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Kousa, Päivi Marketta

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The needs for successful chemistry teaching in diverse classes: teachers' beliefs and practices

Päivi Kousa & Maija Aksela

The Unit of Chemistry Teacher Education, Department of Chemistry,
Faculty of Science, University of Helsinki, Finland

The aim of this case-study was to understand how chemistry teachers experience their work in diverse classes where the needs of differentiated teaching practices are constantly growing. The deeper intention was to perceive new information in order to develop supportive methods that could better correspond to teachers' reality. Eight voluntary Finnish secondary school chemistry teachers participated in semi-structured interviews. Four categorial distinctions for successful chemistry teaching were found according to their beliefs: 1) to have more support and resources, 2) to be able to recognize students' problems, 3) to use supportive materials and methods, and 4) to connect theory and practice with inspiring and meaningful activities. This study presents new insights about teachers' beliefs of diversity and what is needed for successful chemistry teaching. Directions for further research and practices are also suggested.

Keywords: chemistry teachers' beliefs, diverse classes, differentiated teaching practices

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Contact:
paivi.kousa@helsinki.fi

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1 Introduction

Classrooms are becoming more diverse (e.g. Southerland & Gess-Newsome, 1999; Santangelo & Tomlinson, 2012). To meet the needs of all students is one of the biggest concerns in education (Konstantinou-Katzi, Tsolaki, Meletiou-Mavrotheris, & Koutselini, 2013). The teachers do not have sufficient education to teach chemistry in diverse classes (e.g. Mumba, Banda, Chabalengula, & Doleng, 2015) and they do not know their students well enough in order to respond to their needs (Woollacott, Booth, & Cameron, 2014). Consequently, teachers in all levels, find themselves unprepared to implement their teaching to the students with diverse needs. (Norman, Caseau, & Stefanich, 1998). It is clear, that more research, training and teaching models are needed in all levels of science teacher education.

The term *diversity* is challenging or even impossible to define explicitly (Gordon, Reid, & Petocz, 2010) and there are many aspects concerning students' academic and cultural variation (Richards & Omdal, 2007). For instance, students' cultural, immigrant and socio-economic backgrounds, learning disabilities, difficulties with learning, problems with language, gender and sexual orientation and previous

discipline can be linked with diversity (e.g. Goethe & Colina, 2018; Wassel, Kerrigan, & Hawrylak, 2018) although race and ethnicity are mostly used topics concerning diversity (Pohan & Aguilar, 2001). In the field of research and practice, comparative terms such as heterogeneity (e.g. Johnson Rothenberg, McDermott, & Martin, 1998) as well as teaching in mixed ability classrooms (e.g. Valiandes, 2015) are used. Furthermore, the term inclusivity is used when teaching regular students and students with different levels of disabilities (e.g. Norman et al., 1998). In summary: diversity has many features and it can cause numerous challenges in classrooms worldwide (UNESCO, 2004; Subban, 2006; Santangelo & Tomlinson, 2012; OECD, 2013). Since teachers have distinct and ambiguous beliefs about diversity (Gordon et al., 2010), this study takes the various aspects of general academic and cultural variation within a classroom into account (e.g. Richards & Omdal, 2007) without more specific categorization of each student. Despite the different terminology, the goal of the present study is convergent to the others: science teaching should be equally adjusted for all students (e.g. Santangelo & Tomlinson, 2012).

Differentiated teaching can increase student motivation, engagement, subject understanding, learning and achievement (e.g. Konstantinou-Katzi et al., 2013). It also tends to to enhance the equality of students (Lambe & Bones, 2006; Valiandes, 2015), for example by minimizing the achievement-gap between them (Valiandes, 2015). In addition, students' self-esteem and confidence can be improved by differentiation (Norman et al., 1998). However, some studies indicate that it is impossible for a teacher to take all students' needs into account. (Lambe & Bones, 2006). Consequently, a teacher's instructions and assessment does not work similarly with different students or groups because of their different background knowledge. The material should have some significance to the students and point out the importance of science in their everyday life, as well. (Southerland & Gess-Newsome, 1999) Furthermore, it takes time and effort to learn how to differentiate and thus, teach more effectively (Valiandes, 2015). Although teaching diverse classes requires more effort, it can be rewarding and beneficial for the whole class (Janney & Snell, 2006). In this study, the term differentiation is used with teaching methods that are implemented to all students in a classroom considering their diversity (e.g. Morgan, 2014).

There are a few studies about teachers' beliefs of students' diversity (Gordon et al., 2010) and fewer less about chemistry teaching in diverse classes. The aim of this study is to understand how teachers experience their work and teaching practices in their

classes where the needs of differentiated instructions are constantly growing. The deeper intention is to find new information in order to develop supportive methods that could better correspond to in-service teachers' reality. The research question is: What are teachers' beliefs about the successful implementation of chemistry teaching practices in diverse classes?

2 Theoretical background

There are various terms that are connected into teachers' beliefs such as attitudes, opinions, perceptions, conceptions, perspectives, confidence, motivation, self-concept (Pajares, 1992), knowledge, views and principles (Milner, Sondergeld, Demir, Johnson, & Czerniak, 2011). Generally, teachers' beliefs can be categorized as traditional or modern. Teachers' traditional and epistemological beliefs about classroom practices are typically teacher-centered. In that learning environment, passive learners adapt knowledge from the teacher who focuses mostly on the content. Contrarily, teachers' modern and constructivistic beliefs about the classroom practices are student-centered. In the modern classroom, students can participate, choose from different options, work more independently and have topics that are meaningful to them. (Markic & Eilks, 2012)

According to many studies, teachers' beliefs affect their practices (e.g. Nespor, 1987; Pajares, 1992; Van Driel, Verloop, & de Vos, 1998; Bryan, 2012). For example, teachers' positive beliefs are related to students' success in the classroom (Jarvis & Pell, 2005). However, examining teachers' beliefs might not be a straightforward process, because more than one belief has to be taken into account (Cano & Cardelle-Elawar, 2004). In addition, teachers' beliefs and practices are not always similarly connected or recognized (Kagan, 1992). Although teachers' beliefs are mostly positive (e.g. Pedretti, Bencze, Hewitt, Romkey, & Jivraj, 2008), there are some issues that need to be taken into account. Firstly, teachers' beliefs are often obstructing the successful implementation of their practices (Hofstein, Eilks, & Bybee, 2011). Secondly, both positive and negative beliefs tend to be stable (Marbach-Ad & McGinnis, 2008). Therefore, it is important to examine teachers' beliefs (Kagan, 1992) in order to support especially their positive beliefs and successful teaching practices in turn (Lumpe et al., 1998). It is also essential to understand, what are the causes and effects of negative beliefs (DeWitt & Storksdieck, 2008).

Notably, teachers' negative beliefs tend to increase with the level of students' difficulties and differences. Especially science and mathematics teachers have more negative beliefs about teaching in diverse classes compared to other teachers. (Avramidis, Bayliss, & Burden, 2000) Sometimes teachers' and students' negative beliefs can be a result of unsuitable teaching methods and materials (Lambe & Bones, 2006). Additionally, teachers' lack of knowledge and misconceptions about learning disabilities can have a negative influence on students' achievement and future possibilities, for example in their working lives (Norman et al., 1998). However, teachers who are used to teaching diverse classes or use differentiated instructions regularly, have more positive beliefs towards teaching and they are more positive about their abilities to teach diverse students (Avramidis et al., 2000; Konstantinou-Katzi et al., 2013). This is important, because students' success in the classroom is teacher-dependent (Wright, Horn, & Sanders, 1997). It is stated, that student diversity can be dealt with three different ways: by ignoring it, taking most of students' needs into account or using diversity as a resource so that the whole class would benefit from it (Gordon et al., 2010). It is essential, that the teaching methods respond to students' needs concerning their readiness, interests and learning profiles (Tomlinson & Moon, 2013). For example, hands-on activities and field trips can enhance diverse students' positive experiences and attitudes towards science (Norman et al., 1998; Kousa, Kavonius, & Aksela, 2018) as well as inquiry-based activities (Chen, Wang, Lin, Lawrenz, & Hong, 2014) and group work (Vishnumolakala, Southam, Treagust, Mocerino, & Qureshi, 2017). In addition, much can also be done by using science, technology, society and environment (STSE) based issues which can increase students' positive attitudes, conceptual understanding and achievement (Bennett, Lubben, & Hogarth, 2007).

There is a relation between teachers' beliefs about diversity and students' learning (Gordon et al., 2010). However, teachers do not have enough knowledge or skills on how to handle with diversity (Markic & Abels, 2014; Benny & Blonder, 2018). There is also a shortage of suitable resources, teaching materials and methods (e.g. Norman et al., 1998). More time, assistants and possibilities to teach with a colleague are also needed (Lambe & Bones, 2006) as well as instructions on how to manage diverse classrooms and different behavior. Consequently, more properly-planned training and support from the teacher education is needed (Avramidis et al., 2000) because teachers find that the education in teacher training is inadequate. On the other hand,

teacher educators need more research, training and time to organize appropriate support and training for pre- and in-service teachers, as well. (Norman et al., 1998)

Differentiated teaching aims for students' success. The essential role of a teacher is to adjust the teaching case-by-case in order to meet the needs of different students (Morgan, 2014) rather than regularly individualizing the content and the amount of work (Konstantinou-Katzi et al., 2013) or avoiding difficult topics (Sirhan, 2007). In differentiated teaching, the various needs of students are considered by differentiating the "content, process, product, and learning environment" (Santangelo & Tomlinson, 2012). A teacher can give differentiated instructions to an entire class, group or one individual (Thakur, 2014). Curriculum material can be modified by supplementing, simplifying or altering the content (Janney & Snell, 2006). For example, low-achieving students can benefit from tiered material that has the same content and minimum concepts, but the depth of the content, activities and outcomes can be different depending on the skills of the student (Richards & Omdal, 2007). On the other hand, it is not necessarily efficient that students regularly follow certain "tracks", particularly in low levels. The material should be planned and implemented for heterogeneous classes instead. (Johnson Rothenberg et al., 1998)

3 Method

This was a case-study with descriptive content analysis (Cohen, Manion, & Morrison, 2007). Case-study was chosen since it can provide an opportunity to have a general view of real-life phenomena (teachers' beliefs about their work) instead of separated facts (Denscombe, 2010). Semi-structured interviews were used in order to have same procedure and questions but more flexible approach to different participants (Krippendorff, 2004). The aim of this study was to understand how teachers' experience their work in diverse classes where the needs of differentiated teaching practices are constantly growing. All work has been performed in compliance with regulations and guidelines. Informed consent was obtained from all the participants.

The teachers were chosen by purposive sampling (Denscombe, 2010) since the researcher wanted to ensure that the participants were familiar with the general concept of diversity and teaching practices in diverse classes. In that way, the best information about the current situation could be accomplished concerning those teachers who have had at least one obligatory special education course during their pre-service teacher education (5 credits). Consequently, the sample size was selected

small. However, the researcher or participants did not know each other beforehand. The research process included following stages:

Stage 1: Literature reviews concerning the topics of this study were carried out at the beginning of the process. The interview questions were piloted and discussed by a group of randomly selected pre- and in-service teachers. Furthermore, the questions were developed further to 11 major questions.

Stage 2: Eight voluntary chemistry teachers participated in this study. They were chosen from an in-service training program which was organized at the University of Helsinki, Unit of Chemistry Teacher Education, Department of Chemistry, Faculty of Science, Finland by the researcher of this study. The topic of the four-months training program was STSE education and differentiation in chemistry and it was carried out four times. One session lasted four hours. More information about teachers' backgrounds (interview questions 1. and 2.) can be found in table 1.

Table 1. Teachers' background information.

Teachers	Years of teaching experience	Teacher education concerning diversity and differentiation*
A	18	5 credits
B	20	60 credits of special education training
C	11	5 credits
D	2	5 credits
E	5	5 credits
F	4	20 credits of special education training
G	5	5 credits
H	8	5 credits

** 5 credits are included in obligatory teacher training. Special education training is voluntary for subject teachers in Finland.*

Stage 3: A sample of 8 voluntary science teachers (named as A-H) from the Finnish secondary schools in the Helsinki district were individually interviewed by the researcher of this study before the training program so that the teachers' beliefs were not affected before the interview. The interviews were performed in places that the teachers had chosen for themselves, for example in the schools where they worked. The interviews were carried out in Finnish. Each interview lasted approximately sixty minutes. In order to have more personal and relevant information with multiple dimensions, the following semi-structured questions about teachers' beliefs were asked:

1. How many years have you worked as a chemistry teacher?
2. What kind of teacher training have you had concerning diverse students and differentiation?
3. Can you define how diversity appears in your chemistry classes?
4. What kinds of experiences have you had concerning differentiated chemistry lessons?
5. What kinds of difficulties do your students have with chemistry?
6. What kinds of challenges have you faced with diverse students?
7. In what ways diverse students can be taken into account during chemistry lessons?
8. What kinds of methods or materials have you used with diverse students?
9. How to motivate diverse students in order to learn chemistry?
10. What are your experiences and suggestions for planning and implementing a chemistry lesson that is suitable for diverse students?
11. What are your beliefs about teacher training concerning diverse classes and differentiation?

Stage 4: The verbatim transcripts of the audio-recorded interviews of eight teachers were used in this study. Firstly, answers that correlated with the questions 3.-11. were collected. The data was further analyzed and repetitively arranged by comparing the similarities and differences from teachers' utterances. Finally, the categories with distinctive similarities were formed.

Stage 5: Similarities and differences between answers that were collected from the questions were searched by two independent researchers by repetitive readings. 264 codes concerning teachers' beliefs were found.

Stage 6: 264 codes which had distinguish similarities formed four categorial distinctions by the consensus of two researchers. The categories were not contemplated or determined in advance.

4 Results

According to teachers in this study, following categorial distinctions are important in order to successfully teach chemistry in diverse classrooms:

1. to have more support and resources,
2. to be sensitive to recognize students' problems with learning,
3. to use supportive methods and materials, and
4. to connect theory and practice with inspiring and meaningful activities.

There were four main categorial distinctions that emerged from the data of descriptive content analysis. They are next explained in more detail.

4.1 Teachers' needs for support and resources

Firstly, being sensitive to take students' needs into account in diverse classrooms as well as using differentiated instructions were considered as a huge challenge by all teachers. Teachers recognized problems especially with resources: More time, money, materials and possibilities to use different learning environments were needed. "There are many topics in the curriculum and too little time to teach them" (Teacher B). Secondly, teachers' beliefs about working alone with too many students was found challenging. Teachers argued that it is almost impossible to have sensitivity in order to recognize students' individual differences and difficulties in a classroom that is too big. Teacher F stated: "If you have a course with too many students, that also includes those with different native languages you do not necessarily understand how lost they can be in there. The whole course can be a total pain if they just try to understand the language." Thirdly, lack of teacher support and knowledge was recognized as a problem in every level of a teacher's career. From teachers' points of view, the obligatory course in pre-service teacher training (5 credits) did not give them even basic knowledge and skills concerning diverse students and differentiated teaching. Teacher G expressed her problems in a following way: "My lack of general knowledge in chemistry annoys me. I have started thinking how chemistry could be taught to students in different ways. I think that knowing more about general chemistry would be a key position here." Most of all, teachers wanted practical examples about the real-life situations in a classroom instead of theoretical ones. Additionally, their beliefs about supportive methods included peer support from colleagues and special education teachers, consulting, workshops and courses from the university teacher

educators and materials and methods for differentiation. Teacher H had following conclusions about her problems and needs for support H: "Well, I am thankful for everything useful that I can get. The internet is full of videos and other materials, but I do not have time to filter it all by myself."

4.2 Students' problems in diverse classes

Teachers recognized many problems in diverse classes. "I think that those low-achieving students who just sit quietly and do nothing are suffering the most. They can manage to struggle through the whole school-system without anyone recognizing their difficulties" (Teacher A). As a solution, some teachers stated that diverse classes should be restructured into classes with different achievement levels. Furthermore, being sensitive to recognize individual differences between students and even classes were seen as most problematic. Teachers also stated that same teaching methods and materials did not necessarily work at all in different groups even within the same grade. Furthermore, many individual challenges such as learning difficulties from mild to severe, cultural aspects concerning language issues, behavioral problems and conflicts between students were found. In addition, teachers recognized that they are not aware about the suitable teaching practices that could be helpful for the specific problems that students have. From the opinion of Teacher D: "Students with special needs are so different. There are actually two groups: those who have problems with behavior and those who have difficulties with learning. Those are totally different groups who need different actions." According to teachers' beliefs, chemistry itself was a cause of students' problems. Teachers regarded it as the most difficult subjects in school. Chemistry has been found too abstract and therefore, difficult to understand. The terminology and different concepts are also problematic for students. Furthermore, learning has been almost impossible for some of the students because of the special language of chemistry, and because there are too many items that have to be memorized and understood. Teacher A tried to explain the problem with an atomic model: "It is difficult for an eighth-grader to understand what an atom is. You cannot explain an atom like you explain a table: four legs etc. The atom cannot be seen like one sees a table."

Finally, students' lack of motivation and negative attitudes were clearly recognizable problems in teachers' beliefs about their work. According to some teachers, students' motivation tended to decline in the classroom if the issues are too difficult or uninteresting. The main question that students have often asked is, what

is the use of learning chemistry? Consequently, many students have not seen the reason for chemistry studies and are therefore not motivated to learn. Teachers recognized different types of students according to their skills and motivation and the categories were surprisingly similar (see table 2). According to teachers in this study, there are five types of students in their diverse classes: high-achievers who are really talented, those who are not interested and do nothing (mostly students with lower achievement levels), low-achieving students (mostly those who have difficulties with learning or language), diligent students who memorize everything in order to have good grades but do not necessarily understand chemistry (mostly girls), and those who are good at practical things and hands-on activities but poor in content knowledge (mostly boys). The problem with motivation has been summarized by Teacher H: "Occasionally, when you have an ordinary class and there is something interesting going on, the students tell you that the lesson went really fast. But if you stick to the topic for too long or students find them too difficult, the whole lesson can be ruined."

Table 2. Different types of students that exist in diverse classes according to teachers.

Types of students	**Number of teachers who used similar categorization (*N*=8)**
Gifted high-achieving students	7
Students who are not motivated or interested	6
Low-achieving students	5
Diligent students who want good grades	5
Students who are good at hands-on activities but poor in theory	5

4.3 Supportive materials and methods

Teachers used multiple amount of versatile and supportive teaching methods and materials in diverse classes (see table 3). Most of the teachers considered that they were handling diversity most efficiently, when they used alternative teaching methods and materials with examples from everyday life. Alternative approaches were used with content, contexts, methods, materials and activities. Peer support, groupwork, consulting and extra training were also found useful and supportive. However, not all teachers were certain about the usefulness of variation: "Most of the students clearly benefit from alternative methods but some students suffer if something is done differently" (Teacher C). Moreover, teachers found that students benefitted from

structured lessons that included smaller, individual parts. From the teachers' point of view, the written structure of the lesson should be located in front of the class so that the lesson would be easier to follow. Additionally, careful planning was also found important according to Teacher B: "You have to plan the lesson carefully in advance, so that the material is suitable for students with different levels. There will be consequences in the classroom if some part of the lesson does not work." On the other hand, teachers' improvising skills and ability of changing things when needed were also considered necessary.

Teachers believed that differentiated material is needed in order to support students in diverse classes. The differentiated teaching material is very often made or altered by teachers themselves and used either with or instead of the official material. For example, extra questions or comments have been added to the text in order to point out the necessary parts that should be learned. Some teachers have used notes and slides with words or sentences for the same reason. Furthermore, differentiated material that includes bigger or more simple text or added pictures has been considered supportive in order to make students understand and follow instructions. Teacher A stated: "Laboratory activities have to be explained as simply as possible. Therefore, I have added some pictures that help students to follow the instructions. Instead of a text that advice a student to get a beaker, there is also a picture of it, so that the student could recognize the equipment more easily and can continue working." Teachers had conclusions that the differentiated material was challenging and time-consuming to make but it was also beneficial in the long run, because the same material was often suitable for more than one group of students. For example, the same material was used successfully with students with reading difficulties and with students who had different native languages. Moreover, not all students or their parents agreed that everyone else in a classroom should be aware of the differentiated material: "I differentiate also in secret. I have given extra material to the students who do not want to use the material in public. Sometimes parents want it that way. Students have the same material than others in the classroom but differentiated material at home and they also have differentiated exams" (Teacher C).

Table 3. Beliefs of successful teaching practices in diverse chemistry classes.

Teaching practices	Number of teachers who used similar methods and materials (*N*=8)
Versatile teaching practices	6
Examples from everyday life	5
Hands-on activities	5
Altered material	5
Peer/group work	3
Additional instructions	3
Internet-based activities	3
Visits	3
Student-centred activities	3
Structured lessons	1
Easier exams	1
Less writing	1
Presentations	1
Molecular modelling	1
Inquiry-based activities	1

4.4 Meaningful and inspiring connections between theory and practices

Teachers' beliefs about students' abilities to make connections between theory and practice by themselves was considered low and problematic. Many teachers expressed that students cannot see the connection between theory and practice or find why something is important. The situation was seen especially problematic with hands-on activities. Therefore, teachers' efforts to help students to make the connections was dealt with many answers. As Teacher H expressed: "It is a fact, that you do not have a nice demo for everything and everything cannot be connected to everyday life. It won't help students if you say that chemistry is needed for example in solving environmental problems. Or show things that are too easy and familiar like the connection between pH and detergents. The main problem is, how do you explain and demonstrate something that is really difficult to understand such as atoms?"

Some examples about the solutions that teachers have used in order to help diverse students to connect theory and practice were expressed. Most of the beliefs were about connecting theory into familiar examples from students' everyday lives (see table 2). Examples such as food, cosmetics, medicine and different vocations have been used alongside differentiated instruction. There was also a concern where to find examples that can be connected to theory and that encourage diverse students to learn: "Where do you find an example that interests everyone, especially girls? I have been thinking

that there should be a voluntary chemistry course for girls including for example topics such as home economics and cosmetics which they are interested in. Maybe they could then understand, that chemistry is more than what is included in the curriculum. I already have a voluntary inquiry-based course for all but there are only high-achieving boys in there" (Teacher H). Concerning students' future vocations, Teacher F had an example that they have used especially with girls: "Imagine that you will be a hairdresser in the future. There is a lot of chemistry in hair products and how they function. That's why you need to learn chemistry." Moreover, teachers found that discussions and inquiry-based teaching were helpful tools in order to make the connections.

Teachers' beliefs about the importance of inspiring students in diverse classes were discussed actively. There were several methods that were considered very inspiring and suitable for differentiation especially concerning low-achieving students and those who were not interested in chemistry. According to teachers in this study, methods like inquiry-based activities, modelling, using computers, searching for information, making presentations, watching videos and making visits and doubtlessly, presenting exciting chemical reactions were found very inspiring and useful tools for differentiation. However, as Teacher F expressed: "Chemistry lessons cannot be just full of tricks." On the other hand, some teachers were concerned about how to inspire high-achieving students as well, like Teacher A said: "In my opinion, it's not right or inspiring if you just tell your faster students to do more exercises from the book. You can for example, give them some advanced activities or encourage them to plan and implement their own tests in the lab."

Although hands-on activities were mentioned in every category of this study, they were mostly seen as the best method to inspire students with different skills and needs. However, teachers' conceptions about the possibility to differentiate hands-on activities were contradictory. There were also concerns about the discipline in the classroom and lack of time in order to support every student in the way they need. "You cannot use chemicals that can be dangerous. And even if you do not use them you are always scared of what happens next" (Teacher E). In addition, teachers were almost unanimous about the usefulness of a student-centered approach in teaching diverse classes. According to teachers' conclusions, students need to plan, implement and take responsibility for their own school activities because it is notably inspiring for them. "There is no need to be so teacher-led all the time. Students are more inspired if they can decide themselves which level of tasks are suitable for them. For

example, I criticized computer-based activities with different levels at first, but I have noticed, that they can be inspiring and useful for diverse students" (Teacher G).

4.5 Limitations of the study

There are many ways to examine teachers' beliefs. Straight conclusions can be made for instance, by using observations. Additionally, teachers' opinions (espoused beliefs) can be asked for example by using interviews. There is often contradiction between teachers' claims and real practices. (Bryan, 2012) Therefore, the results of this study give insights what teachers say about their work, not necessarily what they do in their classes. Observation of diverse classrooms along with interviews could have provided a bigger picture of the connection between teachers' beliefs and practices.

The results of this case-study can be difficult to generalize since the sample size was small and each participant presented a unique example of chemistry teacher with different backgrounds, teaching experiences and classes. However, this study deepened the understanding about teachers' beliefs differently than a larger-scale survey would have done. Furthermore, this study can provide ideas for corresponding cases concerning chemistry teachers' work in diverse classes. The reliability of this case-study can be considered from the point of view of stability (e.g. Krippendorff, 2004). Stability in this study is ensured by similar contents, procedures and lengths of interviews as well as coding the data several times by two researchers. The semi-structured interview questions were piloted by a group of pre- and in-service teachers and further discussed and developed in order to ensure also the validity of this study.

Furthermore, some concepts like *diversity* are ambiguous and different participants can have varying definitions for such concepts (Gordon et al., 2010). However, this study presents new prospects and understanding about teachers' ideas, experiences and conceptions about diverse classes and differentiation. Furthermore, new categories and discussion that were presented in this study, can give fruitful directions and perspective for further research and practices.

5 Discussion

There is an increasing need to understand diversity and have sufficient knowledge and skills to teach in diverse classrooms (e.g. Norman et al.,1998; Markic & Abels, 2014; Benny & Blonder, 2018). According to this study, there were four categorial distinctions which teachers find important concerning successful implementation of teaching practices in diverse classrooms: (i) to have more support and resources, (ii) to be sensitive to recognize students' problems, (iii) to use supportive methods and materials, and (iv) to connect theory and practice with inspiring and meaningful activities. A case-study with descriptive content analysis was used as method in order to understand more about chemistry teachers' experiences, ideas and opinions about their work in diverse classes. The four categorial distinctions that were found important according to teachers in this study are discussed below in more detail.

5.1 Teachers' needs for support and resources

The biggest concern for teachers in this study was to be able to respond to the various needs of diverse students in large classes where time, resources, materials as well as knowledge about diversity and teaching practices for diverse students are insufficient. Teachers' various needs that emerged from the present data, are also well-known from the previous studies (e.g. Norman et al., 1998; Konstantinou-Katzi et al., 2013; Markic & Abels, 2014; Mumba et al., 2015; Benny & Blonder, 2018). Notwithstanding the fact that most of the teachers' needs and challenges that were recognized in this study were very similar before, there was a distinctive feature which needs more attention. Every teacher in this study, despite their previous teacher experience or education, concluded that they would benefit from practical examples rather than theory-based teacher education and traditional lectures. According to teachers, they need real-life examples and visits to diverse classes, where they could observe and participate in different activities along with theory-based education. Consequently, they could learn more about how diversity and differentiative teaching practices should be carried out in different situations. In summary, teachers' regular practices in authentic environments along with theory, could increase their knowledge about diversity and enhance their professional skills and confidence in order to teach diverse classes.

5.2 Students' problems in diverse classes

This study pointed out clearly, that chemistry teachers are struggling with various problems as a result of insufficient skills, knowledge and resources. Furthermore, one problem was considered fundamental: to be able to understand what kind of problems students have in diverse classes. According to the teachers in this study, basic problems about students' learning difficulties, cultural differences and motivational issues were noticed. It can also be assumed that teachers are sensitive and do recognize the problems and challenges that affect their work as well as students' achievement. Consequently, teachers' general beliefs were considered as negative like in the previous study that concerned science and mathematics teachers (Avramidis et al., 2000). Since teachers' negative beliefs can obstruct the implementation of more successful teaching practices (Hofstein et al., 2011) their beliefs should be examined and taken into account in order encourage the positive beliefs (Lumpe et al., 1998) and find the reasons and solutions for the negative ones (DeWitt & Storksdieck, 2008). This is the case, especially if the materials and teaching practices are not in balance with students' needs (Lambe & Bones, 2006).

5.3 Supportive materials and methods

Supportive teaching methods and materials are essential according to teachers' beliefs about differentiated teaching in diverse chemistry classes. As in previous studies (e.g. Lambe & Bones, 2006), teachers were aware that it is difficult or even impossible to take all students' needs into account. Additionally, the support that is suitable for all was seen unrealistic (Southerland & Gess-Newsome, 1999). Despite the many obstacles that make differentiation in diverse classes more difficult, teachers had plenty of supportive methods that they have used successfully (see table 3). Furthermore, teachers were almost unanimous about the benefits of alternative approaches to teaching although some of the teachers stated that constant changes of materials and methods are not for everyone. Teachers were also aware that even the most effective methods and materials do not work if the lesson is not planned and structured well. Planning and implementing were considered challenging and time-consuming but beneficial for the entire class. That is also indicated for example by Janney & Snell (2006). In summary, it can be assumed that teachers are willing to support their students and have general expertise for it but there are still some issues that have to be taken into account. For instance, students' and parents' negative

attitudes towards differentiation can lead teachers to tricky situations where they have to use differentiative teaching practices secretly. That can be harmful for the whole class since differentiation can enhance the equality of students (Lambe & Bones, 2006; Valiandes, 2015) as well as their self-esteem and confidence (Norman et al., 1998). Consequently, chemistry teaching should include student support with differentiated teaching methods and materials regularly. In that way, the whole school-community from teacher educators to school principals, teachers, students and their parents could get familiar with it and find it as a normal part of education.

5.4 Meaningful and inspiring connections between theory and practices

The constant struggle in order to make meaningful connections between theory and practice was clearly included in teachers' beliefs about differentiation in diverse classes. Teachers in this study were aware of the fact that diverse students prefer methods that are connected to their lives as some studies have indicated earlier (e.g. Kousa et al., 2018). Students also need to know why chemistry is important and therefore, the connectiveness of methods and materials was underlined by their teachers like in previous studies (e.g. Santangelo & Tomlinson, 2012). Teachers in this study have used versatile, familiar and connective examples in order to enhance students' positive attitudes and achievement. As indicated before, topics concerning science, technology, society and environment (STSE) have been found beneficial for diverse students (Bennett et al., 2007). Despite the meaningful connections, teachers noted that there are a lot of difficult aspects in chemistry that are almost impossible to connect to something that is familiar or interesting to students. As presented before, teachers find chemistry extremely difficult because it is abstract and full of difficult concepts and terms. It can be suggested, that those topics that cannot be connected in meaningful ways should be presented as abstract as they are and use methods that students prefer should be used such as computer-based methods, modelling and videos in order to enhance their interest and understanding of issues that cannot be seen.

Furthermore, teachers believed that meaningful connections between theory and practice needed also inspiring examples from students' everyday lives in order to be more interested and successful in chemistry. Teachers found that methods such as hands-on activities are especially inspiring also amongst diverse students. The results are in line with other studies (e.g. Norman et al., 1998). Additionally, teachers agreed that a student-centered approach was far more inspiring than the traditional teacher-led way. This is in line with teachers' modern and constructivistic beliefs about

student-centered teaching practices (Markic & Eilks, 2012). However, there was a striking concern about the different achievement-levels of students and how also high-achieving students have a right to have inspiring tasks instead of more exercises from the chemistry book. According to Tomlinson and Moon (2013), teaching methods should respond to diverse students' readiness, interests and learning profiles. In this case, for example hands-on activities should be planned and implemented for different levels and the tasks should be in line with students' characteristics. On the other hand, a teacher should minimize the achievement gap (Valiandes, 2015), not increase it. All in all, differentiated teaching should aim for the success of all students (Morgan, 2014). That could be accomplished if the teachers have positive beliefs of diversity and differentiative teaching practices (Avramidis et al., 2000; Konstantinou-Katzi et al., 2013). This study suggests, that an inspired teacher with positive beliefs is in the the key role in order to inspire diverse students by providing them methods and materials which they prefer and are familiar with.

6 Conclusions and implications

The aim of this study is to understand how teachers experience their work in diverse classes where the needs of differentiated teaching practices are constantly growing. The deeper intention was to perceive new information in order to develop supportive methods that could better correspond to teachers' reality. The importance of teachers' beliefs concerning their reality as chemistry teachers in diverse classes was clearly indicated by this study. It was discovered, that teachers have basic knowledge about diverse students and they use considerable amount of differentiated methods and materials already in order to support them. However, teachers believe that they are not sufficiently educated in order to meet the needs of diverse students. Therefore, it can be suggested, that teachers' opinions should be taken into account more carefully because of the general and practical expertise that they have about their classes. Based on the results of this study, the following recommendations for future research and practices are proposed:

1. Sufficient teacher support should be provided regularly during teacher's career. Most of all, opportunities to enhance practical teaching skills in diverse classes are needed along with theoretical knowledge. Additional support such as assistance from colleagues and special education teachers as well as

consulting, workshops and courses from the university teacher educators are needed.

2. Teachers' sensitivity and expertise to recognize different problems in diverse classes should be encouraged and their positive and negative beliefs taken into account in order to affect their practices.
3. Chemistry lessons with supportive methods and materials for different achievement-levels should be a normal part of education. Successful teaching practices in diverse classes need time, resources and effort as well as cooperation with teacher educators, school principals, teachers, students and their parents.
4. Theory and practice should be connected in a way that is meaningful for students. Meaningful ways can include familiar contexts from students' lives and/or methods and materials that they prefer. Meaningful and inspiring teaching practices can have remarkable effects on students' interests in chemistry and achievement in turn.

Despite the limitations, this study introduces new prospects and understanding about teachers' ideas, experiences and beliefs about diversity and chemistry teaching practices in diverse classes. However, there are still many problems that need to be solved and questions to be answered. Firstly, more information about science teachers' beliefs about diversity and differentiative teaching practices is needed in order to provide sufficient support for them. Secondly, it is essential to find out more about the benefits, challenges and true effects on regular differentiation. Thirdly, it is essential to understand what features make chemistry difficult and how it can be differentiated without unnecessary alleviations. Finally, more knowledge is needed how science and especially chemistry teachers' positive beliefs and practices could be connected to better student achievement.

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