*Eurasia Journal of Mathematics, Science & Technology Education,* 2014, **10**(4), 271-283

# Heterogeneity and Diversity: A Growing Challenge or Enrichment for Science Education in German Schools?

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*Received 28 September 2013; accepted 16 May 2014*

The present paper gives an overview of research on heterogeneity and diversity in German chemistry classes. The terms "heterogeneity" and "diversity" are first explained before discussing specific studies. The different facets of heterogeneity and diversity are asserted. Finally, the focus will be placed on language and special needs since both of these dimensions are frequently discussed in the German context. A comparison between international and national research are given. The implications and suggestions not only for national but also for international science research are presented.

*Keywords*: Language, Special Needs, Inclusion, International and National View

## INTRODUCTION

The relevance of "heterogeneity" and "diversity" is growing because of such widespread developments as globalization, international migration, and both demographic and ethical changes in societies (Krell, Riedmüller, Sieben, & Vinz, 2007). Germany is also experiencing these developments. For example, in 2011 19,5 % of the German population had a migration background in sensu strictu[1]. And the percentage has been constantly increasing (Statistisches Bundesamt Wiesbaden, 2012). Societal developments also have an impact on the learning processes taking place in schools. The three most important determinants which influence student performance are socio-economic context, family background, and migration status (OECD, 2010).

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doi: 10.12973/eurasia.2014.1082a

Students bring many different prerequisites to the classrooms and teachers have to cope with each one. The differences are multifarious and often overlap. In the U.S. literature these differences are summarized using eight main dimensions. The so-called "Big 8" are age, gender, ethnicity, religion, race[2], sexual orientation, functional role, and mental/physical ability (Krell et al., 2007). Another common representation employed is the diversity wheel, which is mostly used for diversity management in organizations. It distinguishes between internal and external dimensions (Figure 1). The dimensions shown in the diversity wheel can be transferred to school life, because they impact students' achievement, a priori knowledge, beliefs, language skills, ways of learning, interests, motivation, etc. (Bohl, Bönsch, Trautmann, & Wischer, 2012). Teachers often face an enormous combination of such factors in any given classroom. Depending on who you ask, the varying dimensions are considered to carry varying levels of importance (Trautmann & Wischer, 2011).

In the area of psychological research on teaching and learning (*Lehr-/Lernforschung*), the focus often lies on the manner of teaching, the teachers themselves, and any


ISSN: 1305-8223

***State of the literature***

- Students` linguistic skills and special needs influence the achievement in chemisty and science.
- Chemistry teachers are not aware enough or not educated to teach linguistic heteriogenious classes and students with special needs.
- A lack of materials and teaching methods to deal with diversity in chemisty classes exists.

***Contribution of this paper to the literature***

- The assignability of the research from one country to another is in many cases – especially for the topic of hetergenity and diversity – hardly possible.
- Though heterogenity and diversity seem to be a growing challange for chemisty education, the cooperation with different other disciplines seems to be an enrichment for chemistry education as well.
- This paper will help to clarify the German perspective in the context of an international view to achieve a reciprocal enrichment.

contextual factors and social determinants (socio-economic background, culture, language etc.). But student dispositions including a priori knowledge, native intelligence, intrinsic motivation and metacognitive ability also count strongly for different achievements (Helmke & Weinert, 1997). The advantage of this approach is that the determinants can be investigated quite reliably. Dealing with differences means that research must take individual learning prerequisites into consideration in order to optimize teaching practices and learner achievement. Weinert (1997, p. 51) explains four options for reacting to different sets of preconditions:

*Ignore the differences (passive reaction)*
*Adapt the students to the lesson requirements (substitutive reaction)*
*Adapt the lesson to the relevant differences between the students (active reaction)*
*Foster all students individually with specifically differentiated lessons (proactive reaction).*

The reactions named in point 1 and 2 view differences as problems which have to be compensated for. Reactions 3 and 4 claim that difference is the norm. In addition to point 3, point 4 not only demands adaptation of the methods and task complexities, but also requires differentiated aims to be stated and met for each student (or group of students). Teaching and learning must be reformed to fulfil each student's needs and right to equal education[3]. It is the system, not the student, which should be adapted to the situation.

These different perspectives can be labelled as "heterogeneity" (points 1 and 2) and "diversity" (points 3 and 4). "Whereas the paradigm of heterogeneity perceives difference as a challenge to be dealt with actively, diversity as a systemic paradigm perceives difference as an asset" and a resource for learning (Sliwka, 2010, p. 213, Figure 2).

The concept of diversity is a normative one that is not very well-defined in the area of teaching and learning research. This area has to be endorsed by a socio-critical dimension. In the field of social criticism and epistemology, social recognition of diversity and social justice in the education system are being discussed (Trautmann & Wischer, 2011). From this point of view, individual dispositions are perceived as a problematic stigmatization, which is either rewarded with privileges or punished through disadvantages. Certain attributes are traditionally defined as the norm, e.g. to be male, white, western, rich, not disabled, etc. (Leiprecht & Lutz, 2003). But such attributes are historically and socially induced and must not negatively impact one's educational chances. Supporters of the socio-critical perspective urge an inclusive school system where every student is welcome and resources are provided accordingly (Prengel, 2011). This is in line with a human rights approach and with Germany's obligation to follow the UN Convention of Rights for Disabled Persons, an agreement which Germany signed and ratified (United Nations, 2006)[4].

This socio-critical perspective, as interesting as it reads on paper, represents a highly utopian view of the current educational systems in Europe. Thus, we need both perspectives. Psychological research on teaching and learning is necessary to categorize and describe group affiliations, to investigate associated disadvantages, and to plan and apply intervention. Social criticism is needed to bring to remind us of the inclusive function[5] of the school system, to locate the reforms of the education system normatively and to evaluate such reforms in conjunction with a human rights approach (Prengel, 2011).

The dilemma in practice is that the normative view cannot be realized in the current school system. There is an enormous gap between theory and practice. Feyerer (2007) suggests a range of principles which teachers should try to extend to the right-hand side (see Table 1) in order to welcome diversity into their classrooms and to approach the normative perspective. More cooperation and less competition, more teamwork and less single person working etc. have shown to be supportive in inclusive classroom settings. It is important that teachers implement these principles step by step if students are not used to inner differentiation, for example. For some students it can be helpful to work in the way written on the left side in Table 1. Not all students benefit from the same way of teaching.

To be successful all teachers need to cooperate and contribute to the establishment of a changed learning culture. Also science teachers, who traditionally focus on content learning by following the systematics of their subject, are asked to welcome diversity (Lembens & Rehm, 2010). Ever since the emergence of the idea of "science for all" science teachers have also been asked to design their lessons for all the children in their classrooms, not just for future scientists (European Commission, 2007; National Research Council, 1996) or the supposedly "average" student. However, neither pre- nor in-service education sufficiently prepares science teachers for the challenges of dealing with the different diversity dimensions found in the classroom (Burns & Shadoian-Gersing, 2010).

**Dealing with the Diversity Dimensions – An International View**

As mentioned above the consideration of student diversity is meaningful when it comes to teaching and learning science. The following section focuses on two dimensions from an international viewpoint: linguistic heterogeneity and special needs since these are fields that are primarily, but newly discussed in the German educational context and also lie in the area of expertise of the authors. Other dimensions, e.g., gender, have a much longer tradition and are well-elaborated in the German context. Later in the article there are recommendations given for further study.

**Language Skills**

Language is an important issue for every school subject. To facilitate learning students must master the general language of instruction. Additionally, each subject uses its own specific terminology and jargon. Therefore, all students – irrespective of their migration background, culture or gender – need to learn, understand and be able to competently use the language of science (commonly called "scientific language") so that they can develop a certain level of scientific literacy. The acquisition of scientific language is one of the aims of science classes. This is valid for all of students without considering their social-economic status or even their cognitive abilities. There is one common ground for all students: at the end of science lessons they must be able to communicate in society using scientific language. This "foreign language requirement" in science classes is true for each and every student.

However, language acquisition is often impeded by some of the diversity dimensions shown above. There are different factors influencing the development of a second, foreign language such as English or Spanish which are comparable to problems associated with the acquisition of scientific language. Collier (1987) listed the following factors: (a) a student's age of arrival in a new country, (b) total length of residence in the country, (c) grade of entry in a new school, (d) acquisition of first reading and writing skills, (e) formal educational background, (f) the family's educational and socio-

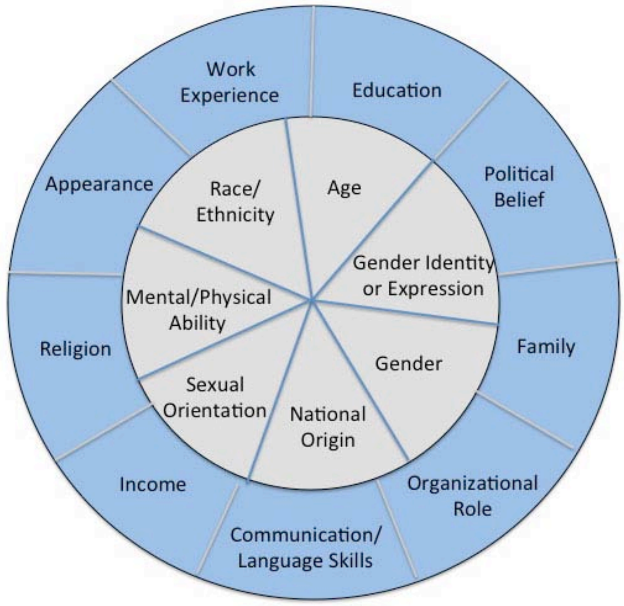


**Figure 1**. Diversity wheel (http://web.jhu.edu/dlc/resources/diversity_wheel/) [26/07/2013]

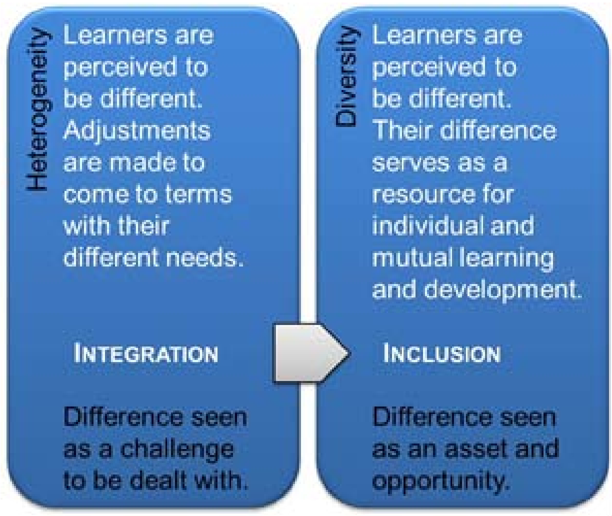


**Figure 2.** Paradigm shift: from heterogeneity to diversity (modified after Sliwka, 2010, p. 214)

**Table 1**. A range of teaching principles (Feyerer, 2007)

| Competition | ⇔ | Cooperation |
|---|---|---|
| Single person working | ⇔ | Team- and group work |
| Selection | ⇔ | Support |
| Assessment | ⇔ | Feedback |
| External differentiation | ⇔ | Inner differentiation |
| Content-centered | ⇔ | Learner-centered |
| Subjects | | Projects |

economic background, and (g) students' former exposure to the new country's lifestyle.

International research has only produced a few studies focusing on educationally diverse students. Salleh, Venville and Treagust (2007) and Miller (2009) showed that students in bilingual classes were able to successfully use scientific learning materials in their own native languages. Furthermore, the undeveloped speech faculties of non-native speakers make content learning in chemistry/science lessons very difficult. Thus, regular chemistry/science lessons turn into a bilingual minefield for such learners. They not only have to assimilate the basic content presented in the lesson, but must also understand and learn the specific language belonging to Chemistry and the scientific endeavour. The study of Verplaetse (1998) shows that teachers tend to speak differently to English language learners (ELL). They usually speak more slowly with ELL, use simpler words, tell students exactly what to do rather than asking them open-ended questions, and they use simple yes/no-questions instead of asking the questions demanding high levels of thinking and linguistic skills. Thus, students have few opportunities to improve their language skills and to engage autonomously in chemistry lessons. Consequently, all students with less-developed linguistic skills in a country's official school language tend to have serious problems learning subject-matter content. They often have an insufficient grasp of the grammar rules governing the spoken and written language which they are expected to master and use (Howe, 1970; Johnstone & Selepeng, 2001). Seedhouse (2004) showed that English language learners rarely enjoy the opportunity to actively participate in regular lessons. They experience language passively and receptively and have thus far fewer opportunities to participate in the group and thereby develop their linguistic competency. Furthermore, underdeveloped language skills make the learning of content matter much more difficult, since students with this deficit often barely understand anything occurring in the science classroom. However, they are expected not only to master the subject-matter content, but must also cope with the country's official language and scientific language simultaneously. Doing so, they lose motivation in science and – even worse – the difference between their linguistic skills in the new language and the linguistic skills of native students grows larger and larger.

There are more international studies focusing on teachers' perspectives. Moore (2007), for example, interviewed three Native American teachers. The study showed that the interviewees were sensitive to the influence of their own language and how they address students. But this is the case because they also experienced the same challenges during their time at school. The teachers in this study view language as a barrier keeping students from learning and understanding science. Furthermore, a quantitative research study of 33 teachers carried out by Cho and McDonnough (2009) revealed that the language barrier and ELL students' lack of foundational science knowledge represent the largest challenges to educators. However, those teachers are specially trained for ELL and aware of the difficulties.

In general, it is difficult to pinpoint studies focusing on science teachers. Most of the studies focusing on student literacy among non-native speakers in science classes were conducted in elementary schools (Lee, 2005). Additionally, most studies centre around English Language Learners. Lee at al. (2009) showed that elementary teachers rarely discuss students' diversity in their own teaching with other colleagues in their schools. Lee at al. (2009) also found that these teachers pay attention to linguistic issues among their students, but they tend to do so quite randomly. One explanation for teachers behaving like this is that they do not feel responsible for explicitly teaching language skills in their science classes. They simply assume that since the students are regularly attending class that they are all capable, efficient users of the country's official language (Bryan and Atwater, 2002). This means that linguistic heterogeneity in the classroom often slips under the radar screen, since many teachers are not sensitive to it. Even if they are, they simply accept it as a given component in their classroom. In summary, science teachers are often unaware of the influence of missing linguistic skills (and cultural differences) as key factors in the learning of science. One frequent opinion which researchers constantly receive from teachers is that the severe time shortages built into the science curriculum are a good reason not to deal with linguistic heterogeneity and its attendant difficulties (Cho & Mc Donnough, 2009).

Not only teachers' sensitivity to these aspects is important, but also the strategies employed for dealing with them. A study carried out by Cho and McDonnough (2009) shows that teachers usually do not have strategies for dealing with linguistically heterogeneous classes. They normally talk about 1) giving students more time, 2) slowing down their rate of speaking, and 3) grouping ELL together. The study also showed that teachers do not directly consult with ELL teachers in order to address linguistic heterogeneity. At first glance, this may come as a surprise, since there are often in-house, expert ELL teachers in many schools, who generally tend to be overlooked or ignored by their colleagues. The very limited use of accommodation strategies and tools found in this study leads to the conclusion that a pressing need for targeted professional development exists.

### Students with Special Needs

As more and more students with special educational needs enter into mainstream schools, teachers, including science teachers, need to know which strategies work best in integrative classrooms so that every student has access to appropriate learning opportunities. There is almost no science education research on students with severe disabilities (Courtade et al. 2010). The Thomas Scruggs research group has conducted several studies in integrative settings to find out which conditions in science classes can help foster mildly handicapped students (Scruggs & Mastropieri, 2007; Scruggs, Mastropieri, & Boon, 1998; Scruggs, Mastropieri, & Okolo, 2008). The researchers mostly concentrated on support in intellectual development, learning and behaviour[6]. From the results of their studies the following variables were concluded to promote effective inclusive science learning:

*"an open, accepting classroom environment*
*administrative support for inclusion*
*general effective teaching skills on the part of the general education teacher*
*special education support, in the form of consultation or direct assistance*
*peer mediation, in the form of classroom assistance or cooperative learning*
*appropriate curriculum (supporting a hands-on approach to science learning)*
*teaching skills specific to particular disability or need areas"*
*(Scruggs et al., 2008, p. 7).*

Textbook-based and frontal lecture formats are common in science classrooms, but they reduce learning opportunities for special needs students who have difficulties in reading and writing scientific texts as profound and fast as their non-handicapped classmates (Scruggs & Mastropieri, 2007). These whole-class approaches usually do not provide the possibility to work in one's own speed and on one's own level of difficulty. Student-centred learning environments allow more differentiation according to the needs of all students. Scruggs et al. (2008) emphasise that students with special needs require more structured learning environments than their non-handicapped peers. A balance of openness and structuring seems to be most effective and appropriate (Werning & Lütje-Klose, 2007). The anxiety that non-handicapped students' achievement might be negatively impacted in such inclusive settings could not be confirmed (Bay, Staver, Bryan, & Hale, 1992; Heimlich, 2007). In fact, classroom practices chosen for special needs students often benefit all of the students. "The evidence (..) suggests that what is good for pupils with special educational needs (SEN) is good for all pupils" (Meijer, 2010, para. 4).

However, "general educators often lack knowledge of and experience in implementing instruction that benefits diverse learners in science" (Scruggs et al., 2008, p. 18). This intensifies at the secondary school level because differences between the students increase with age. Increasing topic specialisation and the different organisation of secondary schools, including "insufficient teacher training and less positive teacher attitudes" are responsible for difficulties in inclusive secondary education (see Meijer, 2005, p. 9; 2010; Norman, Caseau, & Stefanich, 1998). Teachers often do not know how to adapt instruction to the needs of students (Villanueva et al., 2012).

One recommended approach for dealing with these challenges is inquiry-based science education, since it is supposed to facilitate students' achievement across the entire ability range. Many studies in this rather small field investigate inquiry-based learning environments or compare them with direct instructional approaches (Bay et al., 1992; Dalton, Cobb Morocco, Tivnan, & Rawson Mead, 1997; Scruggs & Mastropieri, 2007; Trundle, 2008). Researchers agree that inquiry-based or activity-based approaches are more effective than direct instructional or textbook-based methods with respect to achievement and analytic and processing skills (Courtade et al., 2010). Engaging students in inquiry-based learning by teaching them how to reflect upon their learning processes and end-products enables learners to improve both their learning and their subject matter expertise. Low-achieving students can perform comparably to older or better-achieving students in tests (White & Frederiksen, 1998). These effects seem to be delayed rather than manifested immediately. The results of the investigations suggest that "appropriately adapted science instruction may facilitate inclusion, as well as improve classroom learning and attitudes toward science" (Scruggs et al., 1998, p. 39). Additionally, a higher percentage of students with special learning needs prefer inquiry-based learning to traditional instruction (ibid.).

However, it would be very naïve to consider inquiry-based science education as a panacea (Finkel, Greene, & Rios, 2008). The approach has to be carefully scaffolded, structured and accompanied by differentiated and adapted material to enhance science achievement for all students (Villanueva et al., 2012).

### Situation in German Schools

Just like many other countries in the world, Germany is a multicultural nation. Due to the positive economic situation after the Second World War, migration to Germany rapidly increased during the 1950s and 60s. Workers from different parts of the world came to Germany, primarily from the south and east of Europe (Turkey, Greece, Italy, Spain and former Yugoslavia).

The result was a 1973 moratorium on worker immigration by the German government. New immigrants were only given visas for the purpose of family reunification. The statistics from 2011 show that almost seven Million people in Germany do not possess German citizenship (Statistische Ämter des Bundes und der Länder, 2013)[7]. However, every fifth person in this group was born in Germany. In 2009 roughly 15.7 Million people in Germany had a migration background, which means that they moved to Germany after 1950 or that their parents were repatriated into Germany after the Second World War.

People with migration backgrounds come from 194 different countries, but mainly those in Europe (Statistisches Bundesamt, 2012). The largest group is from Turkey, followed by Italy and Poland. Diversity and immigration have continued to increase thanks to ongoing political changes in Europe, the rising number of European Union member nations, and changes in immigration policy.

Officially, about one-third of German students are not German citizens. However, this number does not describe the real situation in German schools. Most students were born in Germany and are entitled to German citizenship. Their background, however, is not German. Their parents immigrated to Germany sometime in the past, so these students speak another language than German at home and are raised in a different culture. Officially these students are seen as German, however, the question of their acceptance of, successful integration into and their active participation in German society remains open.

The issues of heterogeneity and diversity in German schools are not new ones. The problems became more obvious after different international studies like PISA, IGLU and DESI and national studies such as VERA[8]. The results of these studies revealed that Germany is pretty average in comparison to other nations when it comes to educational success. They also show that the German results would be much better than those of other countries, if students with migration backgrounds were to be excluded from the calculations. This effect is also painfully obvious, if the individual results of the 16 German Federal States are compared to one another. The city-state of Bremen, which has a very large immigrant population, achieved the lowest score in all the studies. Removing the results of students with migration background, Bremen jumps into third place in Germany. So the question remains, whether the immigrants and their children are somehow failing the State or vice versa.

Beginning in this century, the Ministry of Education has discussed the effect of heterogeneity on German schools and put together a paper listing changes which should be carried out in the school systems. Two of the first aims were more support in developing students' linguistic competencies and an offer of compensatory measures for the students coming from lower social backgrounds. Furthermore, a focus on the promotion of intercultural competences has emerged.

In many schools, lessons in German as a Second Language (GSL) are now offered and curricula have been rewritten. However, only students from large minority groups such as Turkish, Russian and Polish, or students whose parents speak English, Spanish, Italian or French at home, tend to fully benefit from such measures. This is especially true when it comes to course offerings and/or explicit language training in a student's native language in school, since trained language teacher for languages such as Arabic, Tamil, former Yugoslavian languages, etc. are generally unavailable. Also, testing out of the second foreign language requirement for university entry by passing oral and written achievement tests in one's native tongue is generally unavailable for smaller minority languages.

There are some new changes in German schools such as movements away from heterogeneity to diversity and from integration to inclusion. Almost all of the German federal States introduced the idea of inclusion into their school systems and curricula. Inclusion does not mean teaching students independent of their requirements, but rather providing individual students with the resources which support them in their individual needs, including their cognitive possibilities, culture, religion, social background and special physical and emotional needs. Unfortunately, most States do not provide the necessary resources to run such programs. Educational funding is generally the first budget item to undergo cuts. Additionally, many State governments use the term "inclusion" as a fraudulent label to save money by closing schools for physically, mentally, emotionally or behaviourally handicapped children and springing them on the unprepared, undermanned and insufficiently trained mainline school system, which itself has insufficient numbers of counsellors, social workers, psychiatric and medical professionals, etc. This results in schools, principals and teachers scrambling to find stopgap measures to fit square pegs in round holes with hardly any outside support.

## Dealing with Heterogeneity and Diversity at German Schools

When it comes to heterogeneity and diversity in German schools, there has been some recent science education research performed. Table 2 shows several German research articles which describe work in the field of heterogeneity and diversity in science education. The dimensions of language and special needs will be described below in detail, this time from a national viewpoint. Furthermore, Germany separates the



 

**Table 2**. Different dimensions of diversity in German science education research

| **Diversity dimension** | **Publication on this topic** |
|---|---|
| Gender | e.g. Bauer & Götschel (2006), Elster (2007), Engeln (2006), Faulstich-Wieland (2008), Herriger and Ducci (2010), Holstermann and Bögeholz (2007), Prechtl and Reiners (2007), Sgoff (2000), Ziegler & Stoeger (2004) etc. |
| Language | e.g. Busch and Ralle (2012), Rincke (2006), Riebling (2012), Leisen (2004), Markic (2012), etc. |
| Culture and Socio-economic status | e.g. Tajmel (2010), etc. |
| Special needs and Gifted Students | e.g. Abels (2012), Adesokan and Reiners (2012), Bolte and Behrens (2004), Krauß and Woest (2011), Schmitt-Sody and Kometz (2012); Anton (2012), Wasmann (2013), etc. |

individual scientific domains of Chemistry, Physics and Biology: the primary focus here will be on Chemistry Education.

### Language Skills

International studies such as PISA, IGLU, etc. have shown that multilingualism is primarily viewed as a disadvantage. In Germany this generally refers to bilingualism or even semi-bilingualism. In the German context this disadvantage increases for families with migration backgrounds in their history. This is considered to be one of the major problems with the German educational system in general and in German science teaching in particular (Stanat et al., 2002). The majority of immigrant students first begin learning German in a standardized, structured fashion after entering primary school when they are six to seven years old (Brandenburger, 2007). Most of these students were never in a German kindergarten, which many German children attend from the age of three. Most have grown up at home with their mother and/or grandparents. Their main contact is normally with children from the same migration background until they enter German school system. Furthermore, outside of school, they almost exclusively speak their mother tongue with their families and friends. Thus, students with migration backgrounds quite often achieve lower overall educational levels than native German speakers due to the simple lack of language skills. Reich and Roth (2002) found that only in a very few cases do bi- or multilingual students ever reach the language standard of native speakers. Thus, German as the official language of schooling lessons becomes a hurdle for such students for two reasons: 1) they often do not know the grammar rules of either their first spoken language and/or German (Maas, 2005) and 2) explicit instruction in their mother tongue (especially in written form) is normally not offered in school settings. One rare exception may be larger, big-city schools in which more predominant minority languages like Turkish or Russian are offered as part of the school curriculum.

This is also the case considering the study done by Wlotzka and Ralle (2008). The authors showed that students with migration background are mainly not able to use learning materials in their own mother language. They were mainly not able to read, understand or write scientific texts in their native language. This is easy to understand, since they use their mother language for mainly oral and not in the school context. The Turkish and Italian students in the study of Wlotzka and Ralle (2008) preferred to use the materials in German language and to write down they observation and answers in German as well.

Viewing multilingualism from the other side, Riebling and Bolte (2008) stated that multilingual students have high meta-linguistic competencies in comparison with monolingual native speakers. This is because they have already been actively exposed to deciphering and learning more than one language system. Students with migration backgrounds also proved to be more attentive with respect to the language used in chemistry lessons. However Riebling and Bolte (2008) are discussing "hidden linguistic issues". They also found that answers given by these students also tend to be much shorter and less complex, with less usage of specific, scientific terminology. This is strongly noticeable in students' answers, their statements and whenever they ask questions. Their answers do not have a high level of complexity when they combine German with the elements of scientific language.

Science education magnifies students' language difficulties by introducing and demanding proficiency in scientific language. Depending on their home situation, students are effectively faced with the equivalent of a third, fourth or sometimes even fifth foreign language for students, since German and English are mandatory in school. Scientific language also differs from everyday language, since the sentences are often packed with technical terms having specifically-defined meanings (Merzyn, 2008). Scientific texts are also frequently discontinuous and switch between prose passages, graphic illustrations and scientific formulas. Syntax in scientific texts is uncommon but nevertheless very important for understanding (Rincke, 2006; Tajmel, 2010). With respect to practical, hands-on work in the classroom, linguistic problems can build a barrier which blocks understanding of both experimental instructions and the theory behind them. Experimental problems start with insufficient understanding of the technical terms for the equipment, the materials or safety regulations. But problems also include composing, editing and managing reports and protocols (Riebling & Bolte, 2008). Furthermore, the underdeveloped linguistic skills of students with migration backgrounds make the learning of science difficult. Regular lessons turn into a bilingual minefield. Not only do the learners need to assimilate the basic content presented in the lesson, but they must also understand and learn the specific language belonging to chemistry (Leisen, 2004). These students lack the language competencies necessary to communicate and to actively participate in the lesson due to this combination (Söhn & Özcan, 2005; Deppner, 1989).

In Germany the problem of insufficient linguistic skills in a school context is associated with a migration background. However, this is not always the case. In larger German cities students coming from families with low socio-economic status quite often have language skills which are notably underdeveloped. This is also true for students with a German family background (Hesse, 2008; Tajmel, 2010). So in the German context, we cannot just speak of linguistic difficulties related to migration backgrounds. We also need to discuss linguistic heterogeneity in science classrooms against the background of multiple reasons for such differences.

From the perspective of educators, German chemistry teachers often do not see the teaching of German as a foreign language as a necessary goal within their own science lessons, nor do they accept responsibility for teaching German, since they did not study it at university. In many cases, they attempt to relegate it to a secondary position as a side issue which should be addressed by German teachers (Tajmel, 2010). Although work on linguistic heterogeneity and dealing with it in science/chemistry classes is already known to be important in the German context, studies concerning science teachers' beliefs on dealing with linguistic heterogeneity are rare. Riebling and Bolte (2008) proposed that chemistry teachers need to be highly attentive and display sensitivity when they are teaching in linguistically heterogeneous classes. This is important so the teachers can recognize the problem, deal with it in their lesson planning and teaching and try to approach this issue. Benholz and Iordanidou (2004) noticed that this is especially difficult for chemistry teachers who are monolingual. The authors showed in their study that monolingual teachers have problems in realizing linguistic heterogeneity in their classrooms. Thus, they plan their lessons and teaching for monolingual classes. We can immediately recognise the gap between how the science lessons are and how they should be with respect to language.

The growing linguistic heterogeneity in German science classrooms has led to the development of many specific pedagogies to try to reduce the problem (Busch & Ralle, 2012; Leisen, 2004; Markic, 2012). Special tools for dealing with students' linguistic heterogeneity in science classes are comparable to the other teaching tools under development (e.g. Leisen, 2004; Markic, 2011). Methods are being devised for supporting linguistic heterogeneous classes and encouraging linguistically sensitive teaching and learning. Initial evidence for applying such language-activating tools has recently become available (see Markic, 2011). The evidence supports the claim that instruction and evaluation of practical work in linguistically heterogeneous classes needs to be assisted by language-activating and supporting tools. This allows for the active inclusion of more students in practical and experimental tasks and contributes to better levels of achievement. However, the use of language tools as a supporting measure for promoting lab work in classes that are linguistically heterogeneous is a relatively new field in German science education. Research regarding good practices and their effects in this area, therefore, is still quite thin. But various curriculum development projects and the accompanying research are currently underway in this field (Busch & Ralle, 2011; Markic, 2011).

Finally, Markic (2011; 2012) concluded that the cooperation between chemistry teachers and GSL teachers offers a good opportunity for developing new teaching materials concerning the linguistic heterogeneity. Furthermore, this project shows that the collaborative development of chemistry lesson plans by science and GSL teachers seems to be a promising way to create motivating and attractive learning environments. These will allow teachers to help their students not only to learn chemistry but also to improve their knowledge and competencies in the German language.

### Special Needs

The European Agency for Development in Special Needs Education collects data for member countries about students with special needs. According to Germany's Federal Statistics Office a total of 480,025 school-aged students were registered in all educational settings for the 2010/2011 school year. 377,922 of these students attended a segregated special school. 102,102 students attended an inclusive setting (European

Agency, 2013). Since the 1970s inclusion has been in demand in Germany and the number of inclusive settings has increased since the 1980s. But the statistics indicate that the conditions wished for by the United Nations (2006) have not been fulfilled yet. As a consequence, more and more teacher education institutes now provide courses on integration/inclusion for prospective teachers in mainstream schools and special needs institutions.

Research on integration in Germany began as so-called "scientific support" in school pilot projects, mostly by the command of education ministries. This was to attest to and also justify the success of integration measures against sceptics and to further develop integrative education (Preuss-Lausitz, 2009). Nowadays, research in this field has developed further and increasingly funded by third parties. It has also become more and more complex. Topics include integration at the secondary school level, teachers' professional development, diagnostics, and socialisation. The results show that modern forms of teaching in heterogeneous groups with inner differentiation are advantageous for joint learning. The results concerning school achievement are, however, inconsistent (Preuss-Lausitz, 2009).

In science education special needs is a relatively new research field with respect to both integrative/inclusive and segregated settings. Only a few science education researchers like Abels or Schmitt-Sody have a background in special needs education. Fortunately, the number of special education researchers achieving a PhD in science education is increasing.

There is only a small body of research evidence up to this point (see Table 2). Most researchers concentrate on one area, for example, listening skills (Adesokan & Reiners, 2012), learning (Schmitt-Sody & Kometz, 2012), social and emotional development (Abels, 2012) or mental development (Krauß & Woest, 2011)[9]. Research questions are quite diverse, but generally cover similar topics to those looked at in general science education, for example, the evaluation of student labs (Schmitt-Sody & Kometz, 2012) or materials development (Krauß & Woest, 2011). Abels (2012) investigated whether or not students with special needs could succeed using guided inquiry. The results suggest that such students benefit from inquiry-based science education and student labs, however, the learning environments need to be much more carefully designed. Differentiation, scaffolding, visualisation, etc. are keywords to support academic achievement among special needs students. The results give some tantalizing hints for practitioners, but they still need to be grounded in a much larger data base before anything definitive can be stated.

## DISCUSSION

Comparing international and German research on heterogeneity and diversity, one quickly realises that Germany's research program is still in its early stages of development. There remains much research which needs to be carried out on both teachers' professional development in the context of diversity and heterogeneity and on the changes necessary in teaching practices.

This is especially true in the field of inclusion, since this area never belonged to the areas of interest in science education research. For a long time there was strong segregation of students in schools based on their abilities and on the different dimensions of diversity. This included science teacher education, too.

International studies also show that the transferability of results between countries is not possible in most cases. First, the German language is different from many others. The German school system and the support measures it offers to students are also not directly comparable to school systems in other countries. Furthermore, there is wide variance in the migration backgrounds and cultural make-up of students in different nations. In Germany the largest numbers of immigrants are mainly Turkish, Polish and Russian; in international studies students tend to come from South America, Japan or China. Therefore, German students with migration backgrounds are different in their languages and their cultures when compared to the students in international studies. There are also large differences in the "degree" of migration. In Germany, migration students tend to be born in Germany. In the international studies, students have generally just arrived in a country and/or are refugees with a spotty or interrupted education.

The second dimension emphasized in this paper – students with special needs – is a new field in German science education research. Traditionally students with special needs attended special schools and were mainly taught by specially-trained teachers with expertise in dealing with special needs students. Recently and in the sense of inclusion, students with special needs have been rerouted into mainstream schools and placed in so-called "inclusion classes". Therefore, there is a severe lack of science teachers who have studied or received special training to teach in and correctly handle inclusion classes. Furthermore, in-service teacher training programs in this direction are almost non-existent. Science educators mainly work with an eye towards science teaching and learning; special education educators work with a focus solely on special education teaching.

This situation resembles the old adage that teachers and educational systems cannot "look beyond their own noses". As studies from Markic (2012) and Abels (2012) have already shown, educational success rates will rise dramatically, if educators and teachers from the two disciplines work together. Although the quantity of German research results lags behind international studies at the moment, the emerging message of current science education research is for schools, teachers and teacher trainers to connect together more of the available disciplines mentioned above.

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[1] Persons "with an immigrant background are all those who have immigrated to the current territory of the Federal Republic of Germany since 1949, as well as all foreigners born in Germany and all persons born in Germany as Germans with at least one parent who had immigrated to Germany after 1949 or was born there as a foreigner" (Statistisches Bundesamt Wiesbaden, 2012, p. 6, translated by Henkes & Stuhler, 2010, p. 3).

[2] The term "race" is negatively connoted in Germany and is not used anymore.

[3] "Equal" does not mean everyone is treated the same, but rather that everyone's personal diversity underlies equal rights when it comes to satisfying socio-emotional and cognitive needs.

[4] http://www.un.org/disabilities/countries.asp?id=166 [18/07/2013]

[5] to be distinguished from the selective function

[6] Integrative schools mostly struggle with students who show emotional/behavioral disorders (Meijer, 2010).

[7] The current population of Germany is roughly 82 million people.

[8] PISA = Programme for International Student Assessment; IGLU = German for the Progress in International Reading Literacy Study; DESI = Deutsch Englisch Schülerleistungen International (Study assessing students' linguistic skills in German and English); VERA = VERgleichsArbeiten (Comparative Study between German students)

[9] The Standing Conference of the ministry of education and cultural affairs gives recommendations for the following foci of support (*Förderschwerpunkte*): emotional and social development, learning, speech, mental development, hearing, vision, physical development, autism and chronic illness (http://www.kmk.org/bildung-schule/allgemeine-bildung/sonderpaedagogische-foerderung.html [17/12/2013]).

## REFERENCES


Abels, S. (2012). Including students with special needs in inquiry-based science education – what can we learn from special needs education? S. Markic, D. di Fuccia, I. Eilks, & B. Ralle (eds.), *Heterogeneity and cultural diversity in science education and science education research* (pp. 163-174). Aachen: Shaker.

Adesokan, A. & Reiners, C. S. (2012). On the way to scientific inquiry – supporting hearing-impaired learners in chemistry classes. S. Markic, D. di Fuccia, I. Eilks, & B. Ralle (eds.), *Heterogeneity and cultural diversity in science education and science education research* (pp. 219-224). Aachen: Shaker.

Anton, M. (2012). Promotiong the aquisition of chemical knowledge by structuring content and processes in instructing gifted students. S. Markic, D. di Fuccia, I. Eilks, & B. Ralle (eds.), *Heterogeneity and cultural diversity in science education and science education research* (pp. 143-154). Aachen: Shaker.

Bauer, R., & Götschel, H. (2006). *Gender in Naturwissenschaften. Ein Curriculum an der Schnittstelle der Wissenschaftskulturen [Gender in science. A curriculum at the interface of the science cultures]*. Mössingen-Talheim: Talheimer.

Bay, M., Staver, J. R., Bryan, T., & Hale, J. B. (1992). Science instruction for the mildly handicapped: direct instruction versus discovery teaching. *Journal of Research in Science Teaching, 29*, 555-570.

Benholz, C., & Iordanidou, C. (2004). *Fachtexte im Deutschunterricht der Sekundarstufe I. 5. - 8. Jahrgangsstufe. Deutschunterricht.* Sonderheft: Das mehrsprachige Klassenzimmer, 4, 19 - 27.

Brandenburger, A. (2007). Fachunterricht ist Sprachförderung ... Selbstständiger und kompetenter Umgang mit Lesetexten und Fachsprache. *Pädagogik*, 6, 29-32.

Burns, T., & Shadoian-Gersing, V. (2010). The importance of effective teacher education for diversity. OECD (ed.), *Educating Teachers for Diversity. Meeting the Challenge* (pp. 19-40). OECD Publishing.

Busch, H. & Ralle, B. (2012). Special language competences – diagnosis and individual support. S. Markic, D. di Fuccia, I. Eilks, & B. Ralle (eds.), *Heterogeneity and cultural diversity in science education and science education research* (pp. 11-22). Aachen: Shaker.

Bohl, T., Bönsch, M., Trautmann, M., & Wischer, B. (2012). *Binnendifferenzierung. Teil 1: Didaktische Grundlagen und Forschungsergebnisse zur Binnendifferenzierung im Unterricht [Inner differentiation. Part 1: Educational foundations and research results concerning inner differentiation in classes]* (Vol. 17). Immenhausen: Prolog.

Bolte, C., & Behrens, J. (2004). Zur Situation des Physik/Chemie-Unterrichts im Förderschwerpunkt Lernen [To the situation of the physics/chemistry education in the focal point of support learning]. A. Pitton (ed.), *Chemie- und Physikdidaktische Forschung und naturwissenschaftliche Bildung.* (pp. 317-319). Münster: LIT.

Bryan, L. A., & Atwater, M. M. (2002). Teacher beliefs and cultural models: A challenge for science teacher preparation programs. *Science Education, 86*, 821–839.

Cho, S., & McDonnough, J. T. (2009). Meeting the needs of high school science teachers in English language learner instruction. *Journal of Science Teacher Education, 20*, 385–402.

Collier, V. (1987). Age and rate of acquisition of second language for academic purposes. *TESOL Quarterly, 21*, 617-641.

Courtade, G. R., Browder, D. M., Spooner, F., & DiBiase, W. (2010). Training teachers to use an inquiry-based task analysis to teach science to students with moderate and severe disabilities. *Education and Training in Autism and Developmental Disabilities, 45*, 378-399.

Dalton, B., Cobb Morocco, C., Tivnan, T., & Rawson Mead, P. L. (1997). Supported inquiry science: teaching for conceptual change in urban and suburban science classrooms. *Journal of Learning Disabilities, 30*, 670-684.

Deppner, J. (1989). *Fachsprache der Chemie in der Schule: Empirische Untersuchung zum Textverständnis und Ansätze zur sprachlichen Förderung türkischer und deutscher Schülerinnen und Schüler.* Heidelberg: Groos.

Elster, D. (2007). Student interests — the German and Austrian ROSE survey. *Journal of Biological Education, 42*, 5-11.

Engeln, K. (2006). Schülerlabore: Interessensförderung bei Mädchen und Jungen [Student laboratories: fostering the interests of girls and boys]. A. Pitton (ed.), *Lehren und Lernen mit neuen Medien. Jahrestagung der GDCP. 2005; Gesellschaft für Didaktik der Chemie und Physik* (pp. 254-256). Münster: LIT.

European Agency for Development in Special Needs Education (2013). *Special needs education. Country data. Germany*. Online: http://www.european-agency.org/country-information/germany/german-files/GERMANY-SNE.pdf [17 Dec 2013]

European Commission (2007). *Science education now: a renewed pedagogy for the future of Europe.* Online: http://ec.europa.eu/research/science-society/ document_library/pdf_06/report-rocard-on-science-education_en.pdf [18 Mar 2008]

Faulstich-Wieland, H. (2008). *Genus – geschlechtergerechter naturwissenschaftlicher Unterricht in der Sekundarstufe I [Genus – gender-neutral science education in lower secondary]*. Bad Heilbrunn: Klinkhardt.

Feyerer, E. (2007). Integration an (ober-)österreichischen Hauptschulen. Eine Standortbestimmung für das Projekt Schulentwicklung durch Schulprofilierung [Integration at (Upper) Austrian lower secondary schools. A standpoint of the project school development by school profiling]. *Zeitschrift für Inklusion, 1*, 1-21.

Finkel, L., Greene, K., & Rios, J. (2008). Accomodating student diversity within inquiry. E. Abrams, S. A. Southerland & P. Silva (eds.), *Inquiry in the classroom. Realities and opportunities* (pp. 91-139). Charlotte, North Carolina: IAP.

Heimlich, U. (2007). Gemeinsamer Unterricht im Rahmen inklusiver Didaktik [Common education in within the scope of inclusive education]. U. Heimlich & F. Wember (eds.), *Didaktik des Unterrichts im Förderschwerpunkt Lernen. Ein Handbuch für Studium und Praxis* (pp. 69-80). Stuttgart: Kohlhammer.

Helmke, A., & Weinert, F. E. (1997). Bedingungsfaktoren schulischer Leistungen [Determinants of educational achievement]. F. E. Weinert (ed.), *Psychologie des Unterrichts und der Schule* (pp. 71-176). Göttingen: Hogrefe.

Henkes, C., & Stuhler, A. S. (2010*). Participation and recognition. European approaches to a social democratic integration policy.* Online: http://library.fes.de/pdf-files/id/ipa/07588.pdf [26 Jul 2013]

Herriger, C., & Ducci, M. (2010). „Forsche Schülerinnen forschen“. Ein Programm zur Förderung des naturwissenschaftlich-technischen Interesses von Schülerinnen ["Self-assertive students research". A programme to foster the scientific-technical interest of female students]. *Chemie konkret, 17*(1), 13-18.

Hesse, S. (2008). Wenn Schülern die Wörter fehlen. Fachunterricht in Klassen mit Migrationshintergrund. *Naturwissenschaften im Unterricht - Chemie, 106/107*, 66-71.

Holstermann, N., & Bögeholz, S. (2007). Interesse von Jungen und Mädchen an naturwissenschaftlichen Themen am Ende der Sekundarstufe I [Interest of boys and girls in scientific topics at the end of lower secondary education]. *Zeitschrift für Didaktik der Naturwissenschaften, 13*, 71-86.

Howe, M. (1970). *Introduction to human memory: a psychological approach*. New York: Harper and Rowe.

Johnstone, A. H., & Selepeng, D. (2001). A language problem revisited. *Chemistry Education Research and Practice, 2*, 19-29.

Krauß, R., & Woest, V. (2011). Untersuchung generativer Prozesse beim naturwissenschaftlichen Lernen von SchülerInnen mit Förderschwerpunkt geistige Entwicklung [Inquiring generative processes during science learning of students with the focal point of support mental development]. D. Höttecke (ed.), *Naturwissenschaftliche Bildung als Beitrag zur Gestaltung partizipativer Demokratie* (pp. 605 - 607). Münster: LIT.

Krell, G., Riedmüller, B., Sieben, B., & Vinz, D. (2007). Einleitung – Diversity Studies als integrierende Forschungsrichtung [Introduction – diversity studies as an integrative line of research]. G. Krell, B. Riedmüller, B. Sieben & D. Vinz (eds.), *Diversity Studies. Grundlagen und disziplinäre Ansätze*. Frankfurt a. M., New York: Campus.

Lee, O. (2005). Science education with English language learners: Synthesis and research agenda. *Review of Educational Research, 75*, 491–530.

Lee, O., Maaerten-Rivera, J., Buxton, C., Penfield, R., & Secada, W. G. (2009). Urban elementary teachers` perspectives on teaching science to English language learners. *Journal of Science Teacher Education, 20*,263-286.

Leiprecht, R., & Lutz, H. (2003). Heterogenität als Normalfall. Eine Herausforderung für die Lehrerbildung [Heterogeneity as normal case. A challenge for teacher education]. I. Gogolin, J. Helmchen, H. Lutz & G. Schmidt (eds.), *Pluralismus unausweichlich? Blickwechsel zwischen Vergleichender und Interkultureller Pädagogik* (pp. 115-128). Münster: Waxmann.

Leisen, J. (2004). Der bilinguale Sachfachunterricht aus verschiedenen Perspektiven - Deutsch als Arbeitssprache, als Lernsprache, als Unterrichtssprache und als Sachfachsprache im Deutschsprachigen Fachunterricht (DFU). *Fremdsprache Deutsch, 30*, 7-14.

Lembens, A., & Rehm, M. (2010). Chemie und Demokratielernen – zwei unvereinbare Welten? [Chemistry and democracy learning – two incompatible worlds?] H. Ammerer, R. Krammer & U. Tanzer (eds.), *Politisches Lernen: Der Beitrag der Unterrichtsfächer zur politischen Bildung* (Vol. 5, pp. 281-302). Innsbruck: Studienverlag.

Maas, U. (2005). Sprache und Sprechen in der Migration im Einwanderungsland Deutschland. Maas, U. (ed.), *Sprache und Migration. Themenh*eft. IMIS-Beiträge, Heft 26, (pp. 89-134). Osnabrück: Institut für Migationsforschung und Interkulturelle Studien.

Markic, S. (2011). Lesson plans for student language heterogeneity while learning about "matter and its properties". *Paper presented at the 9th ESERA Conference, Lyon, FR.* Online: http://lsg.ucy.ac.cy/esera/

e_book/base/ebook/strand3/ebook-esera2011_MARKIC-03.pdf [12 Jun 2012]

Markic, S. (2012). Lesson plans for students language heterogeneity while learning science. S. Markic, D. di Fuccia, I. Eilks, & B. Ralle (eds.), *Heterogeneity and Cultural Diversity in Science Education and Science Education Research* (pp. 41-52). Aachen: Shaker

Meijer, C. J. W. (2005). *Integrative und inklusive Unterrichtspraxis im Sekundarschulbereich. Zusammenfassender Bericht [Integrative and inclusive teaching practice in secondary schools. A summarising report]*. Online: http://www.european-agency.org/publications/ereports/inclusive-education-and-classroom-practice-in-secondary-education/iecp_secondary_de.pdf [31 Jul 2013]

Meijer, C. J. W. (2010). Special needs education in Europe: inclusive policies and practices. *Zeitschrift für Inklusion,* Online: http://www.inklusion-online.net/ index.php /inklusion-online/article/view/136/136 [17 Mar 2014]

Merzyn, G. (2008). Sprache und Chemie lernen. *Naturwissenschaften im Unterricht - Chemie*, 106/107, 84-87.

Miller, J. (2009). Teaching refugee learners with interrupted education in science: vocabulary, literacy and pedagogy. *International Journal of Science Education, 31*, 571-591.

Moore, F. M. (2007). Language in science education as a gatekeeper to learning, teaching and professional development. *Journal of Research in Science Teaching, 18*, 319-343.

National Research Council. (1996). *National science education standards*. Online: http://www.nap.edu/openbook.php?record_id=4962&page=20 [21 Feb 2012]

Norman, K., Caseau, D., & Stefanich, G. P. (1998). Teaching students with disabilities in inclusive science classrooms: survey results. *Science Education, 82*, 127–146.

OECD (2010). *PISA 2009 at a glance*. Online: http://dx.doi.org/10.1787/9789264095298-en [20 Feb 2012]

Prechtl, M., & Reiners, C. (2007). Wie der Chemieunterricht Geschlechterdifferenzen inszeniert [How chemistry teaching orchestrates gender differences]. *Chemie konkret, 14*(1), 21-29.

Prengel, A. (2011). Selektion versus Inklusion – Gleichheit und Differenz im schulischen Kontext [Selection versus inclusion – equality and difference in the school context]. H. Faulstich-Wieland (ed.), *Umgang mit Heterogenität und Differenz* (Vol. 3., pp. 23-48). Baltmannsweiler: Schneider Verlag Hohengehren.

Preuss-Lausitz, U. (2009). Integrationsforschung [Integration research]. H. Eberwein & S. Knauer (eds.), Handbuch Integrationspädagogik (Vol. 7, pp. 458-470). Weinheim und Basel: Beltz.

Reich, H. H., & Roth, H.-J. (2002). *Spracherwerb zweisprachig aufwachsender Kinder und Jugendlicher*. Hamburg: Behörde für Bildung und Sport.

Riebling, L. (2012). Science teaching in linguistically diverse classrooms. S. Markic, D. di Fuccia, I. Eilks, & B. Ralle (eds.), *Heterogeneity and cultural diversity in science education and science education research* (p. 33-43). Aachen: Shaker

Riebling, L., & Bolte, C. (2008). Sprachliche Heterogenität im Chemieunterricht. D. Höttecke, (ed.), *Kompetenzen, Kompetenzmodelle, Kompetenzentwicklung. Gesellschaft für Didaktik der Chemie und Physik – Jahrestagung in Essen 2007* (pp.176–178). Münster: LIT.

Rincke, K. (2006). Alltagssprache versus Fachsprache - eine Bühne für die fachliche Auseinandersetzung mit dem Kraftbegriff?. A. Pitton, (ed.), *Lehren und Lernen mit neuen Medien. Gesellschaft für Didaktik der Chemie und Physik – Jahrestagung in Paderborn 2005* (pp. 66–68). Münster: LIT

Salleh, R., Venville, G. J. & Treagust, D. F. (2007). When a bilingual child describes living things: an analysis of conceptual understanding from a language perspective. *Research in Science Education, 37*, 291-312.

Seedhouse, P. (2004). *The international architecture of the language classroom: a conversation analysis perspective*. Malden: Blackwell.

Schmidt-Sody, B., & Kommetz, A. (2012). Following new paths by students labs in teaching chemistry to children with special needs. S. Markic, D. di Fuccia, I. Eilks, & B. Ralle (eds.), *Heterogeneity and cultural diversity in science education and science education research* (pp. 199-202). Aachen: Shaker

Scruggs, T. E., & Mastropieri, M. A. (2007). Science learning in special education: the case for constructed versus instructed learning. *Exceptionality, 15*, 57–74.

Scruggs, T. E., Mastropieri, M. A., & Boon, R. (1998). Science education for students with disabilities: a review of recent research. *Studies in Science Education, 32*, 21-44.

Scruggs, T. E., Mastropieri, M. A., & Okolo, C. M. (2008). Science and social studies for students with disabilities. *Focus on Exeptional Children, 41*, 1-24.

Sgoff, M. (2000). Mädchen im Chemieunterricht [Girls in chemistry education]. *Praxis Schule 5-10, 4*, 62-65.

Sliwka, A. (2010). From homogeneity to diversity in German education. OECD (Ed.), *Educating Teachers for Diversity: Meeting the Challenge* (pp. 205-217). OECD Publishing.

Söhn, J., & Özcan, V. (2005). Bildungsdaten und Migrationshintergrund: Eine Bilanz. Bundesministerium für Bildung und Forschung (ed.), *Migrationshintergrund von Kindern und Jugendlichen: Wege zur Weiterentwicklung der amtlichen Statistik* (pp. 117-128). Bonn: Berlin.

Stanat, P. et al. (2002): *PISA 2000: Die Studie im Überblick. Grundlagen, Methoden und Ergebnisse.* Berlin: Max-Planck-Institut für Bildungsforschung.

Statistisches Bundesamt (2012). 10,7 Millionen Migranten aus 194 Ländern leben in Deutschland. Online: https://www.destatis.de/DE/PresseService/Presse/Pressemitteilungen/2012/12/PD12_448_122pdf.pdf;jsessionid=0E0573FC71C30F397D9C552A8865CCF1.cae2?__blob=publicationFile [12 Dec 2013]

Statistisches Bundesamt Wiesbaden. (2012). *Bevölkerung und Erwerbstätigkeit. Bevölkerung mit Migrationshintergrund – Ergebnisse des Mikrozensus 2011 [Population and occupation. Population with migration background – results of the micro-cencus 2011]*. Online: https://www.destatis.de/DE/Publikationen/Thematisch/Bevoelkerung/MigrationIntegration/Migrationshintergrund2010220117004.pdf?__blob=publicationFile [26 Jul 2013]

Statistische Ämter des Bundes und der Länder (2013) Bevölkerung – Deutschland [Population – Germany]. Online: http://www.statistik-portal.de/Statistik-Portal/de_zs01_bund.asp [26 Jul 2013]

Tajmel, T. (2010). DaZ-Förderung im naturwissenschaftlichen Fachunterricht [Second language support in science lessons]. B. Ahrenholz (ed.), *Fachunterricht und Deutsch als Zweitsprache [Content-specific* *subject and German as a second language lessons]* (pp. 167-184). Tübingen: Narr.

Trautmann, M., & Wischer, B. (2011). *Heterogenität in der Schule. Eine kritische Einführung [Heterogeneity in the school. A critical introducation]*. Wiesbaden: VS Verlag.

Trundle, K. C. (2008). Inquiry-based science instruction for students with disabilities. J. A. Luft, R. L. Bell & J. Gess-Newsome (eds.), *Science as Inquiry in the Secondary Setting* (pp. 79-85). Arlington, Virginia: NSTApress.

United Nations. (2006). *Convention on the rights of persons with disabilities*. Online: http://www.un.org/disabilities/documents/convention/convoptprot-e.pdf [21 Feb 2012]

Verplaetse, L. S. (1998). How content teachers interact with English language learners. *TESOL Quarterly, 7*, 24–28.

Villanueva, M. G., Taylor, J., Therrien, W., & Hand, B. (2012). Science education for students with special needs. *Studies in Science Education, 48*, 187-215.

Wasmann, A. (2013). Keine Berührungsängste mit den Naturwissenschaften [No reservations with science]. *Der Mathematische und Naturwissenschaftliche Unterricht, 66*, 388-392.

Weinert, F. E. (1997). Notwendige Methodenvielfalt [Necessary variety of methods]. *Friedrich Jahresheft, 15*, 50-52.

Werning, R., & Lütje-Klose, B. (2007). Entdeckendes Lernen [Discovery learning]. U. Heimlich & F. Wember (eds.), *Didaktik des Unterrichts im Förderschwerpunkt Lernen. Ein Handbuch für Studium und Praxis* (pp. 149-162). Stuttgart: Kohlhammer.

Wlotzka, P., & Ralle, B. (2008). Experimentieren in der Muttersprache. Sprachförderung im naturwissenschaftlichen Unterricht durch muttersprachliche Experimentieranleitungen - eine Fallstudie. *Naturwissenschaften im Unterricht - Chemie, 106/107*, 62-65.

White, B. Y., & Frederiksen, J. R. (1998). Inquiry, modeling, and metacognition: making science assessible to all students. *Cognition and Instruction, 16*, 3-118.

Ziegler, A., & Stoeger, H. (2004). Evaluation of an attributional retraining (modeling technique) to reduce gender differences in chemistry instruction. *High Ability Studies, 15*, 63-83.

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