A RISING TIDE LIFTS ALL BOATS?

THE MODEL OF DIFFERENTIATION AS A TOOL FOR DIVERSITY IN SCIENCE TOWARDS SOCIAL INCLUSION

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ABSTRACT

Approaches for inclusive science teaching currently tend to focus on only one dimension of diversity at a time. This neglects the fact that diversity is multidimensional in nature and the consideration of only one dimension of diversity can yield inclusive practices with limited scope. The goal of the Project "Diversity in Science towards Social Inclusion – Non-formal Education in Science for Students' Diversity" (DiSSI) is, therefore, to promote inclusive teaching practices for dealing with several dimensions of diversity simultaneously for non-formal education. Researchers from Ireland, Germany, the UK, Slovenia, and North Macedonia are developing a teaching approach that considers the needs of (i) students with a low socioeconomic status, (ii) students of ethnic minorities or with cultural

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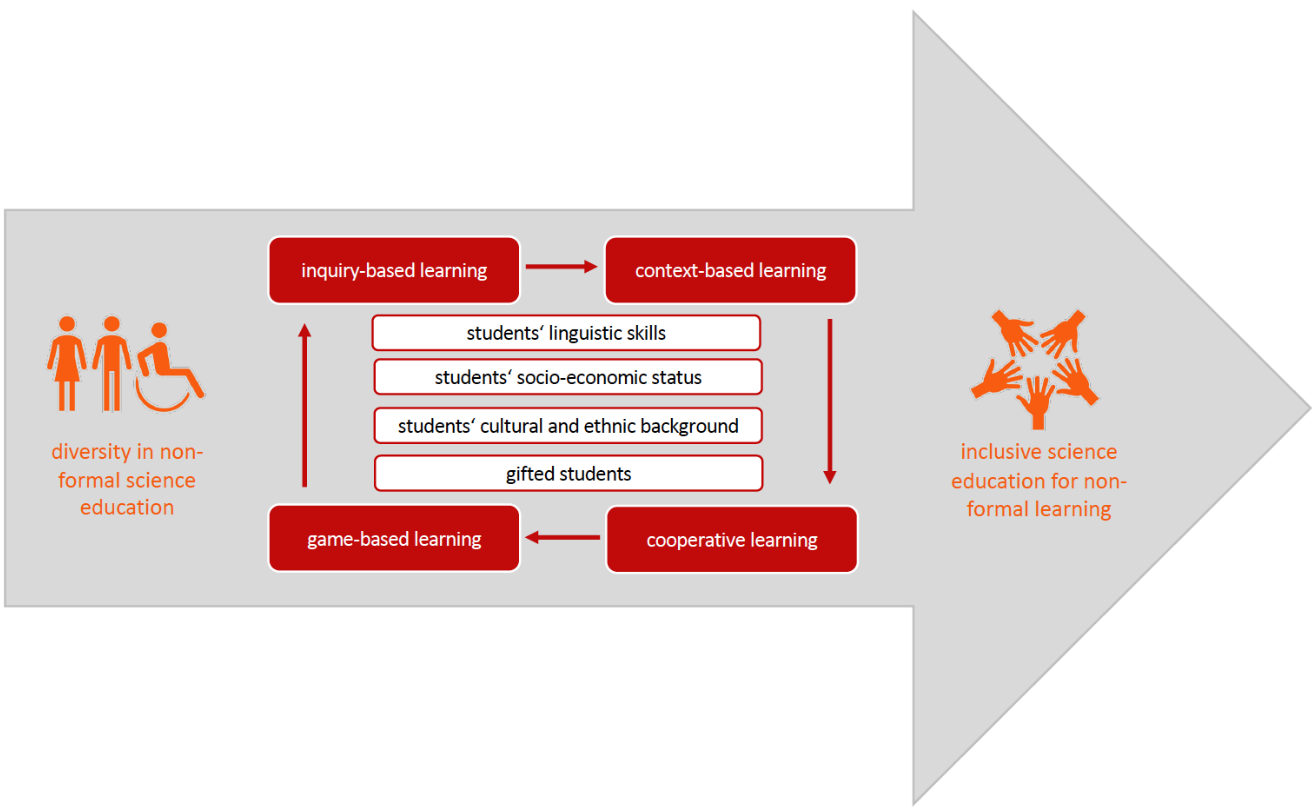
backgrounds that differ from the mainstream culture, (iii) students with low linguistic skills, and (iv) gifted students. For this purpose, a pedagogical model of differentiation is being developed. In addition, the approaches: inquiry-based learning, context-based learning, game-based learning, and cooperative learning were reviewed referring to their suitability for inclusive learning settings for non-formal science education. Conclusions were drawn about the mentioned dimensions of diversity. A new set of pedagogic approaches that benefit all learners and thus is truly inclusive will be presented. The teaching will be inclusive in the sense that it allows for cooperative learning while supporting the learning progress of the four differentiated groups of students simultaneously. Thus, in this paper, the model of differentiation will be presented, explained and the summary of the approaches will be discussed which are applicable for inclusive teaching.

KEYWORDS
Inclusion, Diversity, Differentiation

GRAPHICAL ABSTRACT



INTRODUCTION

From theory and practice, it has been clear for years that groups of students cannot be considered homogeneous. Classroom insights as well as the results of numerous studies (e.g., PISA (1)) show that the composition of learning groups is much more complex. Students in one learning group differ in their learning requirements, their attitude, their linguistic competences, motivation, and their interests (2). They also differ in their ethnicity, religion, culture, and socioeconomic status. These aspects have a significant influence on the individual use of learning offerings (3).

The professional action of a teacher in an educational context requires that students' diversity needs to be noticed recognized. It needs to be reflected upon and considered in various ways (2). In this way, all students get the same learning conditions, which enable them equal educational opportunities (4). According to Sliwka (2) inclusive teaching offers a response to this diversity. Inclusion is not only based on different levels of achievement and impairments but also considers all individual needs and characteristics of each child and adolescent.

However, the focus of research and approaches to socially inclusive chemistry education currently tends to focus on only one dimension of diversity at a time. This often causes exclusion rather than inclusion in the classroom. For example, students and groups of students are excluded by using different or additional materials or learning in separate learning groups instead of being included through this. Students are often addressed as homogenous learning groups and lessons are planned for a group, although it is obvious that every student has a unique personality, which is influenced by his / her individual biography and everyday experiences and determines his / her individual learning conditions and pathways at the same time (5). According to Schumann (4) the avoidance of exclusion and separation of certain groups of students and individuals because they cannot meet the requirements of the school is the focus of inclusion. Schools and teaching must therefore improve their offerings and frameworks to the needs and characteristics of their students. In terms of inclusive science education, goals of Scientific Literacy should be taught taking into account the educational needs and requirements of every single student and their prior knowledge (4).

However, science education for all can only be achieved if both perspectives - inclusive and scientific - are considered and interwoven (6). In doing so, an inclusive science education assumes an adaptation of the teaching and learning materials as well as the learning environment to the students and their needs, which does not focus on their weaknesses. Practices should be found that positively integrate this diversity of students into active participation of all students. This means designing learning environments, supporting students in their learning, providing assistance to ensure equal participation in the classroom for everyone (7). The diversity of a group is to be seen as a resource and a chance for individual and mutual learning processes and as an essential aspect of human development since this productive viewpoint opens up new perspectives for action (8; 2). Thereby, learning and the experiences of individual students can be enriched in the sense of constructivism, as they profit from each other's experience in cooperative activities (8).

Non-formal and informal activities are positively related to science learning (9). The OECD 2012 showed that after participation in science-related non-formal activities students often show better student performance, a stronger belief in their abilities to handle science-related tasks, and greater enjoyment of learning science (9), and greater interest to career interest in Science, Technology, Engineering and Mathematics (10). Non-formal learning is situated between out-of-school informal learning, which is strongly characterized by voluntariness, and formal learning, which is involuntary, highly structured, and organized school-based learning. Thus, non-formal and informal educational offerings lend themselves particularly well to integrative science instruction because of its open and free, yet structured and educational curriculum-oriented framework (11).

The project "Diversity in Science towards Social Inclusion – non-formal education in science for students' diversity" (DiSSI) focuses on the development and implementation of innovative methods, instruments, and activities in the form of best-practice examples of inclusive science education in general, and chemistry in particular, that aim to improve the educational opportunities of various groups of students in non-formal settings that are under-represented in science. Special attention is paid to the targeted promotion of inclusive teaching methods, which take several dimensions of diversity into account simultaneously. Researchers from Ireland, Germany, the United Kingdom, Slovenia, and North Macedonia develop a learning and teaching approach that takes into account the needs of (i) students with low socioeconomic status, (ii) students from different ethnic minorities or with a cultural background different from the dominant culture, (iii) students with low language skills and (iv) gifted students. In parallel, an evaluation framework for assessing inclusive practices in non-formal and informal science education is in the process of development and will be implemented in the project. A more distant aim is to support teachers in teaching science in diverse classes through in-service training.

THEORETICAL BACKGROUND

The UNESCO Commission (12) reacted to the growing diversity of students with the requirement for education for all, which must be achieved. This demand includes equal opportunities to participate in education for all students. Comparative studies such as PISA, show very clearly that this is currently not being achieved in science education (1). The results indicate that participating in education is not possible for some groups. Research has shown that there are specific dimensions of diversity which correspond in particular to groups of students, who are disadvantaged and are more often excluded than included (1). Factors that hinder participation in education include language difficulties, a low socio-economic status, a cultural and ethnic backgrounds that differ from the dominant culture and ethnicity, and giftedness.

Students with low language skills often have difficulties with the language of instruction and in developing of specific technical language especially in chemistry (13). Socioeconomic background affects whether students can identify with science. It is more difficult for working-class students to identify with science than for middle-class boys (14; 15).

Another factor that tends to alienate students from science is the very narrow version presented in the curricula. This version is especially difficult for students whose culture is not the majority culture because they miss many of the common reference points shared by teachers and students (16; 17). In addition, students from non-dominant ethnic groups tend to have lower academic self-concept than those who belong to the dominant group (18).

A major problem in the education of gifted learners is lack of challenge, which is needed to ensure such students can make progress. Lack of challenge can also influence learner motivation, and even lead to boredom. Meeting the needs of gifted learners is therefore a matter of matching task demand to their abilities to meet their emotional as well as their cognitive needs (19).

This results in a need for inclusive educational opportunities that enable all learners to participate in the learning process and thus in science education.

Inclusion and Chemistry Education

To talk about inclusion and to present reflections on an approach to inclusive science teaching for non-formal education, a common context needs to be established. In literature and research, the terms “inclusion” and “diversity” are interpreted differently.

The term “diversity” is a response to the thinking about plurality that the model ”Dimensions of Diversity Wheel” by Gardenswartz and Rowe (20) summarieses. Gardenswartz and Rowe (20) group various aspects of diversity into four dimensions: those of personality, the internal dimension (age, gender, etc.), the external dimension (religion, education, income, etc.), and the organizational dimension (function and classification, place of work, management status, etc.). These aspects are consequently those that either connect individuals or differentiate them (21). Starting from here, Anne Sliwka defines the term “diversity” as following (2, p 214): *Diversity: Learners are perceived to be different. Their difference serves as a resource for individual and mutual learning and development.* The term "diversity" has a positive connotation (2). Following these definitions, Sliwka defines inclusion as (2, p 214): *Difference seen as an asset and opportunity.*

It is through the perception of the varying aspects of diversity and a positive approach to them that inclusion becomes possible (2).

According to Schumann (4) inclusive teaching demands an active response to diversity and is based on the specificity and individual needs of each child. Therefore, the term inclusion must be defined broadly. So, the focus of inclusion is on avoiding exclusion and the separation of certain groups of students and individuals. Different learning opportunities (formal, non-formal, informal) must therefore adapt and often improve their offers and frameworks to the needs and characteristics of their students while considering the diversity of all students (6).

Differentiated learning and teaching are one way to deal with the differences between the students. It is the opposite of one-size-fits-all teaching (22). According to Tomlinson and Allan (23), differentiated teaching addresses the learning needs of all students rather than teaching the class as if all individuals in it were fundamentally the same. Differentiation is an attempt to take into account differences within a learning group by using various methods, tools, and activities that change learning settings to deal with students' individual needs (23). Differentiation does not only refer to the dimension of students' cognitive achievement it takes all the Dimensions of Differentiation into account (22).

We know that these demands are not new. Worldwide, schools are obliged to introduce educational policy measures to make teaching and learning environments inclusive (24).

An approach that deals with the diversity of learners and their multifaceted needs is the Universal Design for Learning (UDL). The Center for Applied Special Technology (CAST) (25) describes three principles to consider for inclusive learning. Three guidelines are listed for each of the principles, and examples of concretization are given for each. These principles include: (1.) "provide multiple means of engagement",(2.) "provide multiple means of representation", and (3.) "provide multiple means of action and expression" (25). Baumann et al. (26) provide an example of how UDL can be used in the planning and delivery of science education with an experimental problem-based learning setting that is aligned with the basic principles of UDL and based on differentiated work materials.

However, the implementation of the more normative outcomes discussed in research is proving difficult in some areas. For example, research has shown that in the natural sciences, especially in chemistry, there is a particular difficulty in combining the often complex and abstract subject content and competencies with inclusive techniques and methods (27). In order to be able to deal with the diversity of students in chemistry lessons, appropriate subject pedagogical approaches are needed. Research projects (e.g., 28) have shown that the "*inclusive pedagogical approach*", which enables the participation and self-determination of all students without prior categorisation due to its open pedagogical design, is particularly suitable for inclusive chemistry teaching (29).

The realisation of the call for "Science education for all" demand can only work if inclusive and scientific perspectives have interwoven (6). Inclusive science education in general, and chemistry education in particular adapts teaching and learning materials to the needs of all students. The aim is to find practices and methods that positively unite the diversity of students in a common science classroom. This results in the task of designing learning settings, supporting students in their learning, providing assistance to ensure equal participation in the classroom for everyone (7).

Research on inclusive education is currently mainly related to science in general. In the following, the focus will be more on science education. The findings presented here can be generalised to chemistry education.

Non-Formal Education

The OECD defines informal learning as learning outside of school without structure or curriculum (30). Informal science learning includes activities in out-of-school settings that are not part of a formally assessable educational or curricular program of an educational institution (30). Examples include voluntary visits to museums, playing a computer game with science content, or watching a science program on television (31). Formal learning is the highly structured and organized learning that takes place in schools (9). Non-formal learning lies between voluntary informal learning and involuntary formal learning and uses characteristics from both extremes (9). Usually, non-formal learning takes place outside of school in an open and free framework but is structured, organized, and oriented towards the education and curriculum (11).

Anderson, Kisiel, and Storksdieck (32) show in a study on teachers' perceptions of non-formal field trips that in addition to the students, however, the teachers are also crucial for the success of non-formal education offerings. Most teachers described a field trip as successful and beneficial if the students enjoyed them and emotional or affective criteria were more important than, for example, specific learning objectives associated with the curriculum (32). In contrast an important point for teachers, to enable them to conduct an out-of-school learning offering, is the fit to the school curriculum. A fit with the curriculum thus plays an important role when it comes to selecting an out-of-school learning offering (32). This point is also confirmed by the study of Garner, Siol, and Eilks (33). The study explored the potential of non-formal learning environments and found that teachers were particularly interested in receiving news and innovative teaching and learning materials for science education, that are oriented at the school curriculum (33). Tried and tested projects on non-formal learning opportunities have already confirmed that there is potential for developing innovative teaching and learning ideas and materials. However, these innovative concepts have not yet found a permanent place in everyday science teaching (e.g., 34).

PEDAGOGICAL MODEL OF DIFFERENTIATION

To develop a multidimensional approach, in the frame of the project a pedagogical model of differentiation (figure 1) has been developed. By differentiation, we mean here the optimal support of all learners - independent of their requirements - within a learning group in the development of their competencies through appropriate pedagogical and didactic measures. Different ranges within a dimension of diversity can be supported, promoted, and fostered by offering various methods and tools, for example, in the form of support material.

The model of differentiation contrasts to common practice and enables active participation of students in different dimensions of diversity. Thus, it can support the learning progress of all students in the mentioned disadvantaged groups at the same time.

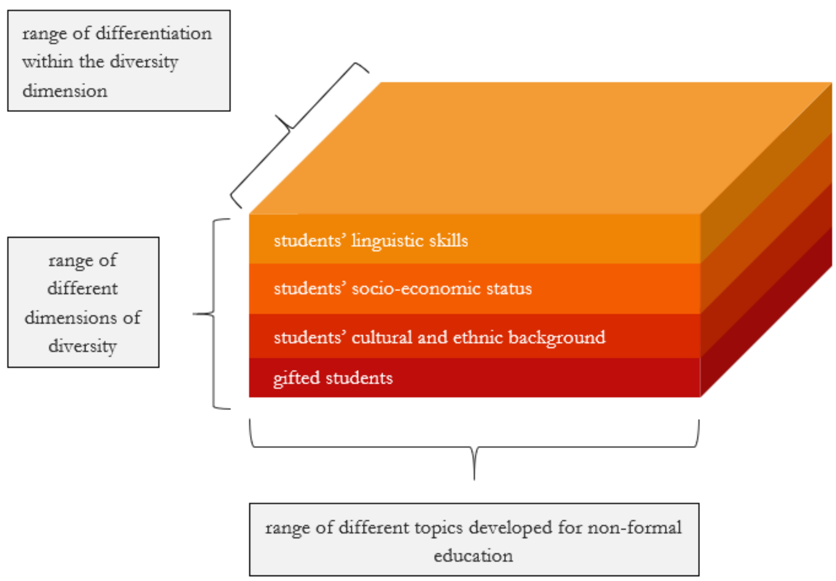


Figure 1. The Pedagogical Model of Differentiation

The model shows how each teaching and learning material can be differentiated according to the range of diversity dimensions if needed and within the dimension itself. The range of different dimensions illustrates the four dimensions of diversity the model focuses on, which must be considered simultaneously through an inclusive approach. Additionally, the range of differentiation within the diversity dimension (from good to fewer language skills referring to the language of instruction, from a low to a high socio-economic status, an ethical and a cultural background that is from more to less similar to the country of immigration, and from lower giftedness to higher giftedness) will be acknowledged as well. Thus, each teaching unit is more flexible regarding the four dimensions of diversity. The range of different topics developed for non-formal education represents the diverse range of possible chemistry topics.

Following the named model and after the evaluation, collection, presentation, and discussion of best practice examples for the in figure 1 named dimensions, DiSSI partners collected following approaches which are presented as best practice for each of the dimensions of the diversity and thus, are in common for all the diversity dimensions:

- Context-based learning
- Inquiry-based chemistry teaching and learning
- Cooperative Learning
- Game-based chemistry teaching

In following each of the named approaches will be discussed in the frame of inclusion.

Context-based learning

International studies have shown that students' interest in science is low and seems to be decreasing in several European countries (35). It is often identified among students at different levels of education that a rather negative attitude towards chemistry can cause a lower level of individual interest for learning chemistry following to non-existing intrinsic motivation for learning chemistry (36). It is generally agreed that learning chemical concepts is a complex cognitive process due to the abstract nature of chemical concepts, being particulate and symbolic (37).

Keeping in mind this complexity of chemical concepts chemistry teaching should emphasize learning in students' known contexts. Context-based teaching has a long tradition in science, especially in chemistry. The development of this approach was stimulated by research showing that students were not learning chemistry, because they have not found it relevant (38). Teaching chemistry in the context of real-world issues and implementing it in environmental and societal issues can be a promising way to help students close the gap between school chemistry, applications of chemistry and technology, and their critical evaluation. The selection of such everyday-life contexts of chemistry and technology should be authentic and relevant to students' lives (39).

Inquiry-based chemistry teaching and learning

It is important to have in mind, that every context-based chemistry lesson should also comprise activities for students where they are engaged in constructing their own knowledge considering chemistry as a natural science. The most important principle that is common to all science while generating new knowledge is inquiry and teaching of science also chemistry must be based on this domain. Through inquiry and practice curriculum, students are expected to be able to apply their knowledge and skills of chemistry to authentic problems (40). The Inquiry-Based Science Education (IBSE) approach follows a student-centered, with constructivist perspective of learning. These IBSE methods provide students with a challenge or problem which they must overcome by learning the concepts without receiving previous explanations (41). The international science education community (42; 43) believe that an IBSE approach can offer a successful teaching method which stimulates students' interest and motivation in science and chemistry learning. Gilbert and Newberry (44) suggest connecting IBSE with specific context that appropriate tasks that provide a personal challenge for each student and are interesting for the students and relevant to their own lives. Learning environments should be presented that is appropriate and supports students' creativity in designing their research strategies for research problems. As Trna (45) concluded the core principles of IBSE are involvement of students in discovering natural laws, linking information into a meaningful context, developing critical thinking, and promoting positive attitudes towards science especially chemistry. As he indicates, IBSE is suitable in the education of all students.

On the other hand, a review of research performed by Rizzo and Taylor (46) also suggests that IBSE is not suitable only for gifted students but also for students with disabilities. They concluded from the twelve studies included in the review, that students with disabilities require supports to participate in an IBSE and demonstrate higher science achievements and that science achievement improves when components of explicit instruction are utilized in both the general and special education setting for students with disabilities.

Cooperative learning

The benefits of cooperative learning have been empirically demonstrated many times (e.g., 47; 48; 49).

Cooperative learning describes like collaborative learning a process in which students at all levels of ability work together in small groups to achieve a task (50). Furthermore, cooperative learning is characterised by five aspects. (1) A positive interdependence, (2) commitment and acceptance of responsibility, (3) face-to-face interaction, (4) social skills (e.g., active listening, asking for help), and (5) evaluation (51). These aspects are demonstrated by learners in a cooperative group listening to each other, taking exact note of how things are said, giving and accepting help, looking for ways to solve difficulties, and actively participating in the development of new understandings and learning (52).

The development and advancement of communication skills, problem-solving skills, and critical thinking are forced by the active participation of the students in the learning process through working in cooperative groups (53; 54; 55; 56; 57; 58; 59; 60; 61; 62). These aspects result in advantages and opportunities for learning science in general, and chemistry in particular through the use of cooperative methods.

Studies have shown that cooperative learning has positive effects on understanding science (63; 64; 65) as well as on students' self-esteem and boosting their self-confidence (66).

Cooperative learning can improve the students' satisfaction and enjoyment (67). Aydin (68) found positive effects in promoting academic knowledge, familiarity with the laboratory equipment, and the development of a positive approach to laboratory studies.

Game-based chemistry teaching

It is easy to assume that games are interesting and fun because each of us has experienced games at some point in our lives. Of course, entertainment is not the main issue in the educational process, but game-based learning certainly helps in the acquisition of concepts and in bringing students together.

According to Perrotta, Featherstone, Aston, and Houghton (69) refer to the key principles of game-based learning, mentioning intrinsic motivation, authenticity (contextualized, goal oriented instead of abstract learning), self-reliance, and autonomy and experiential learning (learning by doing), but also mechanisms of this type of learning (simple rules, clear but challenging goals, interaction, student control, immediate and constructive feedback, a social element etc.).

Learning by using games promotes engagement of all students, active learning, logical connection of concepts, and fun at the same time. The significance of game-based learning is seen in the fact that it can be applied in diverse classrooms to support the variety of learning outcomes and to develop skills students will need in their future life in a friendly collaborative environment. More importantly, students have the opportunity to be directly involved in their own learning and engaged in the activities that meet their individual needs (70).

From the benefits and effects of the presented approaches for learning chemistry in general and about the disadvantaged groups mentioned in the Pedagogical Model of Differentiation, the potential for an inclusive approach to learning environments of different non-formal and informal education offers intending to enable all students to participate in the educational offer arises from the combination of these approaches. To establish differentiation within the single dimensions of diversity and to keep the approach flexible, the inclusive approach is enhanced with appropriate methods, tools, and activities.

Methods, tools, and activities that address the diversity dimension of students' linguistic skills relate to supporting students with difficulties with the language of instruction or the development of scientific literacy or fostering communication skills. An example is the use of language-sensitive and language-supportive designed graded tip cards that support students in doing experiments or formulating their observations and findings (71, 72).

Methods, tools, and activities that help students identify with chemistry, especially when students do not feel engaged by chemistry because of their socio-economic background, culture, or ethnicity, demonstrate relevance to all students' lives and daily routines. An example is working with students' prior knowledge using concepts and Mind Maps (73). Students are given the opportunity to integrate their prior experiences and knowledge through questions and tasks that can be answered in multiple ways (74).

For gifted students, tasks are challenging and exciting when the solution is not easily predictable by just reading or using the knowledge they already have. Examples include open-ended questions and tasks that have more than one solution and where students learn through discussion rather than primarily through writing (75). More practical examples are to be found at the project homepage (dissi.org).

Within the framework of this project, the partners develop various teaching and learning settings for different informal and non-formal education offers (e.g., students laboratories, museums, botanic gardens, etc.) on different topics where approaches and methods can be tested. The concrete learning and teaching material will provide the teachers with good practice examples so that they learn how to apply the strategies developed in DiSSI.

CONCLUSION AND IMPLICASION

To respond to diverse students in the education system, an inclusive science/chemistry approach is needed that addresses the interests and needs of all students. Therefore, developing inclusive learning settings and set of pedagogic approaches that benefit all learners and thus is truly inclusive for non-formal education demands the consideration of different aspects of diversity simultaneously.

This paper discusses an approach to inclusive science/chemistry education for non-formal education based on the four approaches (1) context-based learning, (2) inquiry-based learning, (3) cooperative learning, and (4) game-based learning (figure 2). As shown in the previous chapter each approach is appropriate for learning and teaching chemistry and the active participation of all students, in general. According to the Pedagogical Model of Differentiation (figure 1), the combination of these approaches seems to have positive effects concerning the four dimensions of diversity (i) students' linguistic competencies, (ii) students' socio-economic status, (iii) students' ethnical and cultural background, and (v) students' giftedness as well.

The cooperation within the DiSSI project benefits, in particular, from the fact that the project members are experts in one of the named dimensions of diversity. This cooperation results in parallels and similarities between the individual foci that can be used for an inclusive approach. The work with the Pedagogical Model of Differentiation shows one way to connect these different foci toward an inclusive approach. This connection is shown in a way that gives orientation and allows flexibility to make further differentiations within the dimensions for various informal and non-formal education offers and topics.

Figure 2 presents the common ground that results from different points of view on various dimensions of diversity and summarises this common ground to the point.

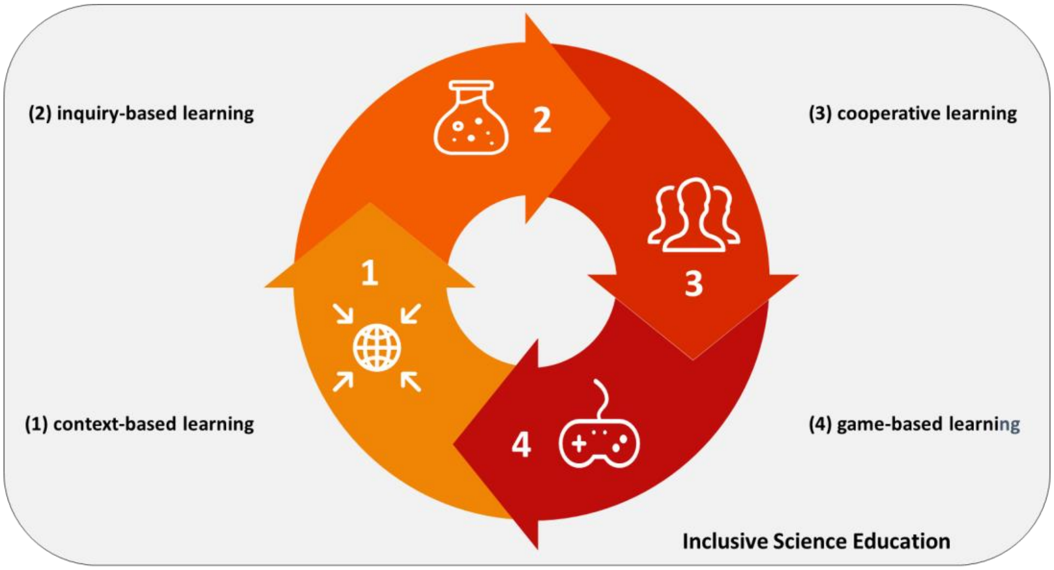


Figure 2. The DiSSI-Approach of Inclusive Science Education

The individual approaches (1) context-based learning, (2) inquiry-based learning, (3) cooperative learning, and (4) game-based learning have shown positive effects on students learning science/chemistry. Especially related to applying knowledge and skills to authentic problems (40), fostering communication (54; 55; 56), and the usage of scientific working methods, e.g. experimentation for knowledge generation (76, 77). As discussed before, various studies have shown the advantages for students using the approaches for learning and teaching science, in general, and chemistry, in particular. Thus, relevant contexts support students in seeing the relevance of chemical topics for their lives (40) and understanding complex chemical content (38). Learning inquiry-based stimulates students' interest and motivation in learning science (42), and inquiry-based learning supports students in linking information in meaningful contexts, developing critical thinking, and promoting positive attitudes toward science (45). A cooperative and a game-based approach fosters the development and advancement of communication skills, problem-solving skills, and critical thinking (58; 59; 60; 61; 62).

Based on these benefits related to science learning, in general, and chemistry, in particular, we suggest the combination of these approaches to promote inclusive science/chemistry education.

The integration of proven methods, tools, and activities positively related to each dimension of diversity allows flexibility in referring to different learning groups. Learning environments that were developed according to the inclusive DiSSI approach can support, foster, and promote all four dimensions of diversity simultaneously using the Pedagogical Model of Differentiation and taking all facets within the dimensions into account. While the Universal Design for Learning approach bases its inclusive claim primarily on its high flexibility and freedom of choice for learners in the three areas of working methods, learning content, and learning outcomes, which requires a very open design that leaves room for individual possibilities (25) , the inclusive DiSSI- approach, together with the pedagogical model of differentiation, proposes concrete approaches and connections.

Non-formal science education offers such as outside-the-school educational settings (i.e. museums, botanic gardens, zoos, institutes, and university laboratories, ...) should develop activities for students focusing on an inquiry-based approach with an emphasis on context learning. In combination with cooperative and game-based approaches communication among students is promoted. They are more often an active part of the learning process and are involved in solving scientific problems.

In non-formal education offers, students attending these activities may learn in a less stressful way compared to formal learning in schools where assessment is an important part of the process. With a view of the named dimensions of diversity, the connection of these approaches seems to be appropriate to foster inclusive science/chemistry education for informal and non-formal education. As mentioned here in the title and saying it in the words of John F. Kennedy "the rising tide lifts all boats". Kennedy said it for the economic development, but we see it also matching for the education as well. Here, we see it that not only the improvement on one dimension of the diversity is needed but in general which will contribute to the benefit of all students in chemistry classes. According to the words of John F. Kennedy, the DiSSI approach could have positive effects on the active participation of disadvantaged groups in the dimension of diversity as well as on the cooperative interaction of heterogeneous learning groups.

In conclusion, the combination of the chosen approaches to the DiSSI-Approach of Science Education enables the development of learning settings for non-formal education offers that not only include disadvantaged groups but also have a positive impact on all students in a learning group.

We suggest that the approaches mentioned here are effective for dealing with diverse groups in non-formal chemistry education. This inclusive approach can be seen as a basis for non-formal education offerings. Furthermore, the arrangement is flexible for individual adaptations and further differentiation possibilities. We see high potential in this inclusive DiSSI approach because it is based on appropriate approaches that have been assessed as helpful by experts in the four named dimensions of diversity. In addition, those approaches show similarities and potential for combination, especially for non-formal education offers.

At this point, we would like to note, that this inclusive approach results from theoretical considerations. Implementation in practice and a detailed evaluation will show in the next step how this approach works in different non-formal education offerings and learning groups.

Finally, we want to add that non-formal education offers that enable all students to participate, foster better cooperation within a learning group, and further inclusive science/chemistry education.

ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available on the ACS Publications website at DOI: 10.1021/acs.jchemed.XXXXXXX. [ACS will fill this in.] Example brief descriptions with file formats indicated are shown below; customize for your material.

Notes for Instructors (DOCX)

Survey Instrument (DOCX)

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