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How do Pre-service Teachers Rate ICT Opportunity for Education? A Study in Perspective of the SCOT Theory

Abstract

ICT have great educational potential. Research shows, however, that ICT are not widely incorporated into education. This situation is presented by the SCOT theory, which shows that teacher ratings of new ICT are consistently and invariably negative. We decided to verify how pre-service teachers rate the ICT solutions and the consistency of their ratings. Results showed that pre-service teachers are indeed relatively consistent and invariable in their ratings. Moreover, those ICT solutions that can be incorporated into the traditional educational model without requiring significant technological framework receive better ratings than those that deviate from this model by requiring significant need for implementation of technology to be used in the educational setting.

Keywords:

ICT, pre-service teachers, SCOT theory, techno-pedagogical approach, TPACK

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1. INTRODUCTION

Brun and Hinostroza (2014, p. 223) notice that "the information and innovation-based society demands from the education systems continuous improvements to prepare new generations for taking full advantage of the new socio-cultural and economic conditions". Many researchers (cf. Andronie & Andronie, 2014; Brun & Hinostroza, 2014; Oreglia, 2014; Sun, Looi & Xie, 2014) point that one of the major strategies of such improvements is introducing to education Information and Communications Technology (ICT). Valtonen et al. (2015, p. 49) see that "the importance of Information and Communication Technology (ICT) for teaching and learning is widely recognized. […] the use of ICT for teaching and learning is associated with so called twenty-first century skills, skills that today's students are expected to acquire as they enter working life". Abilities for creative and critical thinking, problem solving, autonomous learning skills and competences, communication and collaboration, learning and information literacy can be mentioned here (Hernández-Ramos et al., 2014; Valtonen et al., 2015). Ivan and Frunzaru (2014, p. 4) even notice that "the expansion of information and communication technology (ICT) in schools is expected to facilitate the learning process and to create a bridge between students' needs and expectations and labor market demands".

Without doubt ICT have great educational potential. Moreover, it is seen as creating educational opportunity. Research show, however (Hernández-Ramos et al., 2014), that although many developing countries are aware of this relationship and invest in introducing ICT to their education systems, ICT is still not widely incorporated into education. A few years ago this situation could be explained by the fact that there was a problem with access to equipment, lack of technical support and ICT training for teachers (Koh, Chai & Tay, 2014). Today, however, these problems in the developing countries practically do not exist. The failure to use ICT in education is more and more often explained by teachers' negative attitudes towards its implementation (Hernández-Ramos et al., 2014; Koh, Chai & Tay, 2014). Researchers (cf. Haspekian, 2014) highlight that teachers are often not free in their beliefs – it is assumed that these beliefs are socially constructed. This assumption is supported by a theory called the Social Construction of Technology (SCOT theory) (Byker, 2014).

In the classical approach – constructed by Trevor and Bijker (1984; cf. Bijker, 2010; Bijker, 1997) – SCOT theory refers to the concept of social constructivism. It is assumed there that each technology has a different significance for various social groups. Some of the groups see a new technology as a potential for their development, others as a threat. In this context, an often given example is dif-

ferentiation (conflict) in the ratings between the technology creators and its users (cf. Colbjørnsen, 2015). The creators most often rate their product in the category of a chance, but the group of users very often – mostly when a very innovative technology is in its early stages of implementation – rates the product as a threat to their *status quo*.

Moreover, SCOT theory shows that a given social group is most often invariable and consistent in the ratings of a given technology – it constructs its own invariable and consistent ratings (Byker, 2014). It means that, for example, if we asked a group of 100 cooks to rate some new kitchen equipment, their ratings – according to SCOT theory – would have low degree of variation. Furthermore, if we asked them to discuss their ratings in the groups, the negotiated result would be similar to the average result (nobody with the rating that did not match the group trend would be able to persuade others that their rating was reasonable). In the context of ICT, it can be stated that SCOT theory shows that some social groups construct their own (invariable and consistent) ICT ratings and that the more innovative ICT (one that changes the *status quo* of the group) the worse it is rated – at least in its early stage (there is a conflict between producers ratings and users ratings) (cf. Fulk, 1993; Inkinen, 2006; Lakhana, 2014; Lăzăroiu, 2014).

In this article, we present the study results, which show how pre-service teachers rate the ICT solutions for educational purposes and if they are invariable and consistent in their ratings. We formulated the following research questions:

1. Are pre-service teachers invariable and consistent in their ratings of ICT solutions?
2. Do pre-service teachers rate lower those ICT solutions which would significantly transform the traditional educational situations (which put at risk *status quo* of the traditional educational model)?

In the literature, the SCOT theory has not been verified yet in the context of pre-service teachers. What we are aware of, however, is that practicing teachers are invariable and consistent in their ratings of ICT solutions (cf. Brantley-Dias & Ertmer, 2013; Heffernan, 2012; Polly, McGee & Sullivan, 2010). There is a question, though, whether the ratings are constructed during working at school or maybe as early as during studies, therefore whether pre-service teachers are invariable and consistent in the ratings of ICT solutions. Moreover, there are no data which would show whether pre-service teachers, just as teachers, rate lower those ICT solutions which would significantly transform the traditional educational situations. We also cannot assume that the currently studying *digital native* generation cannot be more open to the technological transformation of education that the generation of currently working teachers (cf. Lu, 2014). It can also be stated that such a study

is interesting as it demonstrates attitudes toward the ICT solutions of those who will be influencing education in the years to come, and it may also be a credible voice in a discussion about teachers' education.

2. METHOD

2.1. HYPOTHESIS AND PROCEDURE

In the study, there were two hypothesis based on the research questions described and validated in the introduction:

1. Pre-service teachers are invariable and consistent in the ratings of ICT solutions (H1).
2. Pre-service teachers rate lower those ICT solutions which would significantly transform the traditional educational situations (which put at risk *status quo* of the traditional educational model) (H2).

To measure how a group of pre-service teachers rate the ICT solutions, we conducted a study in 2015, in which one hundred twenty pre-service teachers (from Adam Mickiewicz University in Poznan) were asked to rate six – relatively new – ICT solutions, especially these that they would not have experience with. In the study, a five-point rating scale was used, where "1"stands for "very low opportunity for education", and "5" for "very high opportunity for education". Participants were randomly divided (according to the assumption of SCOT theory described in the introduction) into two groups: in the first group (group A) pre-service teachers rated each ICT solutions individually, and in the second one (group B) they rated each ICT solutions in groups of four or five (in other words in subgroups). In both groups, each ICT solutions was presented in the form of a multimedia presentation. The first group followed with the individual participants' rating. In the second group, a discussion preceded the rating of every group of four or five participants (subgroup). The discussion was directed to negotiate a collective rating (it was supposed to be a short discussion about one's own opinion without any moderator). Then we made a statistical comparison of both groups' ratings. We assumed that:

– since (according to H1) pre-service teachers are invariable and consistent in the ratings of ICT solutions, so: the ratings in both groups do not differ and in both groups there is a low degree of variation. It means that in the group there are not many opinions significantly different from the group trend that are suppressed in the negotiation process (the degree of

variation is higher in A than B), and that the group trend is not sensitive to negotiation attempts (the degree of variation is higher in B than A). Thus, the group is consistent and invariable as far as ratings of the ICT solutions are concerned.

The ICT solutions presented during the study were selected (according to the assumption of SCOT theory described in the introduction) in such a way so that one half of them (Y set) includes the solutions that would enrich traditional educational situations without significant need for technical implementation, and the other half (Z set) would include those solutions which would significantly transform the traditional educational situations due to a high degree of technicization. We assumed that:

– since (according to H2) pre-service teachers rate lower those ICT solutions which would significantly transform the traditional educational situations, so: pre-service teachers would rate the ICT solutions from the Y set higher than those from the Z set, so pre-service teachers would give a greater rating to those ICT solutions whose application does not put at risk *status quo* of the traditional educational model and needs low technology implementation (or effort).

2.2. MATERIALS

The ICT solutions of the Y set include: (1) Augmented Paper Systems, (2) MOOCs, (3) CyberParks, and the Z set: (4) Web-Based Science Learning Environment, (5) SEEK-AT-WD, (6) SMART Education. Below we describe the features of each solution in order mentioned above (during the study they were presented in a random order). The justification of such a division results from the features of these ICT solutions – these features are presented below.

2.2.1. Augmented Paper Systems

Augmented Paper Systems is an approach for using ICT to modernize the traditional, paper-based educational tools. ICT have augmented the traditional paper – without denying it, with the addition of the digital dimension. Prieto et al. (2014), while researching the publications concerning this system, noted that it most often used – in the form of input devices – cameras, barcode readers, RFID readers, scanners (to identify and locate the paper), and digital pens (to convert freeform writing into a digital equivalent). As far as output devices, the system uses screens, projections, sounds, and printers.

Prieto et al. (2014) mention five basic forms of Augmented Paper Systems: (1) Augmented Cards and Post-Its, (2) Augmented Books, (3) Augmented Notebooks, (4) Augmented Printed Documents, (5) Augmented Tables, Flipcharts, and Whiteboards (see Table 1).

Table 1. Characteristics of five basic forms of Augmented Paper Systems

Name	Characteristics
Augmented Cards and Post-Its	"The paper artifact is treated as a physical token that allows accessing and managing digital resources, which are represented by the (paper) physical objects".
Augmented Books	"The book itself has value independently from the digital resources, although usually includes printed markers to link its contents to additional/complementary media".
Augmented Notebooks	"The notebook, initially empty, synchronizes a paper-based and a digital version of the same resource/contents, allowing free handwriting and sketching".
Augmented Printed Documents	"Often work with a pre-printed document, where users can fill in forms, make annotations or mark parts of the document. These actions are then translated to a digital counterpart".
Augmented Tables, Flipcharts, and Whiteboards	"Combine paper-based media with interactive tabletop and/or wall displays, allowing a close integration of paper and digital media".

On the basis of Prieto et al. (2014, p. 170).

2.2.2. MOOCs

MOOCs (Massive Open Online Courses) is a strategy of using the idea of traditional educational activity in the ICT courses. The idea of MOOCs responds to the traditional forms of education such as a lecture, a reading, a writing assignment, or a conversation, however, their realization is to be conducted online through an Internet site. Such sites are to become the space to exchange the detailed information and the in-depth discussion. MOOCs are usually free and available for everyone. The MOOCs users learn in their own time and place. It should be noted that MOOCs are the online version of the traditional forms of education and that they are additional courses, which supplement the offline education (Acosta, Escribano Otero & Toletti, 2014; Andronie & Andronie, 2014).

MOOCs are not the innovative ICT solutions in the context of the traditional education – they just give a possibility to realize, for instance, one subject using the Internet. It is worth emphasizing that this solution is different from e-learning – when educating a person using e-learning we have to incorporate the Internet

into the process of student-teacher communication, MOOCs are, on the other hand, autonomous (separate) courses (Kranz, 2014; Aguaded-Gómez, 2013).

2.2.3. CyberParks

A cyberpark is meant to be an urban open public space (i.e. a park, garden square, plaza, etc., or a natural space inserted in an urban setting, or an urban forest, a protected landscape, etc.) with an augmented digital dimension (people using smart phones, tablets, or Wi-Fi provision). The intertwining of ICT with the public open spaces is already challenging for ICT experts, landscape architects, urban designers, social scientists, and educators. Tackling this challenge is in the center of CyberParks that digital media can be on one hand attractive to bring people outdoors and to lead them to an active and healthy lifestyle. On the other, it can be employed to lead people to learn in public open space (about elements of this space). An example of CyberParks ICT tool is the application WAY CyberParks, consisting of a smartphone app and a web service. This tool tracks the way people use a particular space, allowing them to get contextual information and to send suggestions about the spaces they are interweaving. CyberParks is thus – *inter alia* – a strategy of incorporating ICT into the public space, so that it becomes a place for learning (outside curriculum or extended school studying) and increasing social skills (interacting in public with others)[3].

2.2.4. Web-Based Science Learning Environment

Web-Based Science Learning Environment is a strategy of using ICT in such a way so that it is possible to transfer (partially or totally) science content (of every educational level) to an online environment. Such an ICT solution is different from MOOCs because Web-Based Science Learning Environment is not an externally built, additional course, which is taken in one's free time. Instead, it is an integral element of everyday classes at school. A teacher is required to construct such an environment, teach how to use it, organize students' work at the computers, and support them technologically, etc. Web-Based Science Learning Environment is

[3] For a brief review of this problem, see *CyberParks Project. Fostering Knowledge about the Relationship between Information and Communication Technologies and Public Spaces Supported by Strategies to Improve Their Use and Attractiveness*, www.cost.eu/domains_actions/tud/Actions/TU1306, [Access date: 01.02.2015].

thus such an ICT use, which significantly transforms the traditional educational situation, especially in the context of their radical need for implementation of technology and reorganization of their space (Sun, Looi & Xie, 2014).

2.2.5. SEEK-AT-WD

SEEK-AT-WD (Support for Educational External Knowledge About Tools in the Web of Data) is a strategy of using ICT in such a way so that it is possible to build an Internet platform on which teachers can gather the descriptions of ICT, conduct the pedagogical evaluations and create the pedagogical strategies of using and constructing ICT in order to use them in education in a better way. This platform is built on the following communication model: (1) the platform indexes the non-pedagogical ICT descriptions, (2) teachers describe the indexed ICT using the pedagogical language, (3) teachers evaluate the use of described ICT, (4) teachers discuss their experiences related to these ICT and update the existing ICT descriptions. They also build development strategies for ICT and create ideas for the introduction of new ICT for education (Ruiz-Calleja et al., 2014). Thus, SEEK-AT-WD is such a use of ICT which not only intensifies the process of introducing ICT to education, but also significantly transforms the traditional concept of teacher knowledge – it requires teachers to have the advanced technological knowledge (cf. Day, 2014; Kabakci Yurdakul & Coklar, 2014; Koh & Chai, 2014; Koh, Chai & Tay, 2014).

2.2.6. SMART Education

SMART Education is a strategy of using ICT to build an educational system based completely on ICT. It consists of five elements: (1) Self-directed, (2) Motivated, (3) Adapted, (4) Resource enriched, and (5) Technology-embedded (see Table 2). SMART Education is seen as the fourth most intensive stage of continuum regarding implementation of technology: (1) e-learning, (2) m-learning, (3) u-learning (Jang, 2014).

Table 2. Characteristics of five elements of SMART Education

Name	Characteristics
Self-directed	"Characterizes the change in students roles as recipients to producers of knowledge and the shift of teachers from deliverers of knowledge to learning assistants (mentors). To achieve this, online assessments, academic performance evaluations, and a self-directed learning system will also be implemented".

Name	Characteristics
Motivated	"Highlights the way in which SMART education will encourage students to take interest in learning. SMART Education emphasizes teaching and learning methods that promotes creative problem-solving and process-centered individualized assessment. Students' learning experiences will be transformed from the typical textbook-based to experience-based".
Adapted	"Stands for the pursuing of education through a customized educational system and a customized teaching and learning system. SMART Education strengthens the flexibility of the educational system and facilitates customized learning in connection with personal interests and future career aspirations. It also helps schools evolve from a place of delivering knowledge to a place that supports personalized learning according to students' levels and aptitudes".
Resource enriched	"Describes the support for rich teaching-learning materials. From a cloud learning service, SMART Education provides free access to rich contents developed by public and private institutions and individuals in education, expands the joint use of domestic and overseas learning resources, and promotes collaborative learning through the contents delivery platforms".
Technology-embedded	"Illustrates the use of the latest information and communications technology. SMART Education enables students to learn at anytime and anywhere through information technology. By building an educational environment that encourages student-centered learning, students are provided with diverse methods of learning tailored to self-selected areas of interest".

On the basis of Jang (2014, p. 74–75).

As shown in Table 2, SMART education is such an ICT that maximizes the technologizing process of most educational situations.

2.3. DATA ANALYSIS

We used IBM SPSS statistics for Windows version 22 for statistical analysis. Firstly, we tested the normality of distribution for each rating. Since the normality was not confirmed (Kolmogorov-Smirnov test: all $p<0.01$), we applied a non-parametric statistical procedure and we used Mann-Whitney U test. The results were evaluated with a 99% confidence interval and $p<0.01$ significance level.

3. RESULTS

As shown in Table 3, rating of every ICT solution except for MOOCs in both groups does not vary (difference did not reach statistical significance – let us remember that the results were evaluated with a 99% confidence interval and $p<0.01$ significance level).

Table 3. Differences between ratings of groups A and B

ICT	group A		group B		*U*-value	Sig.
	Mean	SD	Mean	SD		
Augmented Paper Systems	3,880	0,927	4,174	0,778	242,500	0,313
MOOCs	2,960	0,978	3,739	0,810	163,000	0,007*
CyberParks	1,960	1,241	2,522	1,163	202,500	0,068
Web-Based Science Learning Environment	2,080	0,812	1,522	0,593	177,500	0,015
SEEK-AT-WD	2,040	0,841	1,565	0,788	191,000	0,032
SMART Education	1,280	0,542	1,304	0,559	281,500	0,870

* significant at < 0.01

As shown in Figure 1, in both groups there is a low degree of variation in the ratings of the ICT solutions, except for MOOCs. It means that the first hypothesis (H1) made in this study can be accepted only partially. It can thus be stated that the ratings of the ICT solutions of the study group are relatively consistent and invariable.

As shown in Table 4 and in Figure 2, there was a significant difference between the ratings from the Y set and the Z set in the study group. Respondents rated the ICT solutions from the Y set higher that from the Z set. It means that the second hypothesis of this study (H2) can be accepted. Therefore, we can assume that the study group better rates those ICT solutions whose application does not put at risk the *status quo* of the traditional educational model and requires low need for implementation of technology.

Table 4. Mean rating for the Y and Z set

ICT	Mean	SD	*U*-value	Sig.
Y set	3,194	1,264	3547,500	< 0,0001
Z set	1,639	0,763		

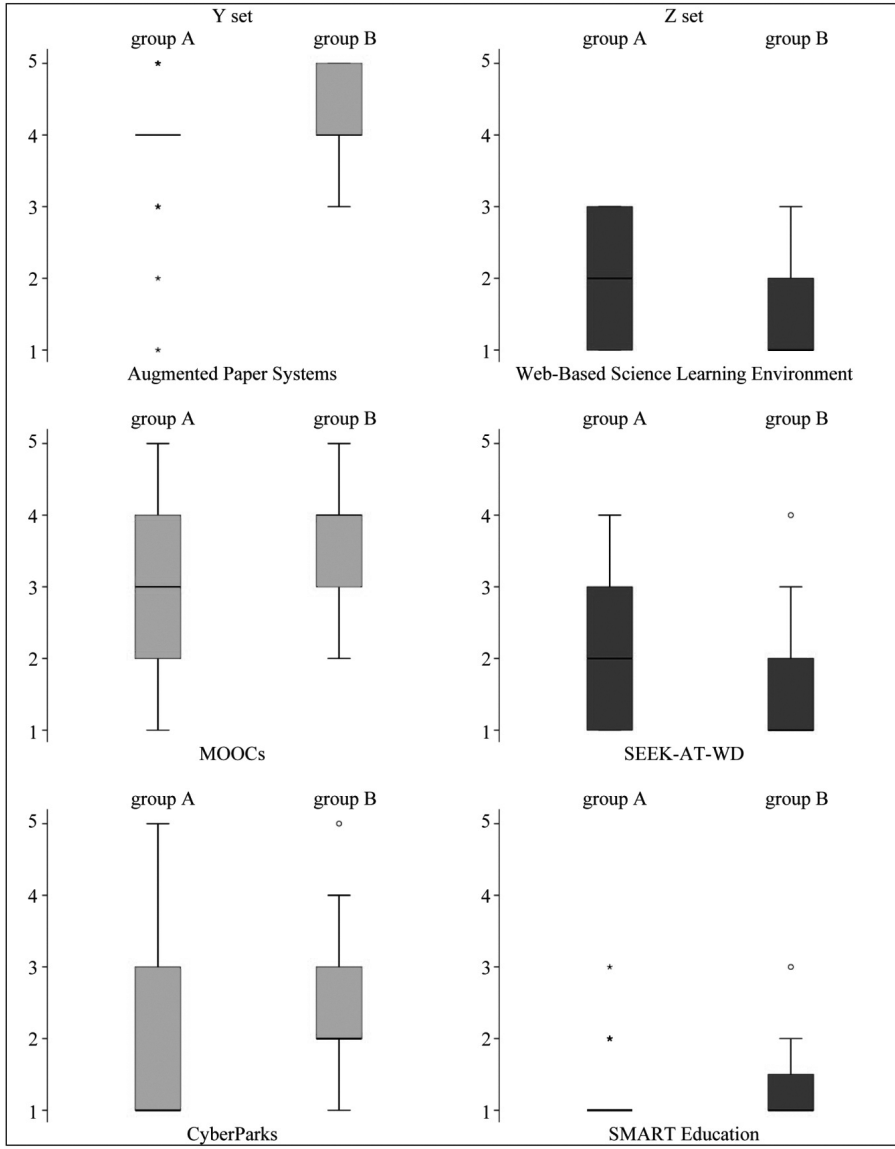

Figure 1. Variation of group A and B ratings. In the left column, there are results for the ICT solutions from the Y set, and in the right column from the Z set. The Augmented Paper Systems ratings have a very low degree of variation in both groups – they are extremely high (4 or 5 points), although in group A there were lower ratings (*) and in group B the ratings equaled 3 points. The MOOCs ratings vary significantly and have a high degree of variation. Despite the lack of significance between differences of the CyberParks ratings, the degree of variation was high, with a score tendency towards 2 points. Ratings of Web-Based Science Learning Environment have a very low degree of variation in both groups, with points that are very low (1 or 2 points). Ratings of SEEK-AT-WD are also low, although they have insignificantly higher degree of variation in group A. In group B, there was only one very high rating (o). The ratings of SMART Education have the lowest degree of variation in both groups and they are the lowest – in group A, a few ratings were a bit higher (*), and in group B there was only one slightly higher rating (o).

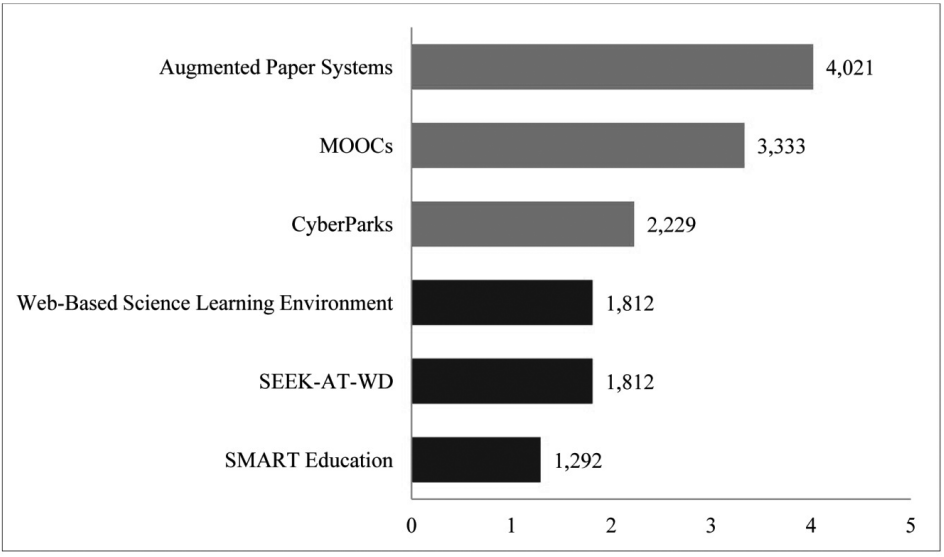

Figure 2. Mean rating for all analyzed ICT; in blue the Y set and in red the Z set.

4. DISCUSSION

As Toki and Pange (2014, p. 184) aptly pointed out, "young people today, the current students, commonly use the web, social web (such as Facebook, Youtube, Twitter, Myspace), they collaborate through wikis, blogs or Skype, they have mobile connectivity and the form everyday tasks such as learning, listen to radio, applying for a job, shopping, dating, and only on. These activities involve the use ICT not just for gathering information but also for creating and publishing information". Therefore, it seems that today's young people, students, and also pre-service teachers should have positive attitudes towards ICT. In some contexts, research has in fact confirmed it. Valtonen et al. (2014) proved, for example, that pre-service teachers have a positive attitude towards ICT as a self-study tool. Additionally, Beacham and McIntosh (2014) demonstrated that pre-service teachers generally have positive attitudes towards ICT that they are already familiar with, but they still reveal some skepticism concerning the use of ICT in education. However, our research showed that:

1. The study group of pre-service teachers is relatively invariable and consistent in terms of the ratings of the ICT solutions.
2. Pre-service teachers give better ratings for the ICT solutions that could be used in the traditional educational model without having to implement

complicated technological solutions, while they give worse ratings for those ICT solutions that deviate from this model and require a more significant technological framework.

The achieved results can be interpreted in a few ways:

Firstly, as using the ICT solutions from the Z set requires more technological knowledge than from the Y set, it is possible that pre-service teachers simply worry that they will not meet these requirements. Such an explanation is in a way confirmed by the research made by Valtonen et al. (2014), in which it was shown that pre-service teachers do not believe they are capable of using ICT and that they do not have experience in using ICT in the educational context. The pre-service teachers' concern may also be related to the digital divide between generations – a common belief that young people are always more technologically advanced (Pyzalski, 2012). In this context, there is an interesting study of Barak (2014), in which it was discovered that pre-service teachers are afraid that using ICT in their educational setting will weaken their authority in the classroom because of their comparatively weaker technology skills in relation to their students.

Secondly, introducing the ICT solutions from the Z set leads to radically higher requirements in technology than when introducing the ICT solutions from the Y set. Hence, pre-service teachers can worry that such an action will strengthen the global digital divide (cf. Berrío-Zapata & Rojas, 2014; Nipo, Bujang & Ting, 2014). As we already know, such an assumption is not correct (García-Valcárcel, Basilotta & López, 2014), however – as Beacham and McIntosh (2014) research shows – pre-service teachers most often do not understand that introducing ICT to education today is a foundation for balancing educational opportunity.

Thirdly, pre-service teachers are most often educated to be able to serve in the traditional educational model – thus they highly rate those ICT solutions that can be placed in this model. Low rating of the ICT solutions that breach the traditional educational model is a form of defending the *status quo*, their – socially constructed – reality.

In summary, if our study is representative, the assumption of SCOT theory refers also to the group of pre-service teachers. Pre-service teachers – similarly to teachers – are invariable and consistent in their rating of ICT solutions. Therefore, it seems that this rating construction is built as early as during studies. If we compare this result with the data concerning low innovative rating for education of ICT solutions, it is worth considering the possible changes in education of pre-service teachers.

There is no doubt that the education of pre-service teachers requires many significant modifications in the context of ICT. It seems invaluable in this context

to start working on introducing so called Technological, Pedagogical and Content Knowledge model (TPACK) to pre-service teachers' education. This model proposes making technological knowledge an obligatory part of the pre-service teachers' education in order to combine it with content knowledge and pedagogical knowledge (Day, 2014; Koh, Chai & Tay, 2014) (see Figure 3). Kabakci Yurdakul and Coklar (2014) defines that TPACK "refers to the teacher's knowledge of effective and efficient use of technology to increase the effectiveness and quality of instruction in the whole teaching process from planning to evaluation in the process of teaching a specific content". It should be highlighted, without the detailed description, that TPACK is a very advanced model, representing a "techno-pedagogical approach" to educate pre-service teachers (Kabakci Yurdakul & Coklar, 2014). However, as Koh and Chai (2014) demonstrated, there are still no precise guidelines as far as its application is concerned.

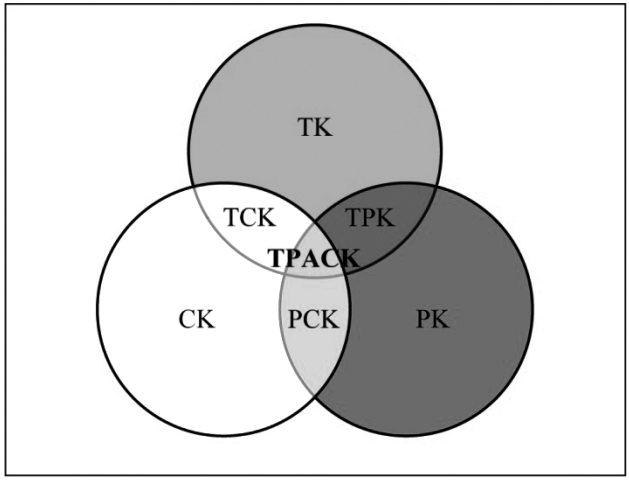

Figure 3. TPACK model of teacher knowledge. CK – Content Knowledge, PK – Pedagogical Knowledge, TK – Technological Knowledge, TCK – Technological and Content Knowledge, TPK – Technological and Pedagogical Knowledge, PCK – Pedagogical and Content Knowledge, TPACK – Technological, Pedagogical and Content Knowledge.

Own work on the basis of Day (2014, p. 25).

The discussed results based on this study have also revealed some weaknesses. The most important one is that the study sample was small and limited to one institution. There were also no measurements in the control groups, which could show how the pre-service teachers ratings compare with the ratings of students' population. It would be worth carrying out a new study, which would take into

account these limitations. Despite these, and maybe more weaknesses, this study can be an interesting argument in a discussion concerning the thesis that teachers' acquaintance with ICT (and thus their ratings of ICT) are built as early as during their studies, and that they are based on a rational fear of having to adapt to a new technological environment in their educational setting.

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