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Differences and Developments in Attitudes and Self-Efficacy of Prospective Chemistry Teachers Concerning the Use of ICT in Education

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ABSTRACT

ICT belongs to modern life and is playing a growing role in education. For effective implementation of ICT in the classroom, teachers need to develop both positive attitudes and self-efficacy towards using these tools in educational settings. However, information measuring how positive such attitudes towards and how developed teachers' self-efficacy on the use of ICT in education are remains scarce. This study examines the development of prospective chemistry teachers' ICT-related attitudes and their corresponding self-efficacy. It focuses on secondary level chemistry pre-service teachers' attitudes and self-efficacy concerning the use of ICT in education in general, and in chemistry teaching in particular. Data was collected from pre-service teachers (n = 239) at different stages of their teacher education programs. The study describes the progression of domain-specific self-efficacy. It also investigates gender differences and highlights the influence of seminars on the use of ICT in science education.

Keywords: teacher education, chemistry education, ICT, attitudes, self-efficacy

INTRODUCTION

Research has shown that teachers are the key factor for the success of any attempted educational innovation (Anderson & Helms, 2001; Hattie, 2009). Effective educational reform will only occur when teachers' attitudes, beliefs, *a priori* knowledge, and pedagogical content knowledge are taken into account seriously in general (Avargil, Herscovitz, Dori, 2012; Chen, & Wei, 2015; Haney, Czerniak & Lumpe, 1996; Shulman, 1986; Veen, 1993), and concerning ICT in particular (Arnold, Padilla, & Tunhikorn, 2009; Pelgrum, 2001). Therefore, exploring teachers' attitudes, personal beliefs and knowledge is a necessary first step, if any attempt to change teaching practices will be made (Van Driel, Bulte & Verloop, 2007). These claims concern both changes in the curriculum and in pedagogical innovations like the use of digital media in class.

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State of the literature

- ICT permeates all domains of modern life among them education. Good preparation of teachers is essential to dig out the upmost potential of the use of ICT in education.
- Teachers are the key for any success of educational innovation. Their attitudes and self-efficacy are essential pre-requisites for any successful practice in the classroom in general and concerning the use of ICT in particular.
- Not much is known about the development of teachers' attitudes and self-efficacy concerning the use of ICT in chemistry education.

Contribution of this paper to the literature

- The study describes the development of domain-specific attitudes and self-efficacy beliefs of prospective secondary chemistry teachers during their pre-service teacher education.
- The study describes gender-specific parallels and differences concerning domain-specific attitudes and self-efficacy of prospective secondary chemistry teachers.
- The study describes the effect of general and domain-specific educational seminars on the use of ICT in education and in chemistry education on the development of domain-specific attitudes and self-efficacy beliefs of prospective secondary chemistry teachers.

Today, we face a world of continuous innovations in technology. With the development of technology changing both people's lives and people's relations within societies, education is also undergoing innovations and necessary reforms. Different countries, based on their different political and social backgrounds, follow different paradigms in educational innovations and reforms concerning information and communication technologies (ICT) in general and in chemical education in particular (Chiu & Linn, 2012; Dori & Kaberman, 2012; Falvo, 2008; Hoffman, Wu, Krajcik, & Soloway, 2003). Modern ICT permeates our whole lives, thereby becoming increasingly important in any kind of education (Hennessy, Ruthven, & Brindley, 2005; Rodrigues, 2010). Many studies have already indicated the potential which modern ICT has for teaching and learning in the sciences and beyond (Falvo, 2008; Dori, Rodrigues & Schanze, 2013). Aside from opportunities for better visualization, simulation, and modelling of content, or support for laboratory instruction in science education (e.g. Barnea & Dori, 2000; Burewicz & Miranowicz, 2006; Taskera & Dalton, 2006; Avramiotis & Tsaparlis, 2013) digital media has also proved itself valuable for promoting forms of self-directed and cooperative learning (Bingimlas, 2009; Krause, Kienast, Witteck & Eilks, 2013). If ICT is used to foster more autonomy in learning, it also shows definite potential for raising students' levels of motivation (Rodrigues, 2010). It is well documented that ICT may foster lifelong learning, enhances active learning, critical thinking, and self-regulated education. These skills are important for future citizens who will need such skills to function as intelligent decision makers in the 21st century (Cox & Marshall, 2007; Groff, 2013; Partnership for 21st Century Skill, 2013; Ruismäki, Salomaa, & Ruokonen, 2015). The advantages and benefits described above of ICT are attributed to the way that the environment is implemented during instruction, rather than its presence in the classroom (Kim & Reeves, 2007).

Some studies have suggested that teachers more often use ICT for administrative purposes and lesson preparation, than for teaching purposes in class. In science classes the use of computers and other digital devices is still quite limited in both its frequency and in the amount of pedagogical variety shown (Cuban, 2001; Fraillon, Ainley, Schulz, Friedman & Gebhardt, 2014). To change this situation in chemistry education investments in research on and for teacher education are needed (Gilbert, Justi, Van Driel, De Jong &, Treagust, 2004). In order to restructure teacher education, it is necessary to understand the underlying reasons to base any proposed changes solidly upon (Van Driel et al., 2007). In respond to this demand the current study focuses examining German secondary level chemistry pre-service teachers' attitudes towards and self-efficacy on the use of modern ICT in education in general and on secondary level chemistry teaching in particular. It focuses also on any development of the pre-service teachers' attitudes and self-efficacy, on gender differences, and on the influence of ICT-focused educational seminars in pre-service education of prospective chemistry teachers.

THEORETICAL FRAMEWORK

The effective and successful integration of ICT in education depends upon a number of factors, which include aspects of the teacher's personality, like personal attitudes and beliefs about one's level of self-efficacy (Albion, 2001; Ertmer, 1999; Joo, 1999; Lim, 2007, Blonder et al., 2013). Baron and Byrne (1991) describe attitudes as general considerations of people about themselves, about other people, and about objects. According to Smith (1968) such attitudes consist of three components: cognitive, affective, and behavioral aspects. The term attitudes, however, is used very broadly and is very difficult to delineate clearly. Nevertheless, the literature shows that teacher's attitudes toward any aspect of practice in their profession influence their pattern of behavior. Positive attitudes towards any item or practice like computers and the use of digital media in class tend to open up practitioners to the various available options, thereby making the corresponding teaching practices possible. Different studies revealed that the successful integration of ICT into the classroom depends upon the attitudes of the teachers (Kersaint et al., 2003; Holden & Rada, 2011; Cavas et al., 2009).

However, positive attitudes towards computers and digital media in general do not necessarily lead to more intense usage of ICT in the classroom. A number of studies have found evidence that although many teachers express positive attitudes towards new media (Tezci, 2011), computers often remain a simple tool to them used only for preparing lessons and for carrying out administrative or management tasks (ten Brummelhuis, 2001). Many teachers acknowledge both the importance of promoting media skills as well as the integration of media education in schools for the educational success of their students. However, they often do not align their own teaching practices according to their stated beliefs (Tondeur, van Braak & Valcke, 2007; Sutherland et al., 2004). In addition, teachers' beliefs dictate decisions about which teaching practices to use in their classrooms (Woolfolk Hoy, Hoy, & Davis, 2009). These beliefs then dictate decisions related to planning the learning experiences for their students, and may influence students' learning opportunities (Rubie-Davies, Flint, & McDonald, 2012).

Teachers abstain from adopting any educational practices if they do not feel skillful enough and self-confident in doing so. Tezci (2012) found that many future teachers still have reservations against the integration of new media forms in teaching and learning processes. There still exists certain skepticism that learning activities for students in the classroom can actually be organized effectively based on new media (Jimoyiannisa & Komisb, 2007). It seems that many teachers have missed opportunities to acquire sufficiently advanced skills, levels of experience, and personal knowledge in such areas. This has affected the development of positive self-efficacy concerning the use of ICT in science classes among these practitioners (Jimoyiannisa & Komisb, 2007). Self-efficacy here means the confidence a person has in his or her abilities to solve a task successfully, or as Bandura (1994) states:

> *Perceived self-efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave (p. 71).*

Self-efficacy influences teachers' motivation, affection, and behavior (Bandura, 1986); it also influences how much effort they will invest when dealing with innovations, challenges, or problems (Bandura, 1977, 1982). Self-efficacy affects how people positively approach a task, how they implement it and whether there is chance for the task's success (Francis-Pelton & Pelton, 1996). Both attitudes and self-efficacy beliefs seem to be important for a person to decide whether or not solving a specific task like using ICT in science teaching will be positively or negatively viewed. Therefore, we can assume that both a positive attitude towards digital media and ICT, as well as a positive feeling about one's self-efficacy to use them in class are prerequisites for the successful implementation of modern ICT in teaching (Niederhauser & Perkmen, 2010).

Therefore, it is important to prepare the teachers so they can be an active agent in the implementation of reform (Pyhältö, Pietarinen, & Soini, 2012). Accepting new ideas and being an initiative teacher is highly dependent on teachers' skills and knowledge as well as on their professional efficacy and motivation to adopt and process a reform at several different levels (Bandura, 1993; 1997; Hoy, 2008). According to Dori, Tal, and Peled (2002), teachers who distance themselves from the reform and claim that limited time and not enough resources to implement ICT, their decision to be part of the implementation of the reform is adversely affected. In addition, the design and model of the professional development program for teachers needs to include elements that refer to teachers' beliefs and perceptions towards the reform (Bell & Gilbert, 1996; Brand & Moore 2011).

However, not much is known about secondary chemistry teachers' attitudes, and corresponding developments, about using computers in their classrooms or about their personal levels of self-efficacy with respect to chemistry teaching. This claim is especially true when we consider the influence of teacher education on future teachers and potential gender differences. In general, research has shown that gender differences exist concerning the use of ICT. Female teachers seem to be more anxious and less confident in using computers than male teachers tend to be (Bradley & Russell, 1997; Lee, 1997), especially if it comes to more complex tasks (Akkoyunlu & Orhan, 2003). The European Commission (2003) also noted in one of its reports that gender is a variable which is determinative in the use of new media by teachers. The gap between men and women is even greater when it comes to using the Internet. It also appears that male teachers are generally more positive towards ICT in education, while female teachers are neutral or may even express negative feelings (Jimoyiannisa & Komisb, 2007). Many studies suggesting gender differences concerning teachers' self-efficacy beliefs of using ICT in teaching (Ogletre & Williams 1990; Shashaani & Khalili 2001; Tezci, 2011; Sam, Othman & Nordin 2005). However, corresponding evidence for German chemistry pre-service teachers and teacher trainees does not exist at present.

In general, we can state that positive ICT attitudes and self-efficacy will lead to higher chances for using ICT-based approaches in the classroom (Niederhauser & Perkmen, 2010). Since the claim has already been made for a more thorough use of ICT in science classes, this paper examines the state of attitudes and self-efficacy beliefs among prospective chemistry teachers in the case of Germany and focuses especially on pre-service teacher education.

The current study aims to answer the following questions:

(1) Are the attitudes and self-efficacy of prospective German chemistry teachers concerning the use of digital media and ICT in the classroom changed by their pre-service training? Are there differences between general attitudes and self-efficacy beliefs and domain-specific ones concerning chemistry education?
(2) Do any gender differences in attitudes and self-efficacy of prospective chemistry teachers exist when it comes to using computers and digital media in the classroom? Is there a difference before and after their pre-service teacher education is completed?
(3) What impact do general and domain-specific educational seminars about the use of ICT in chemistry education have on teachers' attitudes and self-efficacy beliefs? Are there any gender differences?
(4) Where do chemistry pre-service teachers see potentials/barriers of effective use of ICT in chemistry education?

METHOD AND SAMPLE

Method

The current study is based on a multi-page, on-line survey. The questionnaire begins with general questions about the participants' age, gender, school subjects studied, and year of study. The experience level of the pre-service teachers is examined by asking them whether they have already attended courses on the use of digital media in general education or in domain-specific chemistry education seminars. A second part of the questionnaire consists of four sets of Likert items. These four sets concern (I) students' attitudes towards ICT in education in general, (II) their self-efficacy beliefs about using ICT in education in general, (III) their attitudes about using ICT in chemistry teaching, and (IV) their self-efficacy when it comes to using ICT in teaching chemistry (each 10 items). All 40 items were rated according to a five-point Likert scale (1 = "agree" to 5 = "strongly disagree"). A third part of the questionnaire is composed of two open-ended questions: (I) Where do the pre-service teachers see the greatest potential for using ICT in chemistry classes?, and (II) Where do they see any significant hurdles for implementing use of ICT in chemistry education?

Table 1. Reliabilities of the different scales

	Category	Cronbach's alpha
Scale 1:	Attitudes towards using ICT in education *in general*.	α = 0.76
Scale 2:	Self-efficacy on the use of ICT in education *in general*.	α = 0.86
Scale 3:	Attitudes towards using ICT *in chemistry education*.	α = 0.77
Scale 4:	Self-efficacy on the use of ICT in *chemistry education*.	α = 0.80

Table 2. Distribution of the participants' year of study

Year of study	Share [%]
First year of study	8.8
Second year of study	16.3
Third year of study	15.1
Fourth year of study	20.1
Fifth year of study	16.3
More than five year of study	17.1
Trainee teachers	6.3

The Likert part of the questionnaire was piloted using a small sample of pre-service teachers (n = 15). The reliability of each scale was calculated using Cronbach's alpha. Cronbach alpha values were between .76 and .86 and therefore can be considered to be sufficiently reliable for this study (**Table 1**).

Sample

The system of German teacher education is based on three stages. All student teachers elect to enter a teacher education program at the beginning of their undergraduate education. They all study two school subjects, supplemented by general education and domain-specific education when they begin studying at the B.A. level. Each student first earns a Bachelor's degree (3 years) before completing a Master's of Education (2 years). This process includes school internships and is then followed by a compulsory, post-university teacher trainee program (induction), generally lasting 18 months.

Data for this survey was collected by using a cross-sectional method with the help of SoSci Survey (www.soscisurvey.de). The cross-sectional method is suitable for a study if the respondents are highly educated and a strong theoretical background exists (Rindfleisch, Malter, Ganesan & Moorman, 2007). This is the case in this study.

A total of 239 prospective chemistry teachers from three of the German states (Bremen, North Rhine-Westphalia and Lower Saxony) completed the questionnaire. **Table 2** presents the distribution of the participants' year of study. The sample reveals a good spread over the course of German chemistry teacher education. Of the 239 participants 62% were female and 38% were male. A total of 72% of participants were between 18 and 26 years old. These data correspond to the typical age and gender distribution in German pre-service chemistry teacher education programs. Only 14% of respondents were older than 30 years. Sixty-nine percent of the participants had not yet studied any course on the use of digital media in general education. Concerning the domain-specific coursework for chemistry education, this proportion was slightly smaller (52%).

Analysis

Statistical analysis of differences was performed using the Mann-Whitney U-test (also called U-test) for non-parametric data subjected to statistical analysis. Comparisons were made between pre-service teachers at the B.A. and M.Ed. level and between the first and fifth years of study. U-tests were also carried out to assess gender differences and differences caused by participants having taken ICT educational seminars. As the data were

Table 3. Differences in attitudes towards using ICT in chemistry education by stage of study

Category	Time in training	N	Mean Rank	Z	P
Attitudes towards using ICT in *chemistry education*	First year of study	20	36.78	- 2.39	0.017
	Fifth year of study	38	25.67		
	First year of study	20	21.60	- 2.41	0.016
	Trainee teachers	15	13.20		

Table 4. Differences in self-efficacy on using ICT in chemistry education by stage of study

Category	Time in training	N	Mean Rank	Z	P
Self-efficacy on the use of ICT in *chemistry education*	First year of study	21	37.29	- 2.88	0.004
	Fifth year of study	36	24.17		
	First year of study	21	23.45	- 3.86	< 0.001
	Trainee teachers	14	9.82		

ordinally scaled, H-test, U-tests and Chi²-tests were used to calculate statistical significant differences between groups, e.g. gender, years of study or attendance of ICT educational seminars (McCrum-Gardner, 2008; Kruskal & Wallis, 1952).

Analysis of the open-ended questions was carried out using Qualitative Content Analysis according to Mayring (2014). The categories were inductively developed by extracting them from the written answers, and then they were communicatively validated. The categories were then applied by two independent raters. The value of Cohen's Kappa was 0.98 for the first and 0.99 for the second open-ended question. The high values for Cohen's Kappa may be caused by the fact that most participants did not provide narrative texts but rather provided their answers in a bullet point style.

FINDINGS

Analysis with the U-test shows that there are no significant changes in general ICT usage attitudes in education. This held true for first-year to final year students and also revealed no statistically significant differences between beginning pre-service teachers and trainee teachers. This changed when attitudes toward using ICT in chemistry teaching were analyzed. In both cases a significant positive development was observed to take place (**Table 3**).

In the case of self-efficacy beliefs the use of ICT in education in general the picture is almost the same. In the general view a positive trends seem to exist among the different groups. However, the differences obtained are not significant in terms of analysis by the U-test. Here too, the picture is different when it comes to prospective teachers' self-efficacy concerning the use of ICT in teaching chemistry. The self-efficacy beliefs of fifth-year pre-service teachers and teacher trainees are significantly better when compared to beginning students from the first year group (**Table 4**).

A comparison of female and male pre-service teachers and trainee teachers shows that male prospective teachers have significantly more positive self-efficacy for general use of ICT in education. This is particularly true for using ICT in chemistry education (**Table 5**). Concerning their corresponding attitudes no significant differences were found.

There is also a highly significant difference appearing among all prospective teachers when it comes to whether or not they had already attended domain-specific seminars on using digital media and ICT in chemistry education (**Table 6**).

Table 5. Gender differences in self-efficacy beliefs on using digital media and ICT in chemistry education

Category	Gender differences	N	Mean Rank	Z	P
Self-efficacy on the use of ICT in education in *general*	Male Students/trainee teachers	89	98.31	- 3.04	0.002
	Female Students/trainee teachers	140	125.61		
Self-efficacy on the use of ICT in *chemistry education*	Male Students/trainee teachers	86	100.16	- 2.78	0.005
	Female Students/trainee teachers	145	125.39		

Table 6. Differences in self-efficacy beliefs on using digital media and ICT in chemistry education with respect to corresponding course visits

Category	Comparison criterion	N	Mean Rank	Z	P
Self-efficacy on the use of ICT in *chemistry education*	No courses assigned	121	134.69	- 5.24	< 0.001
	Courses assigned	105	89.08		

Table 7. Differences in attitudes and self-efficacy on using ICT in chemistry education with respect to corresponding course visits among female students

Category	Comparison criterion	N	Mean Rank	Z	P
Attitudes towards using ICT in education in *general*	No courses assigned	74	79.07	- 2.12	0.034
	Courses assigned	69	64.41		
Attitudes towards using ICT in *chemistry education*	No courses assigned	73	76.68	- 1.89	0.059
	Courses assigned	67	63.76		
Self-efficacy on the use of ICT in education in *general*	No courses assigned	71	77.63	- 2.46	0.014
	Courses assigned	67	60.89		
Self-efficacy on the use of ICT in *chemistry education*	No courses assigned	76	90.57	- 5.72	< 0.001
	Courses assigned	67	50.93		

Here, gender differences were also found in this respect (**Table 7**). Generally, domain specific courses on using digital media and ICT in chemistry education positively affected the self-efficacy of both male and female prospective chemistry teachers. This is not thus simple the case for the corresponding attitudes in both genders. No significant change was found in the attitudes of the male participants. Conversely, female participants showed a significant change in their general attitudes towards ICT in education during the course of their studies when having attended domain-specific educational seminars on ICT usage in teaching. A nearly significant change concerning the use of digital media and ICT in chemistry teaching could also be identified.

The mean scores were analyzed to check whether any clear tendencies existed and whether these trends differed in terms of male and female teachers. For only eight male and seven female respondents have been in teachers in the post university training program, this group was taken out of this analysis and only the pre-service teachers have been evaluated. Here we found that no general differences exist regarding attitudes or self-efficacy among the prospective teachers over the course of the different phases of study (Bachelor Student vs Master Student). Since this study is a cross-level study and not a long term study, this might be caused by the heterogeneous sample following different study programs in various universities. However, there seems to be an overall positive development with regard to the development of self-efficacy on using ICT in education and in chemistry education for female teachers from the beginning towards the end of the university teacher education program (**Table 9**). There is no corresponding development among the male pre-service teachers although both groups attended overall the exact same programs. The differences between male and female students were also statistically significant with respect to their personal self-efficacy about computer usage both for education in general, and chemistry education in particular (**Table 10**). The same holds true for the positive effects measured for

Table 8. Differences in attitudes and self-efficacy on using ICT in chemistry education with respect to Bachelor or Master Study Program among male and female students

Female Students

Category	Comparison criterion	N	Mean Rank	Z	P
Attitudes towards using ICT in education in *general*	Bachelor Students	65	70.63	-.314	.753
	Master Students	73	68.49		
Attitudes towards using ICT in *chemistry education*	Bachelor Students	62	70.43	-.666	.506
	Master Students	73	65.94		
Self-efficacy on the use of ICT in education in *general*	Bachelor Students	61	71.11	-1.133	.257
	Master Students	72	63.52		
Self-efficacy on the use of ICT in *chemistry education*	Bachelor Students	66	75.36	-1.495	.135
	Master Students	73	65.15		

Male Students

Category	Comparison criterion	N	Mean Rank	Z	P
Attitudes towards using ICT in education in *general*	Bachelor Students	30	37.87	-1.051	.293
	Master Students	52	43.60		
Attitudes towards using ICT in *chemistry education*	Bachelor Students	30	41.32	-.053	.958
	Master Students	52	41.61		
Self-efficacy on the use of ICT in education in *general*	Bachelor Students	28	30.86	-2.825	.005
	Master Students	53	46.36		
Self-efficacy on the use of ICT in *chemistry education*	Bachelor Students	28	36.8	-.787	.431
	Master Students	50	41.01		

Table 9. Differences in self-efficacy on using ICT in chemistry education among female students

Category	Time in training	N	Mean Rank	Z	P
Self-efficacy on using ICT in education in *general*	First year of study	13	20.46	-1.979	.049
	Fifth year of study	19	13.79		
Self-efficacy on using ICT in *chemistry education*	First year of study	15	24.63	-2.956	.002
	Fifth year of study	21	14.12		

Table 10. Differences in the self-efficacy of using ICT in general and in chemistry education between female and male pre-service teachers

Category	Gender	N	Mean Rank	Z	P
Self-efficacy on using ICT in education in *general*	Female	140	125.61	-3.043	.002
	Male	89	98.31		
Self-efficacy on using ICT in *chemistry education*	Female	145	125.39	-2.777	.005
	Male	86	100.16		

the domain-specific self-efficacy, if prospective teachers have already taken ICT courses either for general education ($p < .005$) and/or domain-specific education ($p < .0001$ %).

Table 11 indicates where prospective chemistry teachers identified the greatest potential for the use of ICT in chemistry classes. Most of their answers concern aspects of visualization and presentation. The use of ICT for more student-active pedagogies is only mentioned by a very few of the participants.

Table 11. Potential for the use of computers / digital media in teaching chemistry from the perspective of prospective chemistry teachers

Category	Values in %
Visualization of models and processes, animations and simulations	28 %
Visualization of molecules, structures and reaction mechanisms	24 %
Presenting images and videos of complicated or dangerous experiments	18 %
Educational software, interactive learning environments, WebQuests	11 %
Analysis of data, measurement results and displaying graphs	10 %
Use of the Internet	6 %
Student presentations	2 %
Interactive whiteboards and tablet-PCs	1 %

Table 12. Key barriers to the use of computers / digital media in teaching chemistry from the perspective of prospective chemistry teachers

Category	Values in %
Lack of equipment and high costs to equip classrooms with new media	33 %
The use of new media is very time consuming and other activities might be neglected	16 %
Student-active teaching strengthens contents effectively; real-life experience (for example experiments) may be lost	13 %
Media literacy and interest in new media is low among teachers, for example, thanks to little preparation time or a lack of continuing education	12 %
The computer might become a distraction (e.g. Facebook)	9 %
Too little (good) software and concepts for teaching chemistry exist	9 %
Lacking computer skills of students	4 %
Technical difficulties and maintenance problems	3 %
No availability of computers for school students at home	2 %

Table 12 shows the suggestions of which areas future teachers see as the most problematic for using digital media and ICT in chemistry classes. The most frequent obstacles suggested were the lack of proper equipment in schools, the high associated costs, and the many time constraints faced by teachers.

DISCUSSION AND CONCLUSION

This study shows that prospective chemistry teachers' general attitudes and self-efficacy about ICT seem to be relatively stable from the beginning to the end of their program of university studies. This is not the case when it comes to domain-specific attitudes and self-efficacy in the domain of teaching chemistry. Attitudes and self-efficacy for the use of computers in chemistry classes develop positively. These overall findings are especially influenced by the developments found among the female participants in the study. Positive developments are significantly supported if the prospective teachers have the opportunity to attend educational seminars specifically covering the use of ICT in both general and chemistry education. Also in this area, female prospective pre-service teachers seem to benefit even more from visiting ICT-related educational courses than their male colleagues do. Overall, there seems to be positive developments especially among the female pre-service teachers although these findings have to be handled with sufficient care, since this is a cross-level, not a longitudinal study. A longitudinal study might provide further insights into whether or not this finding was caused by specific factors or mainly influenced by the different groups of students.

The findings in this study support other studies describing gender differences when it comes to teachers focusing the use of ICT in teaching (Ogletre & Williams 1990; Shashaani & Khalili 2001). The high impact of educational courses promoting the use of ICT in education might help to level out the differences in attitudes and beliefs. This is particularly relevant for leveling the gender differences. The positive development shown by female participants found are a promising indication. Nevertheless, the quantitative part of the study reveals only a general direction.

The qualitative part of the study shows that even if positive attitudes and self-efficacy beliefs already exist or can be developed during the course of studies, pre-service teachers' imagination when it comes to using ICT in chemistry teaching is rather limited and mainly focuses on visualization aids. More student-centered pedagogies (educational software, interactive platforms, Internet searches, or student presentations) play a much more minor role, as one participants said: "In my opinion, digital media as support for the visualization of specific content is very helpful. I can't think of much more at the moment. Unfortunately I cannot imagine it yet." The main reasons stated for being skeptical about the application of digital media and ICT in chemistry classes tend to be phrased in terms of insufficient school equipment, monetary restraints and time constraints. This is the case for both male and female prospective teachers. The situation might change over time. It is more likely that we will continue to see very limited application of digital media and ICT, if prospective teachers are not exposed to a broader range of imaginative ideas and potential applications of ICT in the classroom. They must also be supported in developing the corresponding, personal pedagogical content knowledge. This means that evidence-based curriculum development is needed in teacher education, as it was recently described by Krause and Eilks (2015). Only by doing so can we find the most effective ways to not only better prospective teachers' attitudes and self-efficacy, but also to provide future teachers with relevant and corresponding knowledge, skills and examples which they can employ in their teaching practices and classroom activities.

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