

# Decision-making Competence in Biology Education: Implementation into German Curricula in Relation to International Approaches

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The integration of decision-making competence or comparable constructs into science education has been strongly enforced during the last twenty years. Germany captured the tendency with the introduction of national standards for science education that included a domain that refers to decision-making competence. This domain – ‘evaluation and judgement competence’ – is currently depicted by different models. This paper describes the models and existing international approaches on decision-making. To give insights into current research on the German construct, selected results of two studies regarding teachers’ pedagogical content knowledge with the focus on improving the integration of evaluation and judgement competence into biology lessons are presented. Relations of evaluation and judgement competence to international approaches and its integration into biology lessons are discussed.

*Keywords:* decision-making, evaluation and judgement competence, German national standards, moral judgement, pedagogical content knowledge, socioscientific issues

## INTRODUCTION

Genetically modified food, preimplantation genetic diagnosis, organ donation or alternative methods of energy production are new achievements of modern science, which were realised only recently. All of them are issues that originate from science, but include societal components and therefore cannot be solved or evaluated with scientific knowledge and methods only. Therefore, in the international discourse about science education, those issues are referred to as so-called ‘socioscientific issues’ (Sadler, 2011a). Despite involving scientific and societal elements, such themes are

complex, contain ethical and moral aspects and are often subject of controversial public discussion. Their complexity also includes a lack of a straightforward answer or solution. The achievements of modern science have caused a change in the character of science education and in perceptions about what it should contain (Sadler, 2011a). Overall, science education today puts more emphasis on enabling students to take part in public discourse about socioscientific issues and decision-making (Jones, McKim, & Reiss, 2010). Hence, obtaining ‘scientific literacy’ is considered to be an important aim of modern science education (Kolstø, 2001). However, there are different perspectives on the construct of scientific literacy (Sadler, 2011a): On the one hand it is referred to as a construct within science, on the other hand it is regarded as an important element for everyday life of modern society’s citizens (Vision I and Vision II of scientific literacy, respectively; Roberts, 2007; Sadler, 2011a). This paper follows the latter view (cf. Sadler, 2011a). According to Jorde and Mark (2007)

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### **State of the literature**

- The construct of socioscientific issues (Sadler, 2011a) and the approach of moral judgement (Kohlberg, 1974) exist as two different approaches within the discourse about decision-making in science education.
- The inclusion of decision-making processes into biology education has been enforced during the last decades (Jones, McKim, & Reiss, 2010). This trend also appears in the German standards for science education (Kultusministerkonferenz [KMK], 2004).
- The domain of evaluation and judgement competence seems to constitute a challenge for both, biology teachers and learners. Its integration into biology lessons and the resulting problems were examined by Alfs (2012).

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

- The paper at hand briefly outlines two different approaches within decision-making in science education and relates them to the German realisation of corresponding constructs.
- A short overview about the implementation of decision-making competence in German biology education is provided. To date, predominantly German-speaking literature is available regarding this topic.
- Examples of research studies regarding teachers' pedagogical content knowledge (PCK) about evaluation and judgement competence are presented in order to give insights into research about decision-making competence in German biology education. Results of these studies are either presented for the first time or were not available in English language so far.

dealing with socioscientific issues in science lessons can foster the obtainment of aspects of scientific literacy.

Following the first efforts of the science, technology and society approach (STS; Sadler, 2004) in the early 1980s, the tendency of including ethical aspects into science education has been enforced during the last twenty years and has become a main goal of many curricula during the last decade (Jones, McKim, & Reiss, 2010). This can be considered as an international trend (Sadler, 2004; Jones et al., 2010) which also appears in the German educational system. The German national standards for science education, which were released in 2004, determine decision-making competence as a compulsory part of science and, thus, biology lessons (KMK, 2004). The introduction of this competence domain constitutes a major change of curricula.

This paper's goal is to give a brief outline about the implementation of decision-making competence into

German biology curricula and its relations to international approaches. Hence, the approaches of moral judgement and socioscientific issues are delineated. Based on this overview, the article focuses on the German situation and presents theoretical foundations like the standards for science education, before three different models of the competence domain 'evaluation and judgement competence' (for translation of terms, cf. p. 222) will be presented. To give insights into current research regarding evaluation and judgement competence and existing problems with the integration of this domain into biology lessons, two research studies focusing on teachers' pedagogical content knowledge (PCK; Park & Oliver, 2008) regarding this domain are outlined. Finally, similarities and differences of the three models and the relations to the described international approaches as well as the integration of decision-making competence into German biology lessons are discussed.

### **Discourse on decision making competence – international approaches**

Concerning research tradition within decision-making competence in science education two major approaches can be distinguished. On the one hand, there is research subsequent to the developmental psychological work of Lawrence Kohlberg (1974). On the other hand – and more prominent in the context of discussions about modern science education – there is the approach of socioscientific issues (Sadler, 2004; 2011a).

### **Moral judgement**

Research in the context of moral judgement is usually subsequent to the work of Lawrence Kohlberg (1974). Based on the findings of interviews about ethical dilemmas in a long-term study, he generated a cognitive step model depicting the development of moral judgement. He assumed that cognitive structures result from the interaction between a subject and its environment (Hößle, 2001). According to the model, the phenomenon of moral judgement is developed stepwise from simple to more complex structures. Those structures are independent from the content-related issues of a judgement, which vary between persons and cultures. Cognitive structures refer to typical patterns of thinking and argumentation that are used for justification. They often show developmental regularities and possess cross-cultural generality (Hößle, 2001).

The model contains six different levels with each level being subdivided into the sublevels A and B (Kohlberg, 1976). Levels 1 and 2 constitute the so-called pre-conventional level, 3 and 4 the conventional while 5

and 6 form the post-conventional level. Following Kohlberg, most children's moral judgement is still on the pre-conventional level, which is characterised by a disability to comprehend and reflect laws and societal rules. Most adolescents and adults match the conventional levels, meaning that they accept and follow societal rules. Persons on the post-conventional level understand rules of a given society and are able to reflect on the based ethical principles.

Although the model served as a basis for many subsequent studies, it was also subject to criticism (Modgil & Modgil, 1986). Kohlberg reacted with several revisions of the model, which led to a lacking transparency about which version was to be regarded valid (Peltzer, 1986). Especially the stated strict stepwise development of moral judgement in children and adolescents was questioned: Studies showed that young children can – contrary to Kohlberg's findings – act morally and consider themselves as parts of social relationships, which renders the model's first and second level inappropriate (Nunner-Winkler, 1996). Other authors noted that Kohlberg did not consider different types of dilemmas (eg., personal or non-personal dilemmas), which led to a neglect of context effects (Reuss & Becker, 1996). Furthermore, there was criticism regarding Kohlberg's basic moral principle of justice and its relation to the principle of benevolence (cf. Modgil & Modgil, 1986) as well as regarding his approach in mixing the social perspective with moral judgement, preventing a genuine empirical examination of those constructs (Höble, 2001). Nevertheless, despite all criticism, the model still served as a fruitful basis for many research studies (Modgil & Modgil, 1986).

### Socioscientific issues

The construct of socioscientific issues (SSI) currently constitutes the most prominent approach regarding the integration of ethical aspects into science lessons (Ratcliffe & Grace, 2003; Sadler, 2004; Zeidler, Sadler, Simmons, & Howes, 2005; Sadler & Donnelly, 2006; Sadler, 2011a). The term refers to issues that originate from science but always include a social or societal dimension. Thus, they cannot be solved with scientific methods only. Such issues are characterized by the connection of scientific concepts and ethical values and their weighting. According to Sadler (2004; 2011a) SSI are social dilemmas, which contain either conceptual or technological links to one or more fields of science. Topics, which depict SSI are, e.g., global climate change, cloning or stem cell research (cf. Sadler, 2004). SSI are always complex. Their complexity is caused by the necessary consideration of knowledge from different domains and by the obligatory inclusion of ethical values (Kolstø 2001, Zeidler & Sadler, 2007). Furthermore, those issues are “open-ended, often

contentious dilemmas, with no definitive answers” (Sadler, 2004, 514). Zeidler and Nichols (2009, 49) add that SSI are controversial and “have the added element of requiring a degree of moral reasoning or the evaluation of ethical concerns in the process of arriving at decisions regarding possible resolution of those issues.” The goal of including ethical aspects into science lessons through the treatment of SSI is to empower “students to handle the science-based issues that shape their current world and those which will determine their future world” (Sadler, 2004, 514). The treatment of SSI in science lessons is supposed to enhance the connection of scientific facts with students' everyday life and thus making science for students more relevant (Zeidler & Nichols 2009; Hostenbach, Fischer, Kauertz, Mayer, Sumfleth, & Walpuski, 2011). Furthermore, SSI foster students to acquire argumentation skills (Zeidler & Nichols, 2009), which constitute important requirements for taking part in public discourse as a full member of a democratic society.

Sadler et al. (2007) identified four characteristics of decision-making regarding SSI. When dealing with SSI students should be able to a) recognize the complexity of SSI, b) examine the given issues under the consideration of multiple perspectives, c) appreciate that SSI can be subject to enduring inquiry (“science-in-the-making”; Kolstø 2001) and d) exhibit skepticism regarding available information.

### Discourse on decision making competence – Implementation into German Curricula

#### *National standards for science education in Germany: output-orientated learning*

In 2004 Germany introduced national standards for science education. The standards capture general educational goals and determine, which abilities students are supposed to obtain at which age-group level. Those anticipated learning results are phrased as competencies following the definition of Weinert (2001), who describes competencies as the available or learnable abilities and skills to solve problems. Connected with the skills is the motivational, volitional and social willingness to use those problem solutions in variable situations. Research regarding the acquisition of competencies focused and focuses on structure and development of learners' competencies, which are described by developmental or structural competence models (Schecker & Parchmann, 2006).

The introduction of the standards was simultaneously a paradigm shift away from former input-orientated curricula towards competence-orientated, thus explicitly output-orientated learning (cf. Finsham, 2011). Four competence domains were

provided by the standards for science education, which included the domain of ‘scientific content knowledge’ and three process-orientated domains. Those three encompass ‘scientific inquiry’, ‘communication abilities’ and ‘evaluation and judgement competence’. These four competence domains were introduced for all three scientific subjects in the German educational system, i.e. biology, chemistry and physics. Accordingly, students are supposed to be fostered in gaining competencies of the four domains in German science classrooms. Students’ tasks in science lessons are no longer restricted to learn content knowledge or methods of scientific inquiry, but they now also include judgements on contentious ethical problems. Science teachers recently have to enhance their students’ basic knowledge of ethics and apply methods to foster the acquisition of decision-making competence and communication abilities. However, being implemented into an existing structure of an educational system, the introduction of the new standards faced various problems. Especially the new domain of evaluation and judgement competence constituted – and still constitutes – a real challenge for both, science teachers and learners (Alfs, 2012). Particularly teachers of biology faced difficulties integrating this competence domain into their classrooms, because evaluation and judgement competence in biology – contra the corresponding domain in chemistry and especially physics – puts more emphasis on ethical and moral aspects. Hence, biology teachers were now confronted with students’ decision-making processes regarding socioscientific issues, which also include the assessment of construction of arguments. This in turn was traditionally not a part of science teachers’ professional education in Germany and elsewhere (cf. Willmott & Willis, 2008).

### ***Evaluation and judgement competence as a part of national standards***

The competence domain of evaluation and judgement competence has been described by different English terms. Feierabend, Stuckey, Nienaber, and Eilks (2012, 581) chose the label “competence of evaluation”, Eggert and Bögeholz (2008, 231) referred to the domain as “socioscientific decision-making” and Reitschert and Hößle (2007, 125) used “competence of moral judgement” as translation. The paper at hand will follow Hostenbach et al. (2011) in describing the domain as “evaluation and judgement competence”, because this term appears to cover the construct’s characteristics best.

As already outlined, evaluation and judgement competence is one of the four competence domains of the German standards for science education. As such, it is defined as the ability to recognise and evaluate biological issues in different contexts. Focus of ethical

judgement in the context of biology lessons are topics, which refer to the responsible behaviour of human beings regarding themselves and other persons as well as the environment (KMK, 2004). According to KMK (2004) students should clarify biological issues and understand potential problems prior to evaluation. During the clarification they should consider different points of view. These perspectives can include the ones of friends, of one’s family, of other societal groups or different cultures or even nature’s dimensions. This shift of perspective and empathy can enhance personal tolerance. During evaluating different courses of action, students should connect these with ethical values. They should be able to justify their own or different judgements and represent a personal attitude considering individual or societal negotiable values (KMK, 2004). The main goal of acquisition of this competence is to enable students to take part in contentious public discourse about bioethical and environmental ethics issues. This goal is supposed to be achieved by developing an appreciation for an intact nature and a healthy lifestyle, by understanding decisions according to a sustainable development and by interpreting new issues in applications of modern science (KMK, 2004).

Hence, the competence domain of evaluation and judgement competence is to some extent structurally and regarding its aims comparable to the construct of socioscientific issues (Hostenbach et al., 2011) or – to phrase it differently – it is the construct, which embeds SSI in German biology education.

### ***Models regarding evaluation and judgement competence***

With the introduction of the national standards for science education associated with the phrasing of competence domains the problem of lacking competence models occurred. Researchers in science education were challenged to develop evidence-based competence models to improve and monitor the acquisition of competencies (Schecker & Parchmann, 2006). For the domain of evaluation and judgement competence in biology, three competence models were developed independently. They stem from different contexts and were partially developed for different purposes.

### ***Dimensions of moral judgement – a structural model of evaluation and judgement competence***

Reitschert and Hößle (2007) developed a theory-driven model of evaluation and judgement competence. For the model’s development existing models within the didactics of biology regarding moral judgement were analysed. Basic philosophical abilities were examined

(e.g., Baggiani & Fosl, 2003) for their applicability on a model of moral judgement. Also, Kohlberg's step model of moral judgement was taken into account. Subsequently, the developed subdomains were adjusted to competencies from the didactics of ethics. The theory-driven model consists of eight subdomains, which depict the construct of evaluation and judgement competence (Reitschert & Hößle, 2007). The domains were afterwards examined empirically in a bioethical context and could be confirmed (Reitschert, 2009). First attempts to extend the model to other topical contexts like environmental ethics are already made. The eight subdomains are as follows:

*Awareness of moral/ethical relevance:* Students should be able to recognise and phrase a moral or ethical problem in a given issue.

*Awareness of reasons of one's own opinion:* Students should be able to recognise and reflect about possible elements that influence one's opinion.

*Reflection of consequences:* This domain focuses on the ability to anticipate consequences of a hypothetical judgement. Both, consequences of one's own or of a foreign judgement should be reflected.

*To assess:* Students should be able to assess an issue considering facts and reasons for or against a course of action as well as affected ethical values.

*Basic knowledge of ethics:* Students should know basic ethical terms (e.g., value, morality) and use them correctly.

*To judge/to reason:* A justified and reflected judgement should be made. Given new information a judgement can also be modified with recourse to the other domains.

*To argue:* Argumentation skills are usually revealed by a consistent use of a statement's justifications. This domain is considered to be an interdisciplinary ability.

*Change of perspective:* This domain includes the ability to understand different points of view of involved persons or parties and constitutes a very important part of a reflected judgement. The development of empathy is an essential regarding the enhancement of tolerance. Students should be able to understand other person's views as well as societal perspectives. The latter part can be considered as a higher-level ability.

### ***The 'Göttinger model' of evaluation and judgement competence***

The so-called 'Göttinger model' of evaluation and judgement competence was developed in the research group of Susanne Bögeholz at the University of Göttingen, Germany. The model was developed considering existing models regarding decision-making competence and follows a definition of evaluation and

judgement competence in the context of sustainable development, after which it is described as the ability to reach justified and systematic decisions in complex situations of sustainable development, when different opportunities of action are possible (Bögeholz, 2007). Essential for the development was a model of decision-making (Betsch & Haberstroh, 2005), which subdivides the decision-making process into three phases: The pre-selectional phase, in which the problem and courses of action are identified; the selectional phase, in which evaluation and judgement are made considering different criteria and trade-offs and the post-selectional phase, which includes the decision's implementation. The model depicts the competence domain of evaluation and judgement competence by four subdomains. Each of them is graduated by four levels (Eggert & Bögeholz, 2006).

*Knowing and understanding sustainable development:*

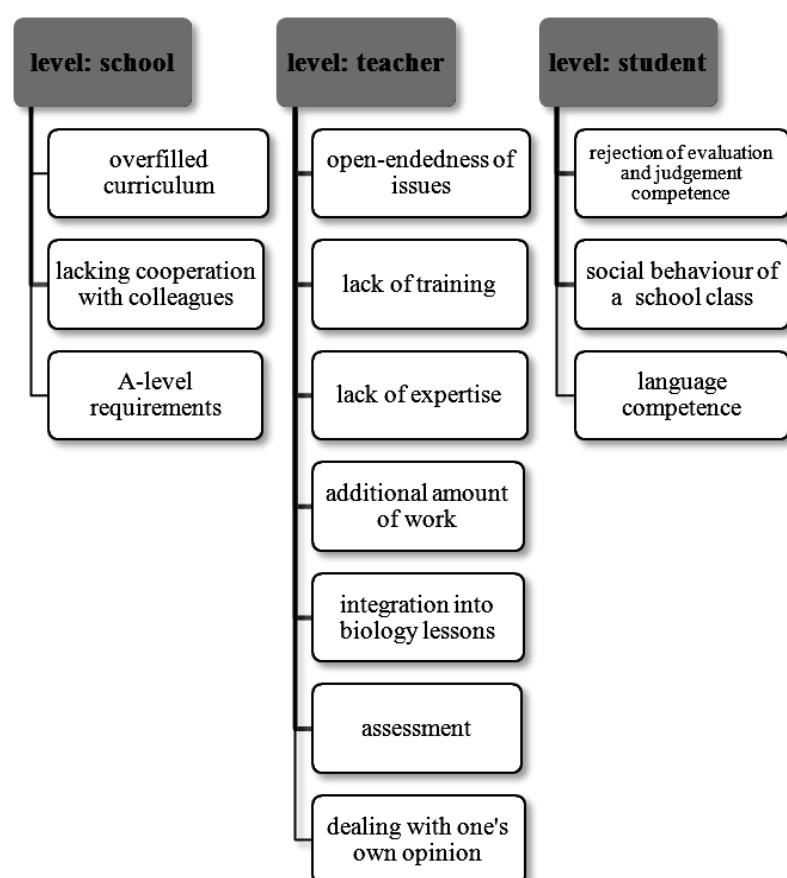
Students are supposed to be able to understand what sustainable development is and means. Knowing the concept of Education for Sustainable Development (ESD) with the important interconnectedness of the economical, ecological and social dimensions is considered to be necessary when acquiring evaluation and judgement competence.

*Knowing and understanding values and norms:* Students should be able to define basic ethical terms like 'values' or 'norms' as well as to differentiate between ethical and factual statements.

*Generation and reflection of factual information:* This domain encompasses students' ability to identify and name different courses of action when faced with a problem of sustainable development. Connected with that is the anticipation of ecological, economic and social consequences of the different options. Students should be fostered in dealing with incomplete or unsecure information as well.

*Evaluation, choice and reflection:* This domain focuses on the main aspects of the selectional phase of Betsch and Haberstroh's (2005) model of decision-making. Decisions can be made using compensatory (different possible courses of action or different solutions in a certain situation should be weighed: trade-off) or non-compensatory (setting absolute criteria: cut-off) decision-making strategies.

The postulated and theory-driven separation of the subdomains 'knowing and understanding sustainable development' and 'knowing and understanding values and norms' was considered to be possible, but not empirically verified (Eggert & Bögeholz, 2006) and Bögeholz (2010) presented a modified version of the Göttinger model, in which these two subdomains are lumped together in order to form the new subdomain



**Figure 1.** Difficulties named by teachers regarding the implementation of evaluation and judgement competence into biology lessons (Alfs, 2012).

‘knowing and reflecting values and norms in the context of sustainable development’.

### *The ‘ESNaS’ structural competence model*

Another competence model (ESNaS – evaluation of the standards for science education in secondary school) was developed in the context of an evaluation of the German national standards for science education (Hostenbach et al., 2011; Schwanewedel & Mayer, 2012). This model can be differentiated for all four competence domains in the subjects of science education and is suited for the use in large scale assessments. In order to develop the model for the competence domain of evaluation and judgement competence, existing models regarding the subject biology were analysed. This approach was considered necessary because the existing models only cover certain aspects of the competence domain in biology (Hostenbach et al., 2011). The domain ‘generation and reflection of factual information’ of the Göttinger model as well as the domain ‘to argue’ of the model of moral judgement were subordinated to other competence domains (scientific inquiry resp. communication abilities) and therefore excluded from

the ESNaS-model of evaluation and judgement competence (Hostenbach et al., 2011).

The achievement of the learning goals, i.e. competencies phrased in the national standards, was examined by special tests, which were based on the competence model. Thus, the tests simultaneously constituted the model’s operationalization. The model itself is theoretically justified and described regarding competence domains and levels. Structural similarities of the three science subjects biology, chemistry and physics are considered as well.

It is assumed that different levels of competencies can be described by complexity and associated cognitive processes. Hence, the model encompasses three dimensions: competence domain, complexity and cognitive processes.

The competence domain is predefined by the national standards; the dimension of complexity is graduated by five levels (one fact, two facts, one coherence, two coherences and higher-level concept). These five levels can be characterised for the three content-related dimensions ‘evaluation criteria’, ‘course of action’ and ‘reflexion’. All three content-related dimensions can be related to personal, societal or ethical aspects. The dimension of cognitive processes depicts

the application of knowledge regarding a problem or a question's solution (Hostenbach et al., 2011). It is subdivided into the hierarchical levels 'to reproduce', 'to select', 'to organise' and 'to integrate'.

The theoretically justified competence model is designed to predict the difficulty of a student's task. In a next step the model is going to be examined empirically by a task-related test instrument (Schwanewedel & Mayer, 2012).

### **Current Research studies**

In the following section two current research projects will be highlighted in order to give insights into the research field of students' evaluation and judgement competence nowadays. Both studies focus on teachers' pedagogical content knowledge and are presented in the current paper, because this aspect seems to contain major difficulties regarding the integration of decision-making processes into biology lessons. The first one (Alfs, 2012) is already completed, while the second study that will be outlined is still a running project.

#### **Pedagogical content knowledge of biology teachers regarding evaluation and judgement competence**

PCK is defined by Shulman (1986, 8) as a representation of "the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction". Based on the assumptions that teacher's professional knowledge constitutes a basis for competent acting in the classroom and that this knowledge can be extrapolated dialogically (Shulman, 1986), problem-centered interviews (Witzel, 2000) with German biology teachers were conducted. Sampling followed the principles of theoretical sampling (Corbin & Strauss, 2008), while the leading principle was the maximisation of contrast regarding teachers' second school subject and professional experience within the sample. Altogether, nine teachers with a professional experience between four and 37 years took part in the study. Data were analysed following the strategies of qualitative content analysis (Mayring, 2000). This procedure led to a deductive-inductively constructed category system, part of which is depicted in Figure 1. The deductive part of the category system was formed by the five domains of PCK: "knowledge of students' understanding", "knowledge of curriculum", "knowledge of instructional strategies", "knowledge of assessment of students' learning of subject matter" and "orientation to teaching subject matter" (based on Park & Oliver, 2008). The five domains were then filled inductively based on the

interview data. Data analysis was supported by the qualitative data analysis (QDA) software tool MAXqda.

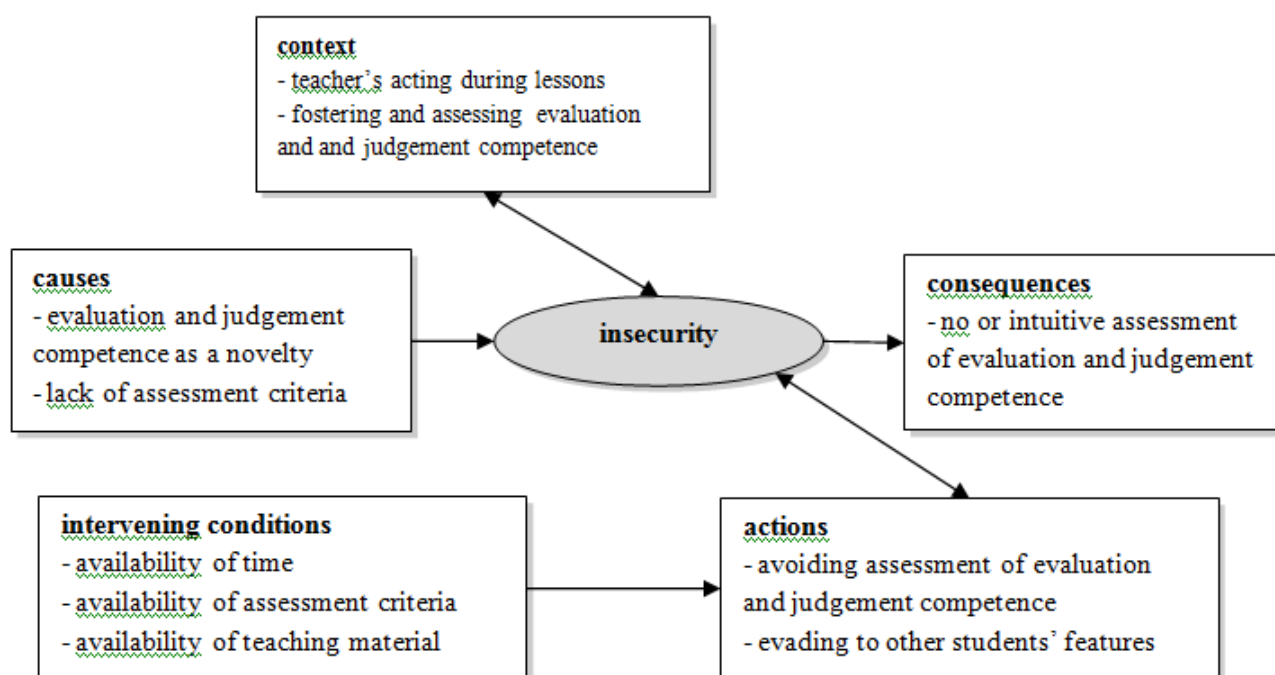
Results indicated that the participating teachers had obvious problems regarding the integration of evaluation and judgement competence. The difficulties could be categorized as belonging to three different levels: school, teacher and student (Figure 1).

Structural problems concerning the level of school included the overfilled curriculum, on the level of teachers self-critical aspects like the lack of expertise were mentioned. However, also the character of evaluation and judgement competence as a not only scientific but also societal and personal domain caused problems like the open-endedness of SSI or the handling of the teacher's own opinion regarding an issue. The assessment or diagnosis of students' performances appeared as a difficulty as well. Problems learners could have with the domain according to their teachers are, e.g. the overall rejection of evaluation and judgement competence as a part of biology and language competence.

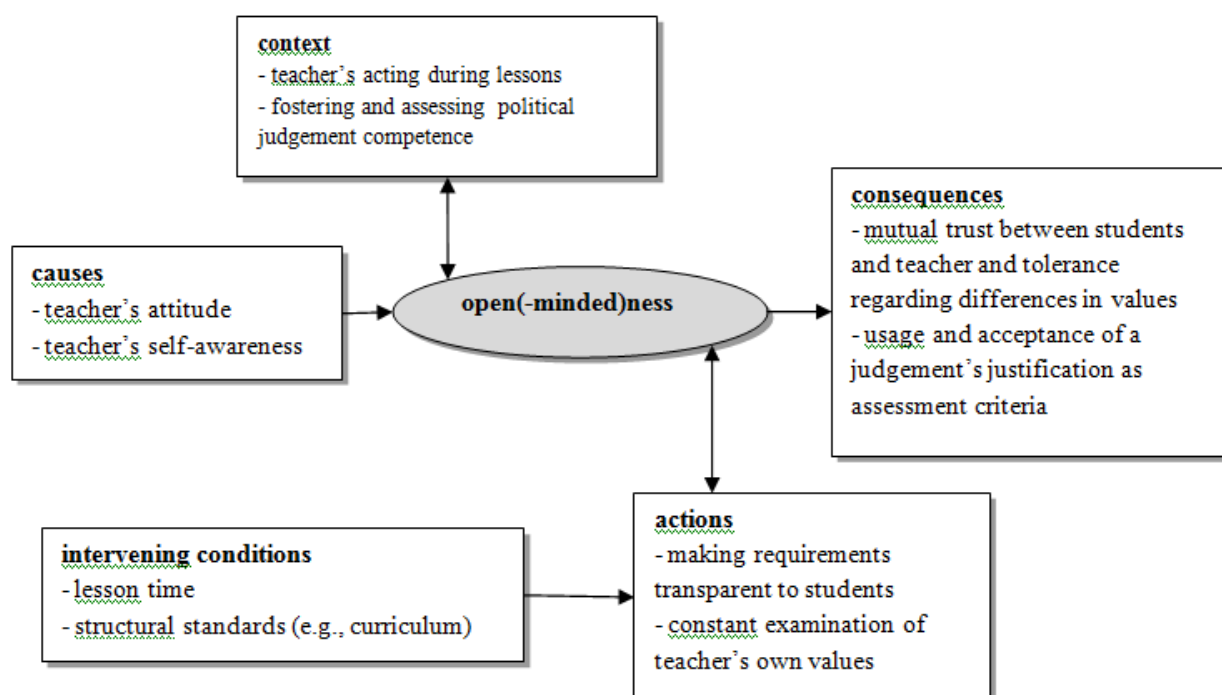
#### **Assessment of students' evaluation and judgement competence - concepts of biology and political education teachers**

Since decision-making in the context of bioethics and environmental ethics constitutes a real challenge for both, biology teachers and students, this study uses a qualitative, interdisciplinary approach between biology and politics to focus on teachers' diagnostic abilities concerning students' evaluation and judgement competence. A lack of assistance and teaching material on the part of the biology teachers renders the diagnosis of students' performances regarding SSI particularly difficult (Alfs, 2012). In contrast to the subject biology, subjects like political education traditionally put more emphasis on the fostering of evaluation and judgement competence.

Assessing or diagnosing students' competencies is an essential in the profession of teachers (Park & Oliver, 2008). Recent studies indicated its importance for teachers' professional education and for improving quality of school and lessons (Artelt & Gräsel, 2009). For this running study a model of diagnosis dividing the diagnostic process into five steps is taken as a basis (based on Helmke, 2009; Jahnke & Hößle, 2011): 1. selecting a student's feature, 2. phrasing expectations concerning the results, 3. choosing or constructing a diagnostic instrument, 4. collecting data, 5. interpreting findings. Aspects of global climate change can be dealt with in both biology and politics lessons. For this reason and for the theme's actuality it is used as topical context, i.e. the SSI within the study.



**Figure 2.** Axial category ‘insecurity’ shown by the coding paradigm of Strauss & Corbin (1996) as a result of a case study of a biology teacher.



**Figure 3.** Axial category “open(-minded)ness” shown by the coding paradigm of Strauss & Corbin (1996) as a result of a case study of a teacher of political education.

The main research question of the study is: Which interpretive patterns and action patterns regarding diagnosis of students’ evaluation and judgement competence do biology and political education teachers have? Key objectives of the study are:

*To gain insight about concepts of teachers regarding diagnosis of students evaluation competence in order to identify problems teachers have with that topic;  
To understand which concepts teachers of political education have regarding evaluation competence and whether these concepts are more elaborated and*



*To draw conclusions about what possibly can be done to improve biology teacher's skills to diagnose students' evaluation competence.*

To obtain answers about these questions and topics, the investigation follows the research strategy of grounded theory (Corbin & Strauss, 2008). Data collection is formed by three steps: First, a semi-structured interview with teachers (Witzel, 2000) about general perspectives on evaluation and judgement competence is conducted, followed – second – by a videotaped lesson in which a role play about a climate change topic is performed by students of the interviewed teacher. Third, another semi-structured interview with the teacher is conducted, which includes the analysis of a few video sequences regarding the involved students' evaluation and judgement competence.

In this study, sampling is generally based on the principles of theoretical sampling (Corbin & Strauss, 2008), with the sample being constraint to teachers of biology and political education. Based on the analysis of these first data, contrasting cases were selected continuously (Patton, 2002).

Analysis of the first cases revealed that biology teachers mainly assessed students' evaluation and judgement competence intuitively and showed signs of insecurity regarding those issues (Figure 2). "You somewhat trust your guts here", summarizes one teacher, who – at the same time – considers evaluation and judgement competence as an important part of modern biology lessons: "Herewith, the subject of biology – other subjects I think already a bit longer – account for a development that the world is not only like it is, but that you constantly have to evaluate things in order to decide how to act in that world". "And here evaluation and judgement competence certainly is the quite right step, because it tries to bring vivid questions of evaluation and judgement into the lessons."

On the side of teachers of political education there were indications of more elaborated interpretive patterns and action patterns regarding the assessment of students' evaluation competence. E.g., in two contrasting cases of a teacher of biology and a teacher of political education the dominant phenomenon regarding assessment of students' evaluation competence proved to be "insecurity" resp. "open(-minded)ness". Making requirements of the curriculum transparent to students and tolerating differences in opinions and values were other important categories derived from the data on the side of teachers of political education (Figure 3).

So far, justified pre-assumptions about the differences between the two groups of teachers were confirmed by the analysis of first cases. Those analyses indicate that training to assess students' competencies based on video sequences or written documents within

teachers' professional education could improve teachers' abilities to assess students' decision-making competencies during learning processes in the classroom.

## DISCUSSION AND CONCLUSIONS

### Classification of evaluation and judgement competence in relation to international approaches

Germany finally introduced national standards for science education as one reaction following the results of the PISA studies in 2004 (KMK, 2004). These standards contain the competence domain 'evaluation and judgement competence' as one of four competence domains for science lessons in German schools. The standards, however, did not contain a model depicting the domain in its different sub-domains. Thus, several research groups within the field of didactics of biology developed models in order to describe the competence domain entirely. But, as already mentioned, the developed models stem from different topical contexts and were partially developed for different purposes. While the model of moral judgement (Reitschert et al., 2007) was developed in a context of bioethics or – more precisely – medical ethics like stem cell research or preimplantation genetic diagnosis, the Göttinger model of evaluation and judgement competence focuses situations of sustainable development (Bögeholz, 2007). The latter one can potentially be adjusted to different themes from the field of, e.g., bioethics (Bögeholz, 2007). On the other hand, first attempts to transfer the model of moral judgement to environmental ethics in order to develop teaching materials were undertaken (e.g., Meier & Nitsch, 2012). However, both models concentrate on specific topics, in which they were developed and therefore according to Hostenbach et al. (2011) only depict certain aspects of evaluation and judgement competence in the subject of biology.

Both models were generated theory-driven, but, however, different sources were considered for their development (cf. Bögeholz, 2007; Reitschert et al., 2007). E.g., for the model of moral judgement the perspective of Kohlberg's model of moral judgement was considered (Reitschert et al., 2007), while the Göttinger model takes the process of decision-making following Betsch and Haberstroh (2005) into consideration. The models' topical contexts somehow cause different possible strategies for decision-making: In the context of medical ethics, learners are confronted with incompatible courses of action and the ethical values of each position. In the context of sustainable development the weighting of different courses of action using trade-off and cut-off strategies is key. In that field, different actions may be consistent with the construct of sustainable development (Bögeholz, 2007).

This differentiation has emerged among the research field of evaluation and judgement competence, but – at least to our knowledge – has not been a thematic priority among the construct of SSI so far.

The ESNaS-model of evaluation and judgement competence finally tries to integrate elements of the Göttinger model and the model of moral judgement into a new model, which is able to depict the competence domain for a large scale assessment in all three science subjects, i.e. biology, chemistry and physics (Hostenbach et al., 2011). While the subdomains of the Göttinger model as well as of the model of moral judgement – given not (yet) thoroughly existing empirically tested levels of each subdomain – could also serve as assessment criteria for teachers regarding students' performances in the context of decision making, the ESNaS-model was developed for the evaluation of the standards for science education. In this model, the domain of argumentation was not considered, because according to the authors, argumentation belongs to a different competence domain of the national standards ('communication abilities'; Hostenbach et al., 2011). In this aspect, the model thus distinctly differs from the SSI approach.

Among the construct of SSI, differentiation, e.g. between environmental ethics and bioethics, does not seem to be considered. All themes that include scientific and societal or social components can be characterised as SSI (Sadler, 2011a). In such complex situations learners are supposed to generate and evaluate different positions in order to resolve a dilemma (Sadler, 2004). Dealing with SSI in science classes is supposed to increase the relevance of science-related topics and create personal meanings by linking science facts with students' everyday life (Zeidler & Nichols, 2009). This is consistent with the aims of evaluation and judgement competence (KMK, 2004). However, the approach of SSI puts more emphasis on argumentation and communication abilities, which in the context of the German national standards are placed in different competence domains. Nevertheless, at least the model of moral judgement contains a subdomain that explicitly refers to argumentation, which in this model is considered to be inseparable from the other subdomains. Altogether, the SSI approach constitutes a more comprehensive movement, since there is "a focus on using these complex issues as contexts for teaching science" (Sadler, 2011a, 4). This implies, that SSI are considered to be a suitable tool for fostering scientific literacy on the whole, a perspective consistent with Vision II of scientific literacy (Roberts, 2007). The obtainment of evaluation and judgement competence is by tendency 'only' contributing to the development of learners' scientific literacy in order to become a responsible citizen of a modern society (KMK, 2004). All in all, SSI includes a broader range of aspects than

evaluation and judgement competence as phrased in the German national standards for science education.

### **Integration of decision-making in German biology lessons**

The integration of decision-making competence into science education has been enforced during the last two decades (Jones et al., 2010). However, the paradigm shift to output-orientated learning in classrooms and the focus on the acquisition of students' competencies being applied by the ministry of education caused difficulties. Output-orientation might cause conflicts with process-orientated standards (Fensham, 2013; Fensham & Rennie, 2013). But, however, the German national standards for science education – explicitly stated as output-orientated (KMK, 2004) – include three domains of process-orientated competencies, one of them being evaluation and judgement competence. The standards for evaluation and judgement competence are, furthermore, verbalised rather abstract. Thus, they at least apparently do not work sufficiently as criteria for assessment of students' performances. This in turn causes – among other aspects – some insecurity on the part of biology teachers. For science and – caused by a strong ethical emphasis in that subject compared to the other science subjects – especially biology lessons, this competence domain turned out to be a challenge for biology teachers and learners (Alfs, 2012). Several research studies focusing on the domain were conducted, two of which were outlined in this article. First studies were mainly exploratory, qualitative investigations, that either focused on the teacher's perspective on the competence domain or on students' acquisition of the competence and resulting competence models (Reitschert, 2009; Bögeholz, 2007; Alfs, 2012). Large investigations are currently running in the context of an evaluation of the national standards for science education (e.g., Schwanewedel & Mayer, 2012).

Results of the outlined research studies also indicate that only the first steps of the integration of decision-making processes into biology lessons are made (e.g. Alfs, 2012). Much work has to be done, e.g. regarding the acceptance of decision-making processes as a part of a modern biology education, the development and testing of appropriate teaching material and the assessment of students' performances concerning this competence (including instruments for diagnosis, e.g. special exercises). The assessment of students' performances with regard to SSI, which turned out to be a problem for the teachers taking part in the outlined studies, also constitutes a challenge for teachers on an international level: "Teaching science through SSI is challenging work that requires commitment and a willingness to struggle with uncertainties" (Sadler, 2011b, 357). This uncertainty also occurs in the above

mentioned case study regarding the assessment of students' performances in SSI. Focussing on the science content seems to be more straightforward, than "assuming the challenge and 'messiness' of SSI" (Sadler, 2011b, 357). Fensham and Rennie (2013, 80) summarize, that "decision-making' has been dogged by a lack of means of assessing it". This phenomenon also occurs in the German curricula and is not (yet) fully solved.

However, evaluating and judging in the context of ethical dilemmas as in SSI or – in the German case – evaluation and judgement competence seems to be an important part of a modern school subject of biology, but comes along with multiple challenges for teachers and students (Alfs, 2012; Sadler, 2011b). In Germany, several research groups within the field of didactics of biology are currently working on improvements regarding those problems and hopefully will contribute to a better integration of evaluation and judgement competence into biology lessons in the future in order to enable students to participate in public discourse about complex, science-related problems as responsible members of a society.

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