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ADOPTION OF ICT INNOVATIONS BY SECONDARY SCHOOL TEACHERS AND PRE-SERVICE TEACHERS WITHIN CHEMISTRY EDUCATION

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Abstract. *This research is focused on secondary school chemistry teachers' (N=276) and chemistry pre-service teachers' (N=159) attitudes towards the use of information and communication technology (ICT) in education. A questionnaire constructed upon Rogers' theory of diffusion of innovation was used. Based on the answers, the respondents were grouped according to their innovativeness – into types of innovation adopters. Analysis of the participants' responses to the statements in the questionnaire suggests that neither gender nor their teaching experience influence their innovativeness. The respondents mostly tend to hold a pragmatic view, accept the role of ICT in education. However, they need proof to decide whether to adopt it in their teaching practice. As the respondents could leave their contact information, it is possible to further focus on particular groups of innovation adopters, to observe their lessons, analyse their approach and mainly influence and support those groups, which maintain a "role model" position and trigger diffusion of innovations.*

Keywords: *chemistry education, ICT, diffusion of innovations, teachers' attitudes, pre-service teachers' attitudes.*

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Introduction

With the huge boom in information and communication technology (ICT) in the last two decades, the question of its use in education arose. Hand in hand with this trend, research data about its impact are needed. The effectiveness of ICT use in education as well as teachers and students' beliefs are the most discussed fields which naturally applies for science education too.

The Czech chemistry educator community lacks information about the use of ICT in chemistry classes (a similar situation is addressed e.g. by Pietzner (2014)). There are several fields such as technology which could be utilized in chemistry education (Chroustová, Machková & Hanzalová, 2016; Stárková & Rusek, 2014), technology-enhanced experiments (Kamtoom & Srisawasdl, 2014; Král & Řezníčková, 2013; Machková & Bílek, 2013, 2014; Šorgo & Kocijančič, 2012) or implementing ICT in teaching/learning methods covered (Iancu et al., 2012; Pietzner, 2014; Stárková & Rusek, 2015b). Nevertheless, the current state of ICT use remains unclear. For this reason, more attention needs to be given to teachers' (Vivian, Falkner, & Falkner, 2014), but also pre-service teachers' beliefs (Özsevgeç, 2011).

In their study, Yeh, Lin, Hsu, Wu, and Hwang (2015) distinguished three groups of teachers according to their proficiency level using ICT according to the Technological and Pedagogical Content Knowledge (TPCK) model (Mishra & Koehler, 2006). The groups were: technology-infusive (TI), technology transitional (TR), and planning and design (PD). When asked about the possible uses of technology in education, the TI teachers were more student-centred, whereas the TR teachers were more teacher-centred. The PD teachers were proficient in planning and designing but expressed lower evenness in their answers than TI and TR. These groups of teachers can be compared to a simplified pentad of innovation adopters – Rogers (2003, p. 282-285) describes five groups of innovation adopters: innovators (comparable with PD-teachers), early adopters, early majority, late majority, laggards (comparable with TI-teachers). Compared to Yeh et al. (2015), Rogers' description (despite its universality) offers a more detailed description of a teacher's attitudes and behaviour. Innovative teachers (mostly innovators and early

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adopters) bring the advantage of enhanced impact on the entire teacher population once larger cooperation is established. Naturally, the impact of such teachers is minor when not supported. Lamanauskas and Vilkonis (2007), in their paper, stress the lack of experts among teachers who would recommend and/or show their colleagues suitable software. With reference to Perceptual Computer Theory (PCT) put forward by Powers (1973), Zhao and Cziko (2001, p. 27) argue that teachers who consider ICT to be a tool for their higher-level goal attainment without affecting their other higher-level goals, will change their ICT usage in practice more easily. However, they add an important aspect – the teacher must believe that he or she has or will have the resources as well as the ability to use technology (cp. Du Plessis, 2016). Naturally, this is much easier, when these teachers have an example in their innovative colleague or have been educated (trained) in an ICT-rich environment.

As far as gender is concerned, there is a considerable amount of research evidence. Some researchers did not prove a significant difference (Harris, Jankins & Glasser, 2006; Zounek & Sebera, 2005) between females' and males' attitude towards ICT. In others, the following differences were found:

Female

- Tend to be less interested in computers, to have less positive views about the value of computing, and to report more computer anxiety and less confidence in their computer abilities (Volman & van Eck, 2001).
- Choose security to compensation over tournament, when there is a vision of a positive result they tend to participate more (Dohmen & Falk, 2011; Dohmen, Falk, Huffman, Sunde, Schupp, & Wagner, 2011).

Male

- Perceive using ICT as easier (Teo, 2014).
- Boys start using computers earlier than girls (Vekiri & Chronaki, 2008), therefore their self-efficacy in the use of ICT is expected to be higher hence they are presumed to be more innovative than women.

Females are often behind in ICT use and ICT knowledge and skills. (Meelissen & Drent, 2008).

Despite ICT development, it is supposed that certain differences in terms of using ICT in the educational process in separate regions of Europe exist (Lamanauskas & Vilkonis, 2007, p. 2). Local studies are therefore needed.

Diffusion of Innovations

In this research, Rogers' theory of diffusion of innovations was used despite the fact it was not originally designed for educational purposes. For its versatility, however, it has found its use in education, too (e.g. Bennett & Bennett, 2003; Ogrezeanu & Ogrezeanu, 2014; Sahin, 2006; Seymour, 2002). In his work, Rogers (2003) deals with the term *opinion leaders*. It "is the degree to which an individual is able to influence other individuals' attitudes or overt behaviour informally in a desired way with relative frequency" (Rogers, 2003, p. 27). It is earned by an individual's technical competence and social accessibility, and also by conforming to the system's norms (Rogers, 2003). If we think of the teacher community on a school, regional, state or international level (enhanced by technology and social/professional networks), the theory enables a method of introducing innovation with more success than if it was ordered by the school management or even ministry of education (curriculum). The theory is directly applied to teachers in this text.

Rogers (2003, p. 26-28) further discusses both innovative opinion leaders and leaders who oppose change. Some leading the promotion of new ideas and others leading active opposition. Therefore, they hold a unique and influential position in the school environment structure and are at the centre of interpersonal communication networks.

With this respect, the term *change agent* is also introduced.

Although Rogers (2003) uses the term innovation as a synonym to technology, it may be understood on a more general level too. The theory of the leaders is further elaborated into five categories of innovation adopters: innovators, early adopters, early majority, late majority and laggards. *Innovators* (venturesome), share their enthusiasm with people of the same focus. Their domain is communication. They are not afraid of risks associated with adopting innovations. They like to try new things and are not afraid of failure. They are usually not accepted

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by their environment, nonetheless their value in the system is in launching new ideas in the social system. E*arly adopters* (respectable) are more integrated in their environment. They have the greatest degree of opinion leadership. Potential innovation adopters look to early adopters for information. The role of early adopters is in decreasing uncertainty of the others about new ideas and adopt it. *Early majority* (deliberate) adopt innovations just before the average members of the system. They are seldom leaders and deliberate before using innovation. Their position is unique as they bridge the innovative members and members who are relatively late to adopt innovations in the diffusion process. *Late majority* (sceptical) includes members who adopt innovations just after the average members of society, usually out of necessity such as the pressure of the environment. They are sceptical and cautious. Adopting an innovation needs to be favoured by the system norms and needs to be pressed by their peers. Almost all their uncertainty must be removed before they feel safe to adopt. *Laggards* (traditional or conservative) possess almost no opinion leadership. Their point of reference is the past. When they adopt an innovation, it may already be out-of-date. They must be sure the adoption will not fail before they adopt (Rogers, 2003, p. 282-285).

Problem of Research

This text represents the initial step in the above mentioned complex study. The first step represents quantitative research. Chemistry teachers will be divided into the above-mentioned Rogers' categories of innovation adopters. After that, trends within these categories will be evaluated.

As discussed by Du Plessis (2016, p. 2), referring to Albion & Ertmer's text cited by Prestridge (2012), teachers' beliefs and their ICT implementation mismatch. For this reason, the second step representing qualitative research could follow. The teachers from particular groups will be interviewed, their enlistment into a Rogers' category confirmed and their lessons observed with a focus on the use of ICT. The clarified chemistry teacher network created in this way could be gradually completed in the future. The innovative teachers' role in diffusion of experience with ICT in education among others (cp. Lamanauskas & Vilkonis, 2007; Rogers, 2003) could be supported by teacher trainers. Piloting and subsequent distribution of materials for ICT-in-education support created by academics could also be directly targeted to the identified teachers who have influence on their colleagues.

With the length of any interference in education in mind, the research also covers pre-service teachers, as their role is crucial for the sustainability of such an endeavour (cp. Özsevgeç, 2011). In this respect, attempts to assess pre-service teachers as innovation adopters in the Czech Republic were made on pre-service teachers in general (Černochová, Siňor & Kankaanrinta, 2001) and later on prospective secondary school teachers (Zounek & Sebera, 2005). Further, the same procedure was used to assess chemistry pre-service teachers (Stárková & Rusek, 2015a).

The following research questions were set:

1) What attitudes do secondary chemistry teachers and chemistry pre-service teachers assume towards ICT in their (future) conception of education.
2) What is the distribution of secondary chemistry teachers and chemistry pre-service teachers according to their innovativeness like?

Methodology of Research

General Background

The aim of the research is to find out what attitudes secondary school chemistry teachers and chemistry pre-service teachers assume towards ICT in chemistry education. Further, to what extent are categories of innovation adopters represented in the sample (cp. Zounek & Sebera, 2005).

In order to achieve this, a quantitative approach was chosen. The research represents a correlational analysis based on a questionnaire. The scope of the research was to describe Czech chemistry teachers' and pre-service teachers' attitudes towards the use of ICT in education. The research took place between March and April 2015.

The teachers' and pre-service teachers' distribution, in particular Rogers' categories, was observed. Innovativeness is regarded with each respondents' attitude towards innovation in their own chemistry-education practice. Based on the literature, the authors of this research assume the expressed teachers' attitudes not only influence the way these teachers and student teachers think about ICT in education, but affect the way they use/are intending to use ICT in their (future) practice.

ISSN 1648–3898 /Print/
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Research Sample

The research sample consists of in-service as well as pre-service chemistry teachers. With the scope of the research in mind, only secondary schools where chemistry is taught in more depth were selected as it is possible to expect ICT could be an important tool for abstract phenomena visualization. Since the curriculum reform in 2009, the nature of chemistry education has changed in the Czech Republic. The majority of secondary school programmes (ISCED 3) contain chemistry only within general education disciplines (see e.g. Rusek, 2014). These programmes were excluded from the sample. Therefore only grammar schools and science (chemistry)-oriented vocational school teachers were addressed. As far as chemistry pre-service teachers were concerned, all departments educating prospective chemistry teachers from all universities in the Czech Republic were addressed.

Several responses were excluded based on an insufficient number of responses. In order to calculate respondents' results, at least three out of five items in a given cluster had to be filled in. The questionnaire was sufficiently completed by 432 respondents, more details are shown in Table 1.

Table 1. Information about respondents.

In-service teachers		Pre-service teachers	
Female	Male	Female	Male
193	78	126	32
Grammar school	Vocational school	Bachelor	Master
163	110	82	77
∑ 273		∑ 159	

Research Tool

Attitudes are a widely observed phenomenon in education research. The research tool usually contains statements the respondents express their position (attitude) to. A questionnaire created by Kankaanrinta (2000), translated and piloted by Černochová et al. (2001) and further used by Zounek and Sebera (2005) was adopted in this research. These authors focused on the respondents' attitudes towards ICT use in education in general. For the purposes of this research, it was clearly stated in the introductory information for the respondents that only ICT in chemistry education was concerned.

The questionnaire consists of two parts. The first contains demographic items (gender, type of studies/type of school, years of teaching practice etc.). The second part consists of 25 statements divided into 5 batteries (clusters). Every cluster (pentad) is instrumental in one of the Rogers' (2003) innovation adopter categories. The respondents expressed their opinion on each statement on a 6-point scale (*Agree*, *Rather agree*, *Do not have a pronounced opinion*, *Rather disagree*, *Disagree* and *I do not know*).

A respondent's enlistment into a particular category was made based on their responses to the corresponding cluster of statements. Each respondent's enlistment into each of the categories was determined by the mean value of their answers. In order to do so, a limit value of 0.8 (the value used by Zounek and Sebera (2005)) was used. The questionnaire was distributed to teachers via e-mail. From the database available at www.skoly-online.cz/databaze-skol/ of secondary schools in the Czech Republic, the above mentioned were selected. An e-mail message with both an online form as well as attached MS Word version of the questionnaire was sent out to all the official contact addresses at 629 secondary schools. It is not possible to calculate the response rate because several emails returned due to an invalid e-mail address, several returned as unread, several were simply not answered. It is possible to argue this approach to questionnaire distribution favours the teachers with a more positive attitude towards ICT.

In the case of pre-service teachers, an e-mail message, again with both versions of the questionnaire, was sent out to teacher educators in respective departments (seven faculties of six universities in the Czech Republic). They were asked to distribute it among students. Some of them submitted the questionnaire to their students in paper in university lessons, some of them forwarded the e-mail with the online version.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Data Analysis

Reliability and significance

In order to determine the reliability of the questionnaire scales and subscales, standard methods used in pedagogical research were utilized. Cronbach *α* (Cronbach & Meehl, 1955; McGartland Rubio & Kimberly, 2005) was calculated for the 5-point Likert scales (Likert, 1932). The reliability of the entire test is $\alpha = .80$, which allows the reliability to be considered sufficient. Sekaran (1992) set the minimum acceptable reliability coefficient level at .60. As a general rule of thumb (Shoukri & Edge, 1996), a reliability coefficient (r) is considered excellent if r is larger than .75, good - if *r* is between .40 and .75, and poor if *r* is less than .40. An α value between .7 and .95 is considered sufficient according to Tavakol and Dennick (2011).

The authors find utilizing the same significance level (typically $\alpha = .05$ or $\alpha = .01$) without respect to the nature of a problem doubtful. That is why a 10% significance level will also be taken into account.

The scale and statistical interpretation

The statements on the scale were assigned the following values: 2, 1, 0, –1, –2 and N – the last item was recoded with a blank cell. Likert scales are usually considered ordinal. Nevertheless, some types of scales can be also considered interval – under the condition that the distance between two of them is the same (see Chytrý & Kroufek, in press). Based on a paper by Carifia & Perla (2007), it is not suited to analyse particular items but whole scales/subscales. The scale used in this study is considered interval (e.g. Maurer & Pierce, 1998; Vickers, 1999). Heeren & D'Agostino (1987), Meek et al. (2007) and Rasch et al. (2007) describe that parametric tests provide the same results as non-parametric tests in cases of smaller groups. When performing the tests, the authors worked on the presumption that either Mann-Whitney, or Kruskal-Wallis ANOVA can be used when a scale is at least ordinal.

The statistics used

Except for common statistics, both statistical significance and substantive significance were calculated for the test (the authors are aware of the statistical constraints regarding the use of effect size for non-parametric data). "Statistical significance examines whether a research result was reached by accident or by variability of the selective data. Material significance deals with the application of the result in the real world." (Kirk, 1996, p. 746). Based on statistical significance, the results were generalized according to the p-level. In the case of material significance, the influence of the observed effect was detected (effect size – further only ES). The two-step model by Robinson and Levin (1997) will be used: first statistical significance is evaluated, if confirmed (statistically significant result), material significance will be evaluated in the second step. Small sample sizes, normality tests have little power to reject the null hypothesis. Almost all normality test methods perform poorly for small sample sizes (less than or equal to 30-40). Since the statistics were only calculated for smaller groups in this research (except for the Innovators and Early majority groups), the particular samples were analysed using both non-parametric and parametric tests (see Heeren & D'Agostino, 1987; Meek, Ceyhun, Dunning, 2007; Rasch, Teuscher, Guiard, 2007). By doing so it was proved that both approaches lead towards the same conclusions.

Respondent grouping

Respondents who scored .8 and higher in a particular cluster were entered in the Belonging group, respondents who scored -0.8 and lower were entered in the Extrinsic group. Some respondents were enlisted in more than one category that is why the sum of enlisted respondents does not equal the total sum of received questionnaires (432).

Results of the Research

First, responses to all the statements were compared. The statements the respondents agreed with the most are from the third category (identifying the early majority), the least agreed with statements are from the fifth (identifying laggards). The most and least agreed upon statements are listed in Table 2.

Table 2. The four most and least agreed upon statements about chemistry education.

		Statement	M	Mdn	SD
The most positive	4C	*Before I start using an application, I want to know if it is useful.*	1.30	1	.81
	3D	*I consider carefully which ICT applications I will use.*	1.06	1	.89
	3A	*I hope I will be able to use the most useful and the most proved applications.*	94	1	.91
	3E	*I prefer successive to revolutionary development of ICT use in education.*	.87	1	.90
The most negative	4D	*I will use the ICT applications only when the pressure of my colleagues is strong enough.*	-1.35	-2	.90
	5A	*I will use ICT applications only when I am forced.*	-1.43	-2	.89
	5D	*I will be among the last who decide to use ICT.*	-1.56	-2	.84
	5C	*I wish I never had to use ICT applications.*	-1.58	-2	.82

First, the responses to all the statements were compared. The statements the respondents agreed with the most were from the third category (identifying the early majority), the least agreed with statements were from the fifth (identifying laggards). The most and least agreed upon statements are listed in Table 2.

It is obvious that the respondents tend to keep a pragmatic attitude towards ICT in their responses. They preferred statements containing the words *useful* or *careful*. On the other hand, based on the least agreed with statements, they seem to accept ICT as a part of contemporary life and the majority do not express negative attitudes.

Second, the respondents' agreement with statements which identify a particular innovation adopter type was analysed.

The overall number of respondents belonging and extrinsic to Rogers' categories are listed in Table 3.

Table 3. Numbers of respondents belonging or extrinsic to Rogers' (2003) categories of innovation adopters.

Category	Innovators		Early adopters		Early majority		Late majority		Laggards	
	N	%	N	%	N	%	N	%	N	%
Belonging	98	23	36	8	234	54	38	9	13	3
Extrinsic	99	23	94	22	12	3	111	16	343	79

Two basic factors (respondent type and gender) were tracked. Figure 1 shows the overall distribution of innovation adopters according to the respondent type (G. – grammar school teacher, Voc. – vocational school teacher, Stud. – pre-service teachers).

The largest group is the Early majority. The second largest for all three respondent types are Innovators. The group of Laggards is the smallest in this research.

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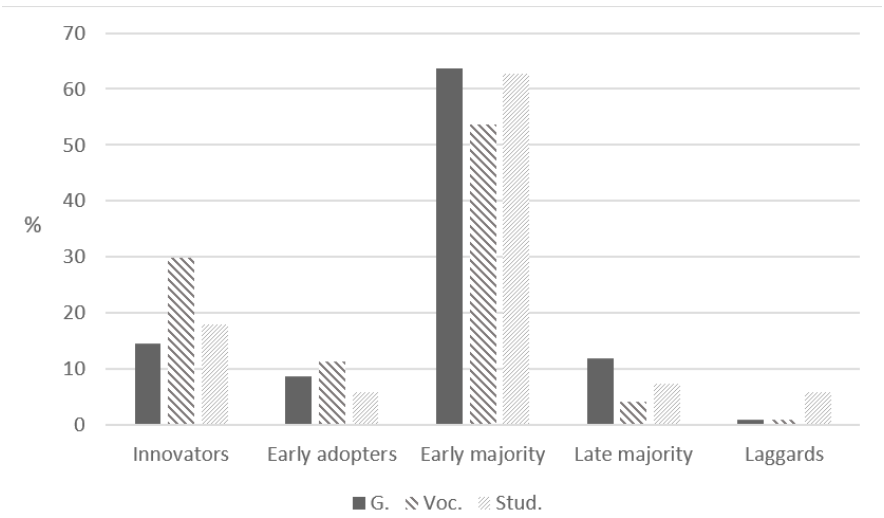

Figure 1: Teachers' and pre-service teachers' distribution in Rogers' categories.

Figure 2 shows the overall distribution per gender. Particular differences will be described in depth below. Both the research questions are answered in more detail for the five groups of innovation adopters.

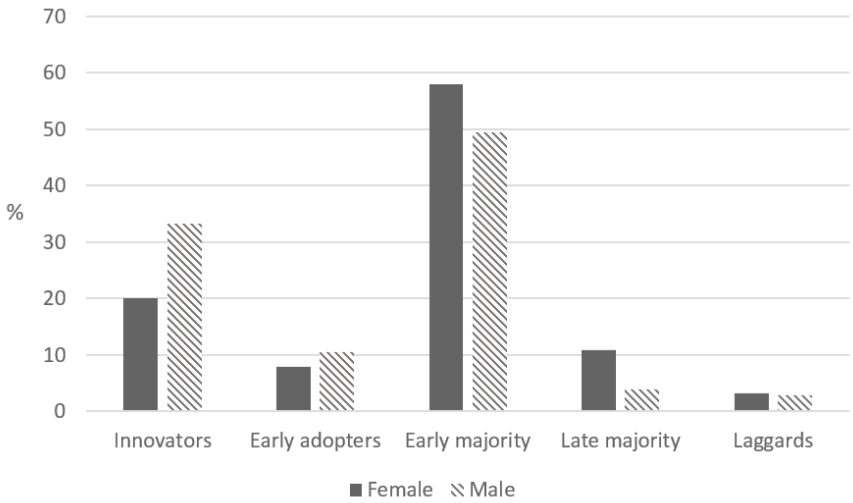

Figure 2: Female and male distribution in categories

Innovators

The respondent sample (N = 98) consists of 64% (63) females and 36% (35) males; 43% (42) grammar school teachers, 29% (29) vocational school teachers and 28% (27) pre-service teachers. The overall response values are shown in Table 4.

ISSN 1648–3898 /Print/
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Table 4. Summary of responses in the first cluster – Innovators.

Item	1A	1B	IC	1D	1E	Mean
Mean	1.29	1.16	0.90	1.57	1.20	1.23
Median	1.00	1.00	1.00	2.00	1.00	1.00
Mode	2.00	1.00	1.00	2.00	1.00	1.00
SD	.87	.66	.88	.52	.79	.40

Based on the p-value of either of the tests used for both identifiers (gender and type of respondent), the zero hypotheses of similar attitudes towards the statements in the first cluster among teachers (grammar and vocational school) and pre-service teachers could not be rejected ($p_g = .3$, $p_t = .6$, p_g - p-value of the test for gender difference, p_t - p-value of the test for respondent type).

When examining each of the items individually, the values of the non-parametric test allow the rejection of the zero hypothesis only in case of the statement 1E - *I dare to risk in testing (so far untried) ICT applications.* - ($p_g = .07$) on the 10% significance level. Male respondents tend to rate the statement more positively than female respondents (median 2 vs. median 1). Nevertheless the effect size ($r = .171$) suggests a small effect (cp. Cohen, 1992).

Early Adopters

The sample (N=36) is the closest to the innovation adopters distribution proposed by Rogers (2003, p. 281). It consists of 69% (25) females and 31% (11) males; 25% (9) grammar school teachers, 39% (14) vocational school teachers and 36% (13) pre-service teachers. The overall response values are shown in Table 5.

Table 5. Summary of responses in the second cluster – Early adopters.

Item	2A	2B	2C	2D	2E	Mean
Mean	1.89	1.31	.55	.91	1.28	1.38
Median	2.00	1.00	1.00	1.00	1.00	1.00
Mode	2.00	1.00	1.00	1.00	1.00	1.00
SD	.78	.47	1.20	.69	.66	.61

The values of both tests for the difference between the respondent groups Kruskal-Wallis ($p_t = .41$), ANOVA ($p_t = .15$) do not allow the zero hypothesis to be rejected. There is no statistically significant difference between pre-service and in-service teachers' answers in this category.

As far as gender is concerned, both the p-value of the Mann-Whitney test ($p_g = .08$) and the p-value of the t-test for independent groups ($p_g = .016$) allow the hypothesis about the equality of median values of male and female respondents' answers on the 10% significance level to be rejected. The result suggests male respondents express a stronger positive opinion on the statements in the second cluster. The difference has a medium effect based on the effect size ($r = .371$).

When examining each of the items individually for male and female respondents' answers, the values of parametric as well as the non-parametric tests allow the zero hypothesis for the statements 2D and 2E to be rejected. In case both the parametric and non-parametric tests suggest a statistically-significant difference, the p-value of non-parametric test is ordered before the p-value of the parametric test. In case of 2D – *I am considered an authority at our school.* – ($p_g = .04$ resp. .035) male respondents tend to answer more positively than female respondents on the 10% significance level. The effect size ($r = .391$) suggests a medium effect. In case of the statement 2E – *My colleagues respect my opinions in the field of education* – the p-value of the test ($p_g = .09$ resp. .08) allows us to reject the hypothesis about equal means given to the statement by male and female respondents on the 10% significance level. Male respondents answer more positively. The effect size in this case is medium ($r = .335$).

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Early Majority

This group is the most numerous from the sample (N = 234). It consists of 78% (182) females and 22% (52) males; 40% (94) grammar school teachers, 28% (66) vocational school teachers and 32% (74) pre-service teachers. The overall response values are shown in Table 6.

Table 6. Summary of responses in the third cluster – Early majority.

Item	3A	3B	3C	3D	3E	Mean
Mean	1.31	1.04	.98	1.38	1.14	1.17
Median	1.00	1.00	1.00	1.00	1.00	1.00
Mode	1.00	1.00	1.00	1.00	1.00	1.00
SD	.63	.81	1.03	.63	.76	.33

Neither of the tests' p-values (parametric and non-parametric) used for both identifiers ($p_{g\ param.}$ = .50, $p_{g\ non\text{-}param}$ .64, $p_{t\ param.}$ = .1593, $p_{t\ non\text{-}param.}$ = .22) allow us to reject the hypotheses about the equal medians or means on either 5% or 10% significance level. The respondents' attitudes towards the statements in the third cluster among teachers (grammar and vocational school) and pre-service teachers are similar.

When examining each of the items individually for male and female respondents' answers, the values of both of the tests allow us to reject the zero hypothesis about the equal answers to the statement 3B – *When I am encouraged to use ICT, I use them.* – ($p_{g\ param.}$ = .03, $p_{g\ non\text{-}param.}$ .02). In this statement, female respondents tend to answer more positively than male respondents at a 5% significance level. The effect size (r = .171) suggests only a small effect.

Late Majority

This group consists of 38 respondents, 89% (34) females and 11% (4) males; 29% (11) grammar school teachers, 21% (8) vocational school teachers and 50% (19) pre-service teachers. The overall response values are shown in Table 7.

Table 7. Summary of responses in the fourth cluster – Late majority.

Item	4A	4B	4C	4D	4E	Mean
Mean	1.26	0.67	1.74	.23	1.16	1.03
Median	1.00	1.00	2.00	.00	1.00	1.00
Mode	1.00	1.00	2.00	1.00	1.00	.80
SD	.83	1.01	.45	1.09	.65	.27

Neither of the p-values of the tests used for gender identification ($p_{g\ param.\ test}$ = .63, $p_{g\ non\text{-}param.\ test}$ = .61) allow us to reject the hypotheses about the equal medians or means at either a 5% or 10% significance level. The overall respondents' attitudes towards the statements in the fourth cluster between are equal.

When examining each of the five items individually for male and female respondents' answers, the values of both the tests allow the zero hypothesis about the equal answers to the statement 4B to be rejected – *When all the others start using ICT applications, I will follow.* - ($p_{g\ param.}$ = .051, $p_{g\ non\text{-}param.}$ = .053). This statement was slightly rejected by the male respondents, whereas the female respondents tend to answer more positively. At a 10% significance level the difference is significant. The effect size (r = .471) suggests a medium effect.

On the contrary to gender identification, the p-value of both the tests used for respondent type identification ($p_{t\ param.}$ = .008, $p_{t\ non\text{-}param.}$ = .036) allows us to reject the hypotheses about the equal medians or means at a 5% significance level. A statistically significant difference was found between the answers of grammar school teachers and pre-service teachers. The effect size (r = .583) suggests a large effect – the largest from the calculated values.

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The pre-service teachers answered the statements more positively than the grammar school teachers who scored only slightly (.05) above the group margin. From this result it is possible to conclude that grammar school teachers do not tend to be part of the late majority group as strongly as the pre-service teachers.

Laggards

As mentioned above, the questionnaire distribution and/or the topic of the research itself may not have favoured conservative respondents. The group of laggards consists of only 13 respondents 10 female and 3 male; 3 grammar school. 1 vocational school and 9 pre-service teachers. For such a small group it is unreasonable to run any statistical tests. The overall response values are shown in Table 8.

Table 8. Summary of responses in the fifth cluster – Laggards.

Item	5A	5B	5C	5D	5E	Mean
Mean	.85	1.38	0.92	1.00	1.31	1.09
Median	1.00	2.00	1.00	1.00	1.00	1.00
Mode	1.00	2.00	1.00	1.00	1.00	1.00
SD	1.21	.77	.76	.71	.48	.21

This group, however, is characterized by the highest portion of respondents who do not belong to this group. The statements concerning compulsion, expression of ICT uselessness etc. were rejected by the respondents.

Discussion

The respondents assume positive attitudes towards ICT and the possibilities of their use in chemistry education. They prefer succession and examples of good practice in implementing ICT in education. A positive finding is in their acceptance of ICT as an integral part of education (cp. Teo, 2011; Venkatesh, Morris, Davis & Davis, 2003) – they do not need to be forced to use ICT in their practice. These conclusions are derived from the most agreed-on statements in the third category and the least agreed on statements in the fifth category. Naturally, in case of the chemistry pre-service teachers the example of good practice is usually a mixture of the teaching style their secondary school teachers applied (a memory which may not be accurate) and ideas presented to them at university.

With a little bit of exaggeration it is possible to state that pre-service teachers tend to hold a slightly more sceptical or conservative opinion compared to in-service teachers. Preliminary expectations about the younger generation – students – having a more positive attitude towards ICT (cp. Hakkarainen et al., 2001) was not proved. On the contrary, they hold a rather pragmatic view with a tendency to scepticism, which differs from findings by Zounek & Sebera (2005) or Teo (2008, 2014). Compared to grammar school teachers, the pre-service teachers statistically significantly belong more closely to the group of Late majority, which only stresses their sceptical attitude towards the use ICT in education. Teo's (2014) findings offer a possible explanation: "… participants perceived themselves to be in control of computers to a lesser degree than they thought the computer was useful and had liked and intend to use the computer." (Teo, 2008, p. 416). This could be considered an example of the environment they studied in at secondary and university level. It is therefore possible to argue that promoting ICT in pre-service teacher training needs to be supported.

The expected more positive attitude of male respondents was not proved in this research (cp. Meelissen & Drent, 2008; Teo, 2008, 2014; Vekiri & Chronaki, 2008). From this point of view the sample seems more homogenous. Only results in the early adopter category (second cluster) of this research are in accordance with the results by Teo (2014) and Veikiri & Chronaki (2008). The share of male respondents in the group is significantly bigger than the share of female. The men's tendency to lead and show their skills can be seen in their more positive attitude towards statements about their position among peers. They feel significantly more like authorities and feel more respected by their peers than the female respondents (see Dohmen & Falk, 2011; Dohmen et al., 2011). Women, on the contrary, perceive that they can be persuaded to use ICT by their colleagues significantly more easily than men and are more likely adopt ICT when everyone is using it.

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To enhance ICT use in chemistry education, offering (prospective) teachers more examples of effective ICT use in education seems vital. Also, teacher trainers could start their effort in diffusion of ICT by focusing on supporting early adopters as a group who accepts innovations willingly but critically, and which then acts like a natural disseminator of this innovation. This process seems to be more effective than either global "top-down" changes or attempts aimed at "anonymous" groups of teachers. The results can also be used by teacher trainers to encourage pre-service teachers to use ICT in their future professional life. Finally, researchers could use the findings to further investigate the process of diffusion of the use of ICT in education. They could also track adoption types and describe the effectiveness of their use of ICT in more depth.

The results could also inform policy makers who manage the rate and the extent of ICT adoption in education (cp. Teo, 2014, p. 134).

Strong Points and Limitations of the Research

Adapting the research instrument also used by other researchers ensures the possibility of higher instrument reliability, which was also confirmed by the acceptable value of Cronbach's alpha. The uniqueness of this research for the Czech Republic comes from the complexity of the research sample, where the results from random chemistry teachers can be compared to the results of most chemistry pre-service teachers. Methodologically, by using more in-depth data analysis to ensure measurement invariance, this research offers a broader view of factors influencing the problematics compared to previous similar ones.

The results of this research are affected by several limitations. Although Rogers' theory is well accepted and the amount of research in various fields which build upon it is large, there is also criticism of this theory for its lower complexity (Lyytinen, 2001). An innovatively thinking person may not act as described by Rogers in their environment for other reasons not included in the questionnaire. As far as the sample structure is concerned, the shift to the left – the larger number of innovative respondents – the method of the questionnaire's dissemination needs to be considered. It may have affected the sample structure since the portion of conservative respondents (cp. 16%, see Rogers, 2003, p. 281) probably did not take part in the survey because they simply did not complete the questionnaires, whereas the research sample of pre-service teachers represents almost the entire population.

Conclusions

Examining technology use and acceptance is one of the frequent research topics internationally. The findings of this research broaden the present knowledge of a description of chemistry in-service and pre-service teachers' attitudes towards the use of ICT in the educational process. In the field of chemistry, there has been no previous research of this matter carried out in the Czech Republic focused on teachers or pre-service teachers.

The research results revealed that the respondents hold rather positive attitudes towards the use of ICT in chemistry education. Innovators represent 23% of the respondents, which is considerably more than expected based on Rogers' theory. The most agreed-on statements in the questionnaire express the respondents' acceptance of ICT and their willingness to use it when a positive effect is proved. Promoting ICT in this field could therefore be enhanced by providing teachers with evidence - examples of good practice. Only 3% of respondents are laggards - the most traditional, conservative group. This offers an optimistic platform for future (in-service) teacher training endeavours.

As far as gender is concerned, statistically significant differences between females' and males' responses were found in four statements concerning willingness to risk or try new technologies. Men seem to be more courageous and independent, willing to set an example to their colleagues, whereas women prefer following others and favour being encouraged to use ICT.

Surprisingly, pre-service teachers expressed their conservative attitude towards correspondent statements significantly more compared to in-service teachers. These students admitted their concern for the hazards associated with the use of ICT in education. They are also more likely to use ICT only after being compelled to. Their mostly careful approach towards the use of ICT in education enables the question of pre-service teacher training with respect to technological and pedagogical content knowledge (TPACK) to be reconsidered.

This research represents the first phase of a process of finding the ways and the extent that ICT is used in chemistry education. Initially, teachers who hold a conservative or progressive opinion on ICT in education - i.e. express positive or negative attitudes towards ICT - were identified. Further, interviews with selected respondents

will be made to match their answers in the questionnaire to their more general views about ICT in chemistry education. This will further clarify inaccuracies caused by the use of self-reported scales. In the following phase, these teachers' lessons could be observed in order to identify patterns in their use of ICT.

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