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Self-Reflection of Digital Literacy of Primary and Secondary School Teachers: Case Study of Slovakia

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Abstract

Development of new digital means requires teachers to dispose such level of didactic technological competences to be prepared properly to implement them into their teaching practice and to be not afraid to use them within their lessons. These facts evoke a need continuously to innovate curricula of the relevant part of teacher trainee study programs, to acquaint future teachers with the newest kinds and versions of available didactic tools and with advantages of their use to support both teaching and learning processes. A question how to design an optimal model of teacher training in the area of teacher trainees` didactic technological competences evoked a need to assess strengths and weaknesses of in-service teachers as to their professional digital literacy

The paper presents a case study the aim of which was to assess level of the digital literacy of primary and secondary school teachers in Slovakia based on their self-reflection. Research sample of the case study consisted of 173 teachers, participants of teacher continuous education, representing three of eight regions of Slovakia. The teachers were asked to assess level of their digital literacy in relation to 17 of selected software applications used in teaching practice, i.e. to assess how skilled they are to use these means in their own teaching practice. Analysis of the teacher self-reflection was done in dependence on their majors (subjects they are qualified to teach) and teaching staff category they belong to.

Results of statistical analysis of the collected data pointed out some important facts that should be reflected in innovations of the relevant area of curricula of teacher study programs at universities, or also in programs of further education of in-service teachers. However, data collection to the presented research was carried out before the corona pandemics. Nowadays, when under the corona pandemics conditions education is moving into the virtual reality and dominantly

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using on-line forms we see that even more important than to train teachers to use digital technologies in general is to train them to work with different application systems used in on-line education processes.

Keywords: curricula innovation, didactic technological competences of teachers, digital literacy, pre-service teacher training, software applications used in teaching.

1. Introduction

Digital didactic means represent very important teaching aids in teacher practice in general. This regards both teachers` preparation for a lesson, as well as their performance during a lesson itself (Klement et al., 2017). Development of new digital means – teaching aids, didactic software applications, virtual learning environments – all this requires teachers to dispose such level of didactic technological competences to be prepared properly to implement them into their teaching practice and they would not be afraid to use them within their lessons (Kosová et al., 2012). Moreover, it is also a general social requirement (Kobylarek, 2018). These facts have to be reflected in pre-service teacher training, what evokes a need continuously to innovate curricula of the relevant part of teacher trainee study programs, to acquaint future teachers with the newest kinds and versions of available didactic tools and with advantages of their use to support both teaching and learning processes (Vezirov, Kostina, 2016; Krumsvik et al., 2016; Petrová, Duchovičová, 2013). A question is how to design an optimal model of teacher training in this area (development of teacher trainees` didactic technological competences), which didactic means should be incorporated into the teacher training and which aspects of their use in teaching should be stressed. Within this context, and also with regard to approaching complex accreditation process of higher education institutions in Slovakia (2024), there was prepared and carried out a broad-scaled research coordinated by the Faculty of Education of Comenius University in Bratislava to create a platform for a proposal of an optimal model of pre-service teacher training in the area of development of teacher trainees` didactic technological competences, especially in the focus on formation their professional digital literacy (O agentúre). Intended innovation has been understood at two levels, level of the relevant subject contents (curricula) and level of time allocation of these subjects (Záhorec et al., 2020). Particular tasks solved within the research were the following ones:

- identification of current needs of pedagogical practice with regard to formation of professional digital literacy of teacher trainees from the point of view of teachers;
- identification of current needs for innovation of pre-service teacher preparation in the area of formation their professional digital literacy from the point of view of teacher trainees;
- analysis of incorporation of the particular subjects focused on application of digital technologies in educational processes into the teaching study programs;
- formulation of recommendations creating a platform to design a model of optimal pre-service teacher training to develop teacher trainee digital literacy (required knowledge and skills to be able to act successfully in their consequent teacher career).

The starting point of the research was to identify in-service primary and secondary school teachers` needs and requirements to upgrade and improve their professional abilities and skills within their digital literacy (i.e. their didactic technological competences). Identification of these needs and requirements was made by screening opinions of in-service teachers (with different length of teaching practice) on importance of the use of different interactive didactic means in teaching with regard to teaching efficiency increase. Subject of the research was:

- to find out which types of software applications teachers use most often in their pedagogical practice (Záhorec et al., 2019);
- to find out for which purposes and in which ways teachers incorporate digital didactic means and with them related interactive educational activities in teaching (Záhorec et al., 2019);
- to find out level of teachers` digital literacy in the use of some specified software applications and digital didactic means in their pedagogical practice.

To find out level of teachers` digital literacy in the use of some specified software applications and digital didactic means in their pedagogical practice there was carried out a survey of self-reflection of digital literacy of primary and secondary school teachers, results of which are presented hereinafter.

2. Methods

Research sample of the carried out survey consisted of 173 teachers – participants of teacher continuous education. The participants were primary and secondary school teachers representing primary and secondary schools in three of eight regions of Slovakia (Nitra region, Trnava region and Bratislava region, regions for participants from which the continuous education was done).

From the total number of 173 participants of the teacher continuous education – members of the research sample, 68 teachers were teachers of primary schools (ISCED 1), 69 teachers of lower secondary education (ISCED 2) and 19 teachers of upper secondary education (ISCED 3). From the total number of 173 teachers 50.29 % had the pedagogical practice within the scale from 5 up to 20 years.

Subjects which the teachers have been teaching at schools were classified into five categories according to their character:

- natural science subjects,
- foreign languages,
- social science subjects,
- artwork and educational subjects,
- professional (vocational) subjects.

From the research sample 133 teachers have taught natural science subjects, 108 social science subjects, 107 foreign languages, 100 artwork and educational subjects and 18 professional (vocational or technical) subjects. The total sum of these numbers is higher than the total number of the participating teachers – members of the research sample (173), as most of them have been teaching two subjects which character had not been of the same character. This means that those teachers who have been teaching subjects of different characters (e.g. math and foreign language) are included in both of the relevant groups (e.g. among the teachers of natural science subjects as well as in the group of foreign language teachers).

Within the carried out survey to collect necessary research data a questionnaire was used. Respondents of the questionnaire inquiry (research sample teachers) were asked to assess level of their professional digital literacy in relation to a set of 17 selected software applications, digital didactic tools (D1 – D17) utilized in teaching practice (i.e. the respondents were asked to assess how skilled they are to use these means in their own teaching practice). List of the selected digital means D1 – D17 is presented in Table 1.

Respondents' self-assessment was based on the use of a five-point scale with a point rating from 0 to 4, with the following meanings:

1 – *I have insufficient knowledge and skills,*
2 – *I have rather insufficient knowledge and skills,*
3 – *I have rather sufficient knowledge and skills,*
4 – *I have sufficient knowledge and skills.*

Additionally, besides these four possible alternative responses to each of the items D1 – D17 respondents could choose also the fifth alternative answer (evaluation) which was the scale value 0 with the meaning:

0 – *I do not consider it necessary for my profession performance.*

This response expressed a strong attitude of the respondent, his or her belief that for the successful performance of teaching profession acquisition of knowledge and skills of working with the relevant software application (digital didactic tool) is not necessary.

Table 1. List of the digital didactic tools (software applications) in relation to which teachers evaluated their professional digital literacy

Questionnaire item	Digital didactic tools
D1	*ActivInspire – creating of interactive teaching materials*
D2	*Flow!Works – creating of interactive teaching materials*
D3	*SMART Notebook – creating of interactive teaching materials*
D4	*Prezi – creating of dynamic presentations*
D5	*Mindomo – creating of mind maps*

D6	*FreeMind – creating of mind maps*
D7	*ActivExpression2 – voting system*
D8	*ActiVote – voting system*
D9	*QRF700/900 – voting system*
D10	*TurningPoint – voting system*
D11	*Socrative 2.0 – creating of online tests and voting*
D12	*Alf – creating of interactive tests*
D13	*Google Documents – collaborative creating through sharing o online documents*
D14	*LEGO – educational sets*
D15	*Microsoft PowerPoint – creating of didactical presentations with educational content*
D16	*Microsoft Word – usage of tools of advanced word processing*
D17	*Microsoft Excel – usage of tools of advanced data processing*

Those teachers who have taught only one subject or two subjects, but both of the same character, stated one answer (responded to each of the questionnaire items D1 – D17 only once). The rest of the respondents, i.e. those who have taught subjects of different characters (e.g. math and foreign language), stated two answers – one response for each of the two subjects they have taught at each of the questionnaire items D1 – D17.

Character of the subjects taught by the respondents (natural science subject, foreign language, social science subject, artwork or educational subject, professional subject) and teacher category which the respondents belong to (primary school teacher, lower secondary education teacher and upper secondary education teacher) were used as segmentation factors in dependence on which responses of respondents were analysed. So besides analysis of responses to the questionnaire items D1 – D17 stated by the research sample as a whole (without any differentiation of the respondents based on the stated segmentation factors), we also analysed differences among the responses of particular groups of the respondents formed on the basis of the given segmentation factors.

3. Results

In Table 2 there are summarized results of the evaluation of the level of knowledge and skills of working with the selected kinds of digital teaching aids and software applications (questionnaire items D1 – D17) for the whole research sample of teachers, i.e. without differentiating them into groups with respect to any segmentation factor.

Table 2. Results of teachers` self-evaluation (for the research sample as a whole, without any differentiation of the respondents)

Item	Mean	Absolute and relative frequency of teachers' responses									
		I have sufficient knowledge and skills		*I have rather sufficient knowledge and skills*		*I have rather insufficient knowledge and skills*		*I have insufficient knowledge and skills*		*I do not consider it necessary for my profession performance*	
			%		%		%		%		%
D1	2.60	39	22.54	65	37.57	31	17.92	37	21.39	1	0.58
D2	2.29	33	19.08	49	28.32	29	16.76	60	34.68	2	1.16
D3	2.18	27	15.61	49	28.32	27	15.61	69	39.88	1	0.58
D4	2.00	26	15.03	28	16.18	41	23.70	76	43.93	2	1.16
D5	2.35	33	19.08	50	28.90	35	20.23	54	31.21	1	0.58
D6	2.53	44	25.43	53	30.64	29	16.76	44	25.43	3	1.73
D7	1.76	11	6.36	32	18.50	42	24.28	81	46.82	7	4.05
D8	1.76	19	10.98	29	16.76	25	14.45	92	53.18	8	4.62

D9	1.69	16	9.25	26	15.03	30	17.34	91	52.60	10	5.78
D10	1.73	12	6.94	35	20.23	30	17.34	87	50.29	9	5.20
D11	1.77	16	9.25	30	17.34	33	19.08	87	50.29	7	4.05
D12	1.96	25	14.45	33	19.08	30	17.34	80	46.24	5	2.89
D13	2.53	32	18.50	67	38.73	36	20.81	36	20.81	2	1.16
D14	2.09	24	13.87	43	24.86	37	21.39	63	36.42	6	3.47
D15	3.88	101	58.38	50	28.90	8	4.62	14	8.09	0	0.00
D16	3.56	113	65.32	47	27.17	10	5.78	3	1.73	0	0.00
D17	3.29	86	49.71	55	31.80	28	16.18	4	2.31	0	0.00

As it is clear from the presented results (Table 2), teachers evaluate their professional digital literacy as sufficient exclusively in relation to Microsoft applications *Word, PowerPoint* and *Excel* (at these items mean values of the achieved scores are above the scale value 3 – *I have rather sufficient knowledge and skills*). An interesting finding is that teachers evaluate level of their skills to work with the software application *Microsoft Word* lower in comparison with their skills to work with *Microsoft PowerPoint*. In our opinion this could be related to the possibility that teachers, for the needs to support their teaching processes, prepare themselves mainly educational presentations, at creation of which they utilize a broader scope of possibilities (tools) offered by *PowerPoint* in comparison with the use of only limited diapason of possibilities offered by *Word*. In other words, we assume that working with Microsoft Word, teachers use only a certain limited number of the tools (functions) offered by this application.

A question is whether teachers acquire appropriate level of skills to use these three software applications within their pre-service training, or whether it is a result of their subsequent practice and self-education (consequent further "self-learning" after they enter into pedagogical practice). This question importance is increased also by other findings (presented in Kosová et al., 2012), namely by significantly powerful demands of teacher trainees to include work with these applications in curricula of teaching study programs.

More or less sufficient level of teachers` digital literacy is indicated by recorded mean values at three other digital tools, namely *ActivInspire*, *FreeMind* and *Google Documents* (values of the recorded means above 2.50). Further three applications *Mindomo, Flow!Works, SMART Notebook*, and education sets *LEGO* are assessed rather at the level of the scale value 2 – *I have rather insufficient knowledge and skills* (values of means recorded at these items are within the range 2.09 – 2.35).

Of course, the presented values of the recorded means need to be considered in relation to school equipment with appropriate digital means and possibilities of teachers to use these means at all. The rate of availability of the relevant equipment may be indicated in part by the percentage of respondents who assessed their digital literacy in relation to the given items through the scale values 3 or 4. In case of the applications *Microsoft Word, Microsoft PowerPoint* and *Microsoft Excel* it is minimum 80 % of respondents (*Microsoft Word* 92 %, *Microsoft PowerPoint* 87 %, *Microsoft Excel* 80 %), in case of the applications *ActivInspire*, *FreeMind* and *Google Documents* maximally 60 % of respondents (*ActivInspire* 60 %, *FreeMind* 57 %, *Google Documents* 56 %).

Opinions that it would not be necessary to acquire work with any of the assessed tools for the teaching profession performance were very rare. They did not occur at all in case of the applications *Microsoft Word, Microsoft PowerPoint* and *Microsoft Excel*. For the other items, absolute frequency of this opinion ranged from 1 to 10, with the „highest" frequency of this opinion recorded at the items *QRF700/900* (10), *TurningPoin*t (9), *ActiVote* (8) and *ActivExpression2* and *Socrative 2*.0 (both 7).

What we were interested in was whether these results are the same for all teachers or whether there are differences among the groups of teachers of different subjects, e.g. whether teachers of natural science subjects or professional (technical) subjects dispose in some cases with a higher level of digital literacy (according to teachers` self-evaluations).

Analysis of teachers` self-evaluation dependence on the subject taught

Similarly, as Table 3 presents results of the self-evaluation recorded for all respondents, i.e. for the whole research sample, without any differentiation of respondents according to any

segmentation factor, Tables 4-8 present results of the self-evaluation of teachers recorded for the particular groups of teachers differentiated according the segmentation factor of their major subjects.

Table 3. Results of digital literacy self-evaluation of natural science subject teachers

Item	Mean	Absolute and relative frequency of teachers' responses									
		I have sufficient knowledge and skills		*I have rather sufficient knowledge and skills*		*I have rather insufficient knowledge and skills*		*I have insufficient knowledge and skills*		*I do not consider it necessary for my profession performance*	
			%		%		%		%		%
D1	2.69	36	27.07	47	35.34	24	18.05	25	18.80	1	0.75
D2	2.38	28	21.05	39	29.32	23	17.29	42	31.58	1	0.75
D3	2.26	21	15.78	42	31.58	21	15.78	48	36.09	1	0.75
D4	2.04	21	15.78	23	17.29	31	23.31	56	42.11	2	1.50
D5	2.35	25	18.80	37	27.82	31	23.31	39	29.32	1	0.75
D6	2.60	36	27.07	43	32.33	21	15.78	31	23.31	2	1.50
D7	1.83	9	6.77	28	21.05	33	24.81	57	42.86	6	4.51
D8	1.81	16	12.03	23	17.29	21	15.78	66	49.62	7	5.26
D9	1.70	11	8.27	23	17.29	23	17.29	67	50.38	9	6.77
D10	1.75	9	6.77	30	22.56	21	15.78	65	48.87	8	6.02
D11	1.76	12	9.02	24	18.05	23	17.29	68	51.13	6	4.51
D12	2.00	20	15.04	27	20.30	23	17.29	59	44.36	4	3.01
D13	2.50	26	19.55	49	36.84	25	18.80	31	23.31	2	1.50
D14	2.11	19	14.29	35	26.32	26	19.55	48	36.09	5	3.76
D15	3.35	78	58.65	37	27.82	5	3.76	13	9.77	0	0.00
D16	3.54	87	65.41	34	25.56	9	6.77	3	2.25	0	0.00
D17	3.30	70	52.63	37	27.82	22	16.54	4	3.01	0	0.00

Table 4. Results of digital literacy self-evaluation of social science subject teachers

Item	Mean	Absolute and relative frequency of teachers' responses									
		I have sufficient knowledge and skills		*I have rather sufficient knowledge and skills*		*I have rather insufficient knowledge and skills*		*I have insufficient knowledge and skills*		*I do not consider it necessary for my profession performance*	
			%		%		%		%		%
D1	2.63	27	25.00	39	36.11	18	16.67	23	21.30	1	0.93
D2	2.33	22	20.37	29	26.85	21	19.44	35	32.40	1	0.93
D3	2.26	16	14.82	33	30.56	22	20.37	37	34.25	0	0.00
D4	2.02	15	13.89	19	17.59	28	25.93	45	41.67	1	0.93
D5	2.36	20	18.52	30	27.78	27	25.00	31	28.70	0	0.00
D6	2.63	30	27.78	35	32.41	18	16.67	23	21.30	2	1.85
D7	1.82	7	6.48	21	19.44	31	28.70	44	40.74	5	4.63
D8	1.78	11	10.19	20	18.52	18	16.67	52	48.15	7	6.48
D9	1.71	11	10.19	16	14.81	19	17.59	55	50.93	7	6.48
D10	1.70	4	3.70	26	24.07	18	16.67	54	50.00	6	5.56

D11	1.73	8	7.41	18	16.67	23	21.30	55	50.93	4	3.70
D12	1.98	14	12.96	22	20.37	22	20.37	48	44.44	2	1.85
D13	2.56	23	21.30	39	36.11	22	20.37	24	22.22	0	0.00
D14	2.17	18	16.67	25	25.00	24	22.22	39	36.11	2	1.85
D15	3.31	60	55.56	32	29.63	6	5.56	10	9.26	0	0.00
D16	3.53	70	64.81	28	25.93	7	6.48	3	2.78	0	0.00
D17	3.25	54	50.00	31	28.70	19	17.59	4	3.70	0	0.00

Table 5. Results of digital literacy self-evaluation of foreign language teachers

Item	Mean	Absolute and relative frequency of teachers' responses									
		I have sufficient knowledge and skills		*I have rather sufficient knowledge and skills*		*I have rather insufficient knowledge and skills*		*I have insufficient knowledge and skills*		*I do not consider it necessary for my profession performance*	
			%		%		%		%		%
D1	2.68	29	27.10	40	37.38	14	13.08	23	21.50	1	0.93
D2	2.36	24	22.43	27	25.23	21	19.63	34	31.78	1	0.93
D3	2.31	18	16.82	36	33.64	14	13.08	39	36.45	0	0.00
D4	2.03	17	15.89	16	14.95	28	26.17	45	42.06	1	0.93
D5	2.36	19	17.76	33	30.84	23	21.50	32	29.91	0	0.00
D6	2.66	32	29.91	32	29.91	19	17.76	23	21.50	1	0.93
D7	1.80	8	7.48	17	15.89	31	28.97	48	44.86	3	2.80
D8	1.79	11	10.28	19	17.76	19	17.76	53	49.53	5	4.67
D9	1.70	11	10.28	13	12.14	22	20.56	55	51.40	6	5.61
D10	1.73	3	2.80	27	25.23	20	18.69	52	48.60	5	4.67
D11	1.75	8	7.48	17	15.89	25	23.36	54	50.47	3	2.80
D12	1.94	11	10.28	24	22.43	22	20.56	48	44.86	2	1.87
D13	2.57	20	18.69	43	40.19	23	21.50	20	18.69	1	0.93
D14	2.13	13	12.15	29	27.10	26	24.30	37	34.58	2	1.87
D15	3.35	62	57.94	30	28.04	5	4.67	10	9.34	0	0.00
D16	3.52	68	63.55	30	28.04	6	5.61	3	2.80	0	0.00
D17	3.28	56	52.34	29	27.10	18	16.82	4	3.74	0	0.00

Table 6. Results of digital literacy self-evaluation of artwork and educational subject teachers

Item	Mean	Absolute and relative frequency of teachers' responses									
		I have sufficient knowledge and skills		*I have rather sufficient knowledge and skills*		*I have rather insufficient knowledge and skills*		*I have insufficient knowledge and skills*		*I do not consider it necessary for my profession performance*	
			%		%		%		%		%
D1	2.64	27	27.00	34	34.00	16	16.00	22	22.00	1	1.00
D2	2.37	22	22.00	27	27.00	19	19.00	30	30.00	2	2.00
D3	2.31	17	17.00	32	32.00	16	16.00	35	35.00	0	0.00
D4	2.06	17	17.00	16	16.00	24	24.00	42	42.00	1	1.00
D5	2.34	16	16.00	31	31.00	24	24.00	29	29.00	0	0.00
D6	2.60	26	26.00	34	34.00	16	16.00	22	22.00	2	2.00

D7	1.88	8	8.00	23	23.00	22	22.00	43	43.00	4	4.00
D8	1.85	13	13.00	19	19.00	14	14.00	48	48.00	6	6.00
D9	1.79	13	13.00	15	15.00	17	17.00	48	48.00	7	7.00
D10	1.80	7	7.00	25	25.00	15	15.00	47	47.00	6	6.00
D11	1.82	11	11.00	17	17.00	19	19.00	49	49.00	4	4.00
D12	2.01	16	16.00	19	19.00	18	18.00	44	44.00	3	3.00
D13	2.44	18	18.00	35	35.00	21	21.00	25	25.00	1	1.00
D14	2.17	15	15.00	25	25.00	25	25.00	32	32.00	3	3.00
D15	3.31	56	56.00	29	29.00	5	5.00	10	10.00	0	0.00
D16	3.53	65	65.00	26	26.00	6	6.00	3	3.00	0	0.00
D17	3.29	53	53.00	27	27.00	16	16.00	4	4.00	0	0.00

Table 7. Results of digital literacy self-evaluation of professional (technical) subject teachers

Item	Mean	Absolute and relative frequency of teachers' responses									
		I have sufficient knowledge and skills		*I have rather sufficient knowledge and skills*		*I have rather insufficient knowledge and skills*		*I have insufficient knowledge and skills*		*I do not consider it necessary for my profession performance*	
			%		%		%		%		%
D1	2.83	6	33.33	6	33.33	3	16.67	3	16.67	0	0.00
D2	2.22	3	16.67	5	27.78	3	16.67	7	38.89	0	0.00
D3	2.33	3	16.67	6	33.33	3	16.67	6	33.33	0	0.00
D4	2.00	2	11.11	4	22.22	4	22.22	8	44.44	0	0.00
D5	2.11	1	5.56	6	33.33	5	27.78	6	33.33	0	0.00
D6	2.50	3	16.67	7	38.89	4	22.22	4	22.22	0	0.00
D7	2.22	3	16.67	6	33.33	2	11.11	6	33.33	1	5.56
D8	2.06	3	16.67	5	27.78	1	5.56	8	44.44	1	5.56
D9	2.06	3	16.67	5	27.78	1	5.56	8	44.44	1	5.56
D10	1.89	2	11.11	4	22.22	3	16.67	8	44.44	1	5.56
D11	2.00	3	16.67	4	22.22	2	11.11	8	44.44	1	5.56
D12	2.06	4	22.22	3	16.67	2	11.11	8	44.44	1	5.56
D13	2.72	5	27.78	7	38.89	3	16.67	2	11.11	1	5.56
D14	2.50	5	27.78	4	22.22	5	27.78	3	16.67	1	5.56
D15	3.72	13	72.22	5	27.78	0	0.00	0	0.00	0	0.00
D16	3.67	12	66.67	6	33.33	0	0.00	0	0.00	0	0.00
D17	3.50	10	55.56	7	38.89	1	5.56	0	0.00	0	0.00

As to the software applications *Microsoft Word, Microsoft PowerPoint* and *Microsoft Excel* results of the digital literacy self-evaluation in case of all five segmentation groups of teachers (differentiated based on the subject they teach) are the same as in case of the results achieved for the whole research sample (without any segmentation of the respondents). The only „deviation" is the group of professional (technical) subject teachers, in case of which the recorded mean of the digital literacy self-assessment related to the application *Microsoft PowerPoint* is of a higher value than the mean of the digital literacy self-assessment related to the application *Microsoft Word*. However, difference between the two recorded values is not a significant one (also with respect to the low number of these respondents), i.e. the level of the digital literacy of this group of teachers is in principle the same with respect to all three given Microsoft applications.

With regard to digital teaching means at which the overall digital literacy of teachers was recorded (i.e. without distinguishing the teachers according to the subjects they teach) at a more or

less sufficient level or at least at the level of the scale value 2 – *I have rather insufficient knowledge and skills*, results of all groups of the teachers segmented according the taught subjects also copy results recorded for the whole research sample. Digital literacy at the level of the scale value of 2 was recorded in case of all five groups of teachers, besides the applications *Mindomo, Flow!Works, SMART Notebook* and education sets *LEGO* also at the application *Prezi* (2.00 – 2.06). In case of natural science subject teachers and artwork and educational subject teachers it was recorded furthermore at the application *Alf* (2.00 – 2.01), and in case of professional (technical) subject teachers also at the tools *ActiVote* (2.06), *QRF700/900* (2.06) and *Socrative 2.0* (2.00).

In case of artwork and educational subject teachers and professional (technical) subject teachers as some „deviations" can be understood results recorded at the items *Google Documents* and *ActivExpression2*. In comparison with the other groups, artwork and educational subject teachers state a lower level of their digital literacy in relation to *Google Documents* (2.44, i.e. below the limit 2.5 of the used scale value). Contrary to this, professional subject teachers unlike the other groups of teachers state a relatively high, in principal sufficient, level of their digital literacy in relation to the use of the vote system *ActivExpression2* (2.22).

Analysis of teachers` self-evaluation dependence on teacher staff category

In frame of the research data processing and evaluating there was verified a statistical null hypothesis:

H_o: Respondents` answers to the particular items D_i (i = 1, 2, ..., 17) do not depend on the teacher category which a respondent belongs to.

This hypothesis de facto represents 17 partial null hypotheses formulated for the particular kinds of the digital didactic means and software applications (D1 – D17, Table 1). All 17 partial null hypotheses were verified at 5 % level of significance. Independence of digital literacy in regard to the given digital tools on the segmentation factor of teacher category which the respondents belong to was tested through both parametric as well as nonparametric tests (Kuna et al., 2017).

Hereinafter only results of the items D2, D5, D6 and D15 are presented and discussed, as these were the items at which the tested dependence (partial null hypotheses formulated for them) was proved.

Following results of the analysis of variance of simple sort as well as its nonparametric alternative Kruskal Wallis test, in case of the items D2: H (2, N = 173) = 6.698562, p = 0.0351; D5: H (2, N = 173) = 8.693615, p = 0.0129; D6: H (2, N = 173) = 8.961734, p = 0.0113; and D15: H (2, N = 173) = 6.406162, p = 0.0406 the partial statistical null hypotheses stating that the differences at evaluation of the questionnaire item D2, as well as D2, D6 and D15 among the groups of the respondents is not statistically significant were rejected (p < 0.05). This means that the variables D2 (declared level of teachers` digital literacy related to the application *Flow!Works – creating of interactive teaching materials*), D5 (declared level of teachers` digital literacy related to the application *Mindomo – creating of mind maps*), D6 (declared level of teachers` digital literacy related to the application *FreeMind – creating of mind maps*) and D15 (declared level of teachers` digital literacy related to the application *Microsoft PowerPoint – creating of didactical presentations with educational content*) are dependent on the factor of the category of pedagogical employee (teaching staff) to which the teacher belongs.

After the null hypothesis H_o for the items D2, D5, D6 and D15 was rejected, we were interested among which teacher categories of respondents differences of their responses to the given items are statistically significant. Results of their multiple comparison are summarized in Table 8.

Table 8. Multiple comparison for items D2, D5, D6 and D15 in dependence on the factor of teaching staff category

Item D2			
Factor value	A4a	A4b	A4c
A4a		0.043721	1.000000
A4b	0.043721		0.596108
A4c	1.000000	0.596108	

Item D5			
Factor value	A4a	A4b	A4c
A4a		0.119763	0.584702
A4b	0.119763		0.031892
A4c	0.584702	0.031892	

Item D6			
Factor value	A4a	A4b	A4c
A4a		0.021931	1.000000
A4b	0.021931		0.156387
A4c	1.0000000.156387		

Item D15			
Factor value	A4a	A4b	A4c
A4a		1.0000000	0.046628
A4b	1.000000		0.131432
A4c	0.0466280.131432		

Notes: A4a – primary education teachers; A4b – lower secondary education teachers; A4c – upper secondary education teachers

Identified statistically significant differences ($p < 0.05$) among the groups of the respondents differentiated according to the factor of teaching staff category are in Table 8 highlighted.

Box graphs in Figures 1-4 present evaluation of the items D2, D5, D6 and D15 in a graphical form. There are given median, quartile range (half of the range of the upper and lower quartile) and variation range (interval in scope of which particular values of respondents` responses to the given item were recorded) of these items.

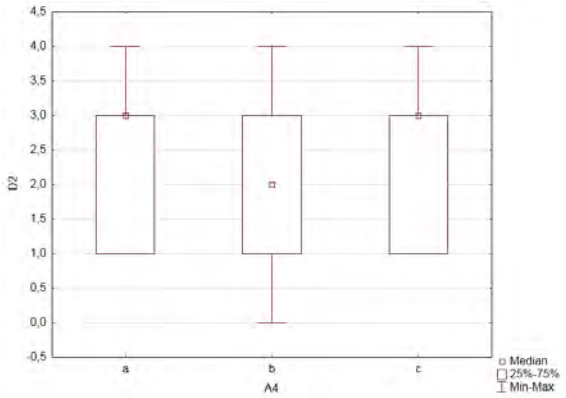

Fig. 1. Visualization of responses to item D2

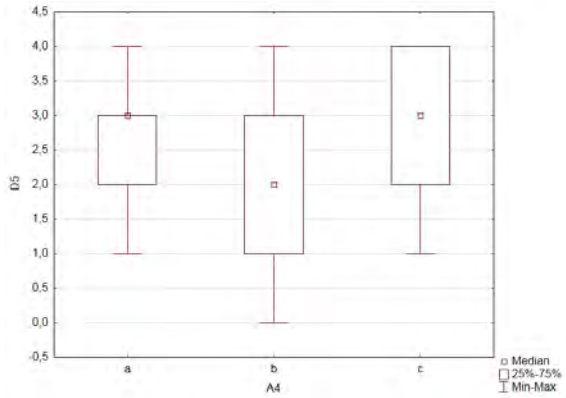

Fig. 2. Visualization of responses to item D5

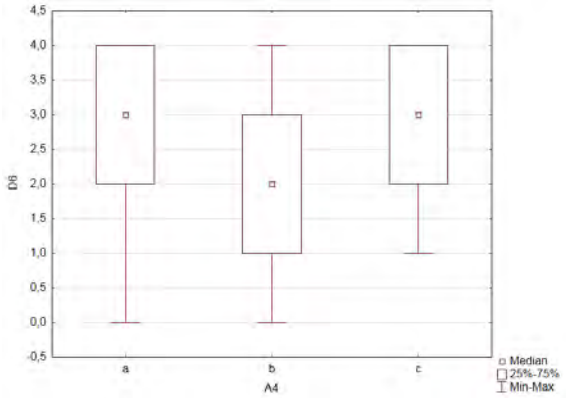

Fig. 3. Visualization of responses to item D6

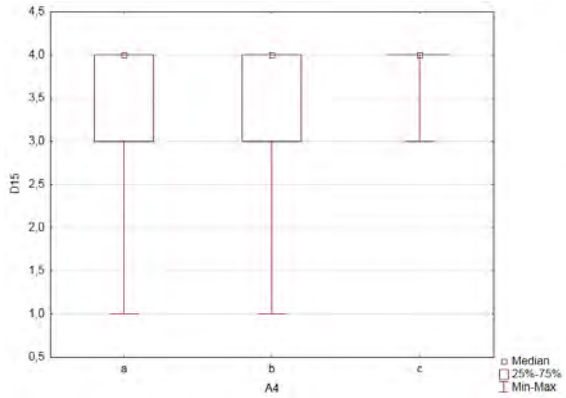

Fig. 4. Visualization of responses to item D15

Note: A4a – primary education teachers; A4b – lower secondary education teachers; A4c – upper secondary education teachers

As the graphs in Figures 1-4 show, the lowest quartile range (value of the quartile range 0) was recorded at the item D15 (*creating of didactical presentations with educational content in the application of Microsoft PowerPoint*) in the group of *upper secondary education teachers* (A4c – value of the quartile range 0), i.e. in this group the highest homogeneity of responses to the concerned item among all four tested variables was recorded (D2: Figure 1; D5: Figure 2; D6: Figure 3; D15: Figure 4).

4. Discussion

At the item D2, 50 % of responses in all three groups of respondents is at the level *I have rather sufficient knowledge and skills* (scale value 3) up to *I have insufficient knowledge and skills* (scale value 1). At this item a more positive self-evaluation of the teacher research sample was expected. Recorded results, according to us, may be a consequence of the fact that creation and using tools of the software environment *Flow!Works* of the interactive white board QOMO do not belong currently to trends preferred by pedagogical employees, as development of this software has been suspended by its producer. Furthermore it can also be a consequence of the fact that scope of tools supported by the environment of *Flow!Works* does not reach not half such scopes as it is in case of the development environments of *ActivInspire* and *SMART Notebook*. Because of that schools probably prefer rather to buy and use tools of the development environments *ActivInspire* supporting interactive white boards ActivBoard and *SMART Notebook* supporting interactive white board SMART Board.

At the items D5 and D6 respondents assessed their digital literacy related to the use of computer/tablet applications *Mindomo* (D5) and *FreeMind* (D6). So, here their knowledge level and skills related to design of mind maps usable in teaching and learning activities with pupils and students, including pupils and students with special needs, were assessed. Statements of the particular groups of teachers recorded at these questionnaire items were almost the same. Reached median of the responses *I have rather sufficient knowledge and skills* (median of the scale value 3) in the group of *primary education teachers* (A4a) as well as in the group of *upper secondary education teachers* (A4c) proves that teachers have relatively sufficient digital literacy to create interactive mind map. A question remains whether they also really use in practice this by them declared level of literacy to work with *Mindomo* and *FreeMind*. According to Schubertová and Bednárová (Schubertová, Bednárová, 2018), mind maps help pupils to systemize acquired knowledge and facts and to increase amount of remembered knowledge. Moreover, use of mind maps in connection with integrated audio visual elements and great measure of interactivity can influence in a positive way pupils` attitudes towards those subjects which in general belong to less popular or unpopular (non-favourite) (Pushkarev, Pushkareva, 2019).

At the item D15 all three groups of teachers assessed their digital literacy to work with *Microsoft PowerPoint* as sufficient (Figure 4). It is generally known that creation of *Microsoft PowerPoint* educational presentations and their utilization as didactic means supporting teaching and learning processes is relatively broadly used by teachers at all levels of education (Ghavifekr, Rosdy, 2015). According us, within the context of the development of teachers` (of all levels of education) presentation skills the teachers should pay a greater attention to acquisition and use of new tools of presentation software means, as are e.g. *Prezi* or *Microsoft Sway,* as internet online alternatives to the standard (offline) *Microsoft PowerPoint* application. Use of educational presentations designed in still more and more popular presentation platform of *Prezi* offers at the same time also a space to apply innovative methods in teaching (Kuna et al., 2018; Kozík et al., 2012). As well the online tool *Sway*, as an integral part of the Microsoft 365 package, enables similarly to *Prezi* to design in innovative ways interactive documents and presentations. According to Fuchsova and Korenova (Fuchsova, Korenova, 2019), it is almost sure that very soon to design graphical presentation of thoughts will be equally important as to write coherent texts.

5. Conclusion

Presented results of the carried out research survey point out to some pedagogical practice needs and requirements regarding curricula design to achieve an optimal model of pre-service teacher training to form and develop professional didactic technological competences necessary for a successful and efficient performance of future teachers in their consequent teaching practice. However, the whole research from which the findings were derived, was done before the corona pandemics situation. This means that it was carried out at time when we had no experience of teaching in corona pandemic conditions. In that time, the core of the teacher training related to the use of digital technologies was appropriate implementation of different software applications into teaching. Nowadays, in conditions of the pandemics, education is more and more moving into the virtual reality and we see that may be even more important is to train teachers to work with different on-line systems. For pupils, students and their teachers too, a new situation has arisen. To support distance form of education at all its levels, digital multiplatform tools are used.

For many teachers this form of education is no novelty (Balogh, Kucharik, 2019). This form had been used in specific situations also before (for example in case of pupils/students` illness already for a longer time. But on the other hand a majority of teachers had not come into the contact with this form of education in their teaching practice before. From the position of the teacher, they are not familiar with methodology of online teaching. So beside the above mentioned research results also the new (corona) conditions should be taken into the consideration with respect to upgrading the teacher training in the area of their didactic technological competences. And taking into consideration the situation under the corona pandemic means that into the curricula of the teaching study programs also the issue of teaching through online systems (such as e.g. *Microsoft Teams, Zoom, Cisco Webex, GoToMeeting, BlueJeans*) should be included.

References

Balogh, Kucharik, 2019 – *Balogh, Z., Kucharik, M.* (2019). Predicting Student Grades Based on Their Usage of LMS Moodle Using Petri Nets. *Applied Sciences-Basel*. 9(20): 1-16. DOI: https://doi.org/10.3390/app9204211

Fuchsova, Korenova, 2019 – *Fuchsova, M., Korenova, L.* (2019). Visualisation in Basic Science and Engineering Education of Future Primary School Teachers in Human Biology Education Using Augmented Reality. *European Journal of Contemporary Education*. 8(1): 92-102. DOI: 10.13187/ejced.2019.1.92

Ghavifekr, Rosdy, 2015 – *Ghavifekr, S., Rosdy, W.A.W.* (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *International Journal of Research in Education and Science (IJRES)*. 1(2): 175-191.

Klement et al., 2017 – *Klement, M., Dostál, J., Kubrický, J., Bártek, K.* (2017). ICT versus teachers: adoration or resistence? [ICT nástroje a učitelé: adorace, či rezistence?]. Olomouc: Palacký University Olomouc. DOI: 10.5507/pdf.17.24450926

Kobylarek, 2018 – *Kobylarek, A.* (2018). Science as a bridge. Science in action preface. *Journal of Education Culture and Society*. 9(2): 5-8.

Kosová et al., 2012 – *Kosová, B. et al.* (2012). Vysokoškolské vzdelávanie učiteľov. Vývoj, analýza, perspektívy [Higher education of teachers. Development, analysis, perspectives]. Banská Bystrica: Faculty of Education, Matej Bel University. [in Slovak]

Kozík et al., 2012 – *Kozík, T., Kuna, P., Šimon, M.* (2012). Koncepcia využitia prvkov priemyselnej automatizácie v návrhu reálnych vzdialených experimentov [The concept of using elements of industrial automation in the design of real remote experiments]. *Edukacja – Technika – Informatyka: wybrane problemy edukacji technicznej i zawodowej*. 4(3): 45-56. [in Slovak]

Krumsvik et al., 2016 – *Krumsvik, R.J., Jones, L.Ø., Øfstegaard, M., Eikeland O.J.* (2016). Upper secondary school teachers' digital competence: analysed by demographic, personal and professional characteristics. *Nordic Journal of Digital Literacy*. 1(3): 143-164.

Kuna et al., 2017 – *Kuna, P., Kozík, T., Kunová, S., Šebo, M.* (2017). Software tools for creating and presenting virtual 3D modells. *Advances in Intelligent Systems and Computing: ICL 2017. 20th International Conference on Interactive Collaborative Learning*. 716: 17-26.

Munk et al., 2017 – *Munk, M., Drlík, M., Benko, Ľ., Reichel, J.* (2017). Quantitative and Qualitative Evaluation of Sequence Patterns Found by Application of Different Educational Data Preprocessing Techniques. *IEEE ACCESS*. 5: 8989-9004. DOI: 10.1109/ACCESS.2017.2706302

O agentúre – O agentúre. [Electronic resource]. URL: https://saavs.sk/o-agenture/

Petrová, Duchovičová, 2013 – *Petrová, G., Duchovičová, J.* (2013). University Preparation of Teachers in the Context of Transformation Processes. *Lifelong Learning – celoživotní vzdělávání*. 3(1): 8-37. DOI: http://dx.doi.org/10.11118/lifele201303018

Pushkarev, Pushkareva, 2019 – *Pushkarev, Y.V., Pushkareva, E.A.* (2019). Communication foundation for intellectual culture: Tendencies of contemporary development. *XLinguae*. 12(4): 212-218.

Schubertová, Bednárová, 2018 – *Schubertová, R., Bednárová, M.* (2018). Využitie pojmového mapovania pri skúmaní predstáv žiakov a študentov o prepojení orgánových sústav [The use of conceptual mapping in the study of pupils 'and students' ideas about the interconnection of organ systems]. *Scientia in educatione*. 9(1): 104-121. DOI: https://doi.org/10.14712/18047106.999 [in Slovak]

Vezirov, Kostina, 2016 – *Vezirov, T.G., Kostina, E.A.* (2016). Educational web-technologies in training bachelors and masters of pedagogical education. *Science for Education Today*. 6(4): 39-49. DOI: http://dx.doi.org/10.15293/2226-3365.1604.04

Záhorec et al., 2019 – *Záhorec, J., Hašková, A., Munk, M.* (2019). Teachers´ Professional Digital Literacy Skills and Their Upgrade. *European Journal of Contemporary Education*. 8(2): 378-393. DOI: 10.13187/ejced.2019.2.378

Záhorec et al., 2020 – *Záhorec, J., Hašková, A., Munk, M.* (2020). Digitálna gramotnosť učiteľov v kontexte ich profesijnej prípravy [Digital literacy of teachers in the context of their professional training]. Bratislava: Comenius University in Bratislava, 1. ed. [in Slovak]

Záhorec et al., 2019 – *Záhorec, J., Nagyová, A., Hašková, A.* (2019). Teachers` attitudes to incorporation digital means in teaching process in relation to the subjects they teach. *International Journal of Engineering Pedagogy*. 9(4): 101-120. DOI: https://doi.org/10.3991/ijep.v9i4.11064