using the Spearman correlation coefficient and the Cheddock scale.

Based on the analysis of the results, the specialists of the Department of Informatics of the TNPU developed teacher’s development programs for their lifelong learning. Based on these programs, trainings are designed to help university teachers develop

their own digital capabilities. In modern conditions, they are very important, in particular for distance learning. The educational offer of advanced training courses is quite broad. These are digital skills development courses and trainings that cover topics such as:

1. Distance learning organizations using digital technologies. This will enable the use of technological infrastructure and the digital environment to ensure inclusive experience for all learners.
2. Designing digital capabilities in the curriculum. The purpose of this training is to achieve mastery in digital curriculum design. According to these programs, teachers will prepare students for successful learning and living in the digital world. The training is aimed at developing digital creativity and problem solving skills.
3. Digital educational leaders program. It provides the digital capability and success of the entire educational institution.
4. Students' employment development skills. The program provides the skills, knowledge and experience of graduates using digital technologies.
5. Supporting the digital identity of teachers. The training will help educators make informed and responsible choices when using digital technology in their professional activities.

We hope that these trainings will help educators to achieve high digital ability and meet today's challenges. It provides guided paths through teacher support scenarios. We believe that these, modern educators will work effectively in the fast-paced, complex digital world that is shaping new learning realities.

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