Conceptions of prospective biology teachers about the Wadden Sea ecosystem

Till Schmäing* , Norbert Grotjohann

Faculty for Biology, Didactics of Biology (Botany/Cell Biology), University of Bielefeld, 33516 Bielefeld, Germany

ARTICLE INFO

Keywords:
Biology education
Didactics of Biology
Biology teacher
Environmental education
Word associations
Wadden Sea

ABSTRACT

The present study contributes to the thematization of the UNESCO World Heritage Site Wadden Sea in biology didactics. Despite the uniqueness and high potential of the Wadden Sea ecosystem, especially for out-of-school learning, it has hardly been considered in biology didactics so far. The overall aim of this study is to gain insight into prospective biology teachers’ existing conceptions regarding the Wadden Sea. Students are not only learners in their role at the university but prospective teachers as well due to their intended professional goal. Therefore, they can be considered the intersection of these two perspectives and are of particular interest to relevant research projects. In this paper, prospective biology teachers (n = 209, mean age 22.89 years) from Germany were surveyed using a word association test. Associations to the stimulus words Wadden Sea, mudflat hiking tour, tides, national park, and UNESCO World Heritage Site were collected. In the analysis, a category system was developed as literally as possible from the associations. This paper uses mind maps to provide a detailed overview of the identified associations. There was a wide range of identified associations: In addition to subject-area-related and subject-didactic associations, there were experience-oriented associations as well as associations unrelated to the subject. To place these results in context, secondary school students’ associations to the same stimulus words are used for comparison. A central commonality is associations that encompass the experience possibilities at the Wadden Sea. In contrast to the secondary school students, the prospective teachers focus more on the school context. Conclusions are drawn regarding the education of biology teachers. In addition to identifying possible future research projects, this study suggests the need to consider the Wadden Sea in university teacher training.

1. Introduction

It is important to examine the factors that may impact students’ decision to earn a teaching degree in biology, such as their conceptions of nature. The overall aim of this study is to gain insight into prospective biology teachers’ existing conceptions within the context of the Wadden Sea. The decision to earn a teaching degree depends on many different factors, including altruistic-intrinsic reasons (Balyer and Özcan, 2014), specific and educational interest (Stellmacher et al., 2020), as well as extrinsic reasons (Yüce et al., 2013). Overall, the motives for choosing this profession are diverse (Bergmark et al., 2018). In the natural science context, empirical studies have investigated, among other things, the attitudes and knowledge of prospective biology teachers. These studies found that the most relevant professional reason for starting a degree program was an individual’s interest in nature and animals (Urhahne, 2006). In this context, the respondents perceived biology teaching as an interactive, lecture-based, and visual process (Subramaniam, 2014). In general, experiences from one’s own school years were not found to have any connection with the way prospective teachers want to teach in the future (Schumacher and Wilde, 2021).

The area of knowledge is central for prospective teachers and therefore essential in relation to teacher education (Brown et al., 2013). Within the framework of teacher education, a fundamental distinction can be made between the three knowledge domains, content knowledge, pedagogical content knowledge, and pedagogical knowledge, and how they are developed (Großschedl et al., 2015). Educational research focuses not only on higher education itself but also on the students’ entry into professional life. No gender-specific differences were found in terms of science, technology, engineering, and mathematics (STEM) teachers' motivation upon starting their careers (Watt et al., 2013).

Prospective teachers are of particular interest from the perspective of educational research. On the one hand, as students at universities they...
are learners, but as a result of their anticipated career aspirations, they are also prospective teachers. During their studies, students in a pedagogical field already gain experience as teachers in schools due to the practical training phases. This learner-teacher interface that prospective biology teachers assume is relevant for tapping into the perspectives of learners and teachers on selected topics.

The present study focuses on the UNESCO World Heritage Site Wadden Sea and is part of a project that examines this special ecosystem from the empirical-research perspective of biology didactics. Despite its outstanding biological relevance, the Wadden Sea has so far hardly been considered in subject area of didactics. For detailed comments on the state of research in pedagogical subject areas, see Schmaing and Grotjohann (2021a). This project’s previous research considered the learner perspective on the Wadden Sea. Among other things, differences regarding the surveyed secondary school students’ general level of awareness of the Wadden Sea were identified with regard to their place of residence, and the presence of non-subject-related conceptions was highlighted (Schmaing and Grotjohann, 2021a). Furthermore, these students were found to have a very low level of awareness regarding the two protection designations of the Wadden Sea UNESCO World Heritage Site and National Park (Schmaing and Grotjohann, 2021b). As was done in the two studies mentioned, a survey was conducted among prospective biology teachers as a means of unlocking learners’ perspectives. Thus, a word association method was used for various stimulus words from the topic area of the Wadden Sea to examine German prospective biology teachers’ conceptions of the Wadden Sea. Another aim of the study is to draw concrete conclusions that can positively impact the practical education of biology teachers. Currently, there are no other research projects concerning future science teachers’ conceptions of the Wadden Sea in the field of science didactics.

2. Methods

In order to ensure comparability of the data obtained in this study with those from the studies on the conceptions of learners from secondary schools, the same methodological approach was chosen. Detailed justifications supported by additional literature can be found in the explanations of the two studies (Schmaing and Grotjohann, 2021a; 2021b). Following these descriptions, central aspects are presented to illustrate the design of this study. All important information is given in detail in these explanations and also in the description of the analysis process to aid the reader in comprehending the methodological analysis.

2.1. Word association methods in empirical educational research

Word association methods have been used in biology didactics research for several decades in different contexts (Bogner, 1995) and are used to explore cognitive structures (Tsai and Huang, 2002). They have been used in empirical studies not only to survey students in school (e.g., Burger, 2001 or Schaefer, 1979) and out-of-school contexts (e.g., Bogner and Wiseman, 1997 or Dieser and Bogner, 2019). As in this research project, word association methods were established for use with prospective biology teachers (Dikmenli, 2010a, 2010b; Kurt, 2013a; Kurt, 2013b; Kurt et al., 2013).

In general, a word association is the response of respondents to a particular stimulus word. With regard to the concrete implementation of a word association test, there are many different possibilities. According to Woodworth and Schlosberg (1965), a differentiation is made on two dimensions: between the poles discrete and continuous or free and controlled. This ultimately results in four different possible combinations with respect to the specific procedure for conducting word association experiments. To ensure that the method of data collection is as open as possible, a continuous-free association method was used. There was no restriction on the number of association words and no further specifications (e.g., with regard to the content).

Another central step in planning an association experiment is determining the stimulus words. Ultimately, in addition to an extensive literature review, the selection was made in an iterative process by nine experts from different professional fields including biology, biology didactics, education for sustainable development, and environmental education, some with decades of experience with the Wadden Sea. The terms Wadden Sea, mudflat hiking tour, tides, national park, and UNESCO World Heritage Site were defined as stimulus words. Following the technical discussions of the individual terms in the theoretical part of this paper, the central reasons for their selection are presented briefly. The last section of each section describes the reasons for selecting the words as well as the related objectives.

2.2. Formulating the research questions

Considering the objectives of this research as stated in the introduction and the selected methodological approach, the following central question can be formulated:

1. What word associations do prospective biology teachers have with the terms Wadden Sea, mudflat hiking tour, tides, national park, and UNESCO World Heritage Site?

In addition to an intensive examination of the word associations, there is also a discussion that takes the technical meaning of the stimulus words in the subject area into consideration. Therefore, the second research question can be phrased:

2. Can the identified word associations be understood from a subject-area-related perspective?

This study seeks to compare the data with the results of the two other studies, which examined the word associations of secondary school to these terms. The following question will also be addressed:

3. What are the points of reference between the associations of prospective biology teachers and those of secondary school students?

2.3. Analysis procedure

There are various ways of analyzing the data obtained by word association methods. According to Abric (2003) from the field of social representations, prototypical analysis and similarity analysis represent one approach. In accordance with the previously established research questions, a general content-based analysis method is implemented in the present study. In general, a distinction is made between the analysis at the group level and at the level of individual cases. In line with the research questions, analysis at the group level was chosen for the present study because the focus is not on the individual differences between the associations expressed by the individual respondents. Rather the aim is to look at which associations to the individual stimulus words arise in general among the prospective teachers. This allows conceptions about the Wadden Sea ecosystem be identified, in turn yielding implications for further studies. Categories were formed according to a quantitative content
ability was calculated. To do so, 10% of the association forms were coded. If the degree program (72.25%). A total of 2920 associations were given for all various courses of biology didactics. All students gave informed consent.

The respondents is 22.89 years, 66.5% of them are female. The data were obtained from biology didactic studies (Sellmann, 2011). This procedure served as the basis for calculating Cohen’s kappa (κ-value). In science didactics, this measure has been found to be very suitable for calculating interrater reliability (Hammann and Jördens, 2014). The κ-value determined is 0.95 and is therefore to be evaluated as very good (Altman, 1991).

3. Theoretical consideration: the professional background to stimulus words

In light of the second research question, a professional subject-area-related view of the stimulus words is essential. This prerequisite is fulfilled in this section, and the five terms selected as stimulus words are each briefly considered from a subject-area-related perspective. The explanations of the terms national park and UNESCO World Heritage Site are based on those of Schmaing and Grojohann (2021b). Finally, explanations are provided for the experts’ selection of each term as a stimulus word.

3.1. Wadden Sea

The Wadden Sea of Europe extends from Skallingen in Denmark along the entire coast of the German North Sea to Den Helder in the Netherlands, covering a distance of about 450 km (Dijkema, 1991). The width of the tidal flat is 10 km at its narrowest point near Ameland and is largest at 50 km in the Jade Bay (Hofstede, 2003).

The living conditions for the organisms of the Wadden Sea are mainly characterized by the tides and are extreme due to the associated periodic change between flooding and dryfall. Nevertheless, about 10,000 different species of animals, plants, and fungi live in the dynamic system of the Wadden Sea (Reise et al., 2010). From a zoological point of view, the lugworm (Arenicola marina) or the shore crab (Carcinus maenas) as well as botanically the salt marsh plant glasswort (Salicornia europaea) or sea lettuce (Ulva lactuca) can be highlighted as particularly characteristic species. In addition, the Wadden Sea is an irreplaceable food source for up to twelve million birds during breeding, molting, or wintering, as well as during migration (Laursen et al., 2010). For migratory birds in particular, the Wadden Sea is one of the most important wetlands in Europe and serves as a kind of hub for various migration routes, reflecting global linkages over thousands of kilometers (Rössner, 2018). The Wadden Sea is therefore of great relevance for biodiversity. For this reason, the Wadden Sea is protected on both the national and international level (for more in-depth explanations, see the discussions on the stimulus words National Park and UNESCO World Heritage Site).

The stimulus word Wadden Sea was chosen to ensure maximum openess for the respondents. There are no specifications as to which levels participants should consider when forming associations. Therefore, both content-related and emotional aspects, such as personal experiences with the Wadden Sea, can be addressed. At the same time, this openness is the basis for participants mentioning special associations, since they are not restricted and can therefore be freely named.

3.2. Mudflat hiking tour

A mudflat hiking tour is understood in the broadest sense as an excursion into the Wadden Sea. No distinction is necessarily made between a scientific excursion considering specific questions within the

| Table 1. Example of the formation of categories. |
|-----------------|-----------------|
| Category        | Associations which have been assigned to this category |
| nature conservation | nature conservation |
|                  | protected nature |
|                  | is protected    |
|                  | nature that is protected |
|                  | area to be protected |
|                  | protected area  |
| dangerous        | dangerous       |
|                  | danger          |
|                  | various dangers |
|                  | hazardous       |
|                  | partly risky    |
context of associated investigations and an excursion such as a guided tour (e.g., during vacation). The latter can generally be classified under the theory of edutainment, representing the intention of supporting education with various forms of entertainment (Aksakal, 2015). To outline the absorbent mudflat excursions offered in the Lower Saxon Wadden Sea National Park, it is useful to add the educational concept of the national park institutions. This shows that for explorations of the Wadden Sea from a didactic perspective, methods from the field of wilderness education, environmental education, and education for sustainable development, among others, should be considered as a basis for conceptualization (Nationalparkverwaltung Niedersächsisches Wattenmeer, 2017).

On the one hand, a mudflat walk aims at providing participants the opportunity to actively explore the flora and fauna of the Wadden Sea and usually entails a group of people who are guided by a qualified person (“mudflat guide”). On the other hand, just walking in the Wadden Sea can be considered as a mudflat hiking tour. Even with this form of mudflat hiking, the potential danger of being in the Wadden Sea cannot be neglected and special precautions have to be taken. Especially under such weather conditions as thunderstorms and fog, there can be danger to human life in the mudflats. Likewise, a large number of people are not aware of how quickly and unpredictably the water rises with the tide through the tideways, which can cut off the way to land. There are numerous rescues each year, which is why these challenges are considered extensively in water rescue (Fischer, 2013). In many areas, there are other safety precautions. For example, in the mudflat area off Cuxhaven, there are seven rescue beacons which offer protection and can be visited in an emergency (Freie und Hansestadt Hamburg, 2009).

The aim of selecting the stimulus word mudflat hiking tour is to potentially elicit participants’ potential previous experiences with the Wadden Sea and the related associations. In addition, in the role of the university students as prospective biology teachers, a focus could be placed on the potential of the Wadden Sea as an out-of-school learning site and, for example, out-of-school learning could be thematized from different points of view.

3.3. Tides

As already outlined, the Wadden Sea is characterized by the tides ebb and flow. These tides arise both from the effect of the gravitational force of the moon (and the sun) on the earth and from centrifugal forces, which arise from the rotation from the combination of moon and earth (Müller, 2017). These constellations give rise to two flood water mountains on Earth. During the flood, the water runs up until the water level of the high tide is reached. Subsequently, during ebb, the water runs down again to the low water level. The difference in water levels at high and low tide is called the tidal range. The tidal range plays a central role in the formation of the Wadden Sea. It is decisive in determining whether a closed balancing coast or just a tidal flat with an offshore island barrier develops (Bose et al., 2018). Ebb and flow shift every day due to the orbital velocity of the moon by about 50 min (Müller and Frings, 2009). In addition, there is a local time shift of the tides as a result of the resulting tidal waves. For example, high tide is about 2 h earlier on Borkum than in Cuxhaven (Glebe, 2011). Furthermore, certain positions of the sun, moon, and earth relative to each other can influence the intensity of the tides. If the three celestial bodies are approximately on a straight line, the tidal forces are added, and a particularly large tidal range or spring tide occurs. This phenomenon occurs at full moon and new moon. The opposite is the case at halfmoon. Because of the 90° position, the tidal forces compensate each other the most, so that the tidal range is the smallest and consequently, a neap tide occurs (Kuphal, 2013).

In addition to these physical discussions, meteorological factors should not be neglected. Especially storm surges, which occur due to very strong onshore winds, represent a great danger for the coasts, but also for the islands. Another risk is the consequences of the ongoing sea level rise, which is already the subject of scientific studies in relation to the Wadden Sea region (Wachler et al., 2020).

The stimulus word tides was chosen in order to anticipate a content-related examination of tides and their influence on the Wadden Sea ecosystem after the initially open or experience-oriented stimuli. At the same time, the necessary openness is ensured.

3.4. National park

The Wadden Sea in Germany is protected at the national level by three national parks. The first national park, the “Schleswig-Holstein Wadden Sea National Park”, was established in 1985 (Brunckhorst, 1995); the “Lower Saxon Wadden Sea National Park” was established one year later (Sübeck and Rahmeln, 2018). Hamburg’s tidal flats off Cuxhaven were declared the “Hamburg Wadden Sea National Park” in 1990 (Körber, 1995).

Yellowstone National Park was the world’s first national park to be established in the USA in 1872 (Sellars, 2009). In order to understand the general objectives of national parks and their overarching functions, the internationally recognized IUCN categorization of nature reserves can be used. National parks are assigned to the second of a total of seven categories (Dudley, 2013). In addition to the overarching idea of protection, this definition also includes the requirement for various park offerings for visitors to experience the national park. In the Lower Saxon Wadden Sea National Park, this has been incorporated into the general objectives. Ultimately, this national park has ten overarching objectives. Five of them are related to protecting the ecosystem of the Wadden Sea under different aspects. The other five objectives are related to scientific research, improving the environment in certain areas, ensuring a nature-compatible experience for visitors, and providing high-quality educational offerings and public relations work (Nationalparkverwaltung Niedersächsisches Wattenmeer, 2020). The latter function is fulfilled in part by the national park houses with their various educational offerings. These also include the wadden excursions already discussed. With regard to the implementation of the objectives, there is also a separate legal basis with the “Law on the National Park ‘Lower Saxony Wadden Sea’”. In addition to defining organizational responsibilities, this legal text primarily outlines prohibitions regarding various human interventions in the ecosystem (Gesetz über den Nationalpark ‘Niedersächsisches Wattenmeer’, 2001).

The choice of the stimulus word national park can be justified primarily by its direct reference to the Wadden Sea. It was also aimed at evoking associations detached from this ecosystem. Similar to the previous stimulus word, a subject-area-related content dimension is particularly relevant to allow focus on the general functions of a national park or the consequences for human behavior.

3.5. UNESCO World Heritage Site

The protection of the Wadden Sea within the national parks is a responsibility at the national level. In addition, the tidal flats of Germany and the Netherlands were declared UNESCO World Heritage Sites in 2009 (The World Heritage Committee, 2009). Five years later, a corresponding declaration was made for the Wadden Sea in Denmark (The
The Wadden Sea is singled out as being of equal importance to other unique natural landscapes, such as the Grand Canyon or the Great Barrier Reef. Although this international designation suggests a higher protection status to the public, this does not necessarily mean legal implementation, as this still remains anchored at a national jurisdictional level (Bertacchini et al., 2016).

In general, a distinction is made between natural World Heritage sites and cultural World Heritage sites and the criteria that define them. The designation of the first World Heritage Site was made by the relevant committee in 1978 (Adie and Hall, 2017). World Heritage sites can receive funding in various forms based on their designation. In addition to loans, support can be provided for research or skilled workers can be provided or trained, among other things (UNESCO, 1972). Certain criteria must be met for inclusion in the World Heritage List. Potential World Natural Heritage Sites must represent an outstanding natural phenomenon, have geological and biological significance, and be relevant to the biodiversity conservation (Abdulla and Obura, 2013). The Wadden Sea was designated as a World Heritage Site based on meeting the previous three criteria (The World Heritage Committee, 2009, 2014). However, the designation can be revoked from the sites due to various threats (UNESCO, 1972). In the meantime, there was a threat of the Great Barrier Reef being added to the list of World Heritage Sites in danger (Davey and Gillespie, 2014). This illustrates the significance of the necessary link to protection on a national level. Trilateral cooperation regarding this idea of protection has existed between the countries involved in protecting the Wadden Sea, Denmark, Germany, and the Netherlands, for several decades (Südbeck and Bunje, 2015).

Selecting the stimulus word UNESCO World Heritage Site has similar objectives as the selection of the previous term. Therefore, both a concrete reference to the term and a consideration of the Wadden Sea are possible. In addition, a comparison between these two protection designations can be made, and in this way, similarities and differences can be highlighted.

4. Results

In the following, the identified categories for each of the five stimulus words Wadden Sea (Figure 1), mudflat hiking tour (Figure 2), tides (Figure 3), national park (Figure 4) and UNESCO World Heritage Site (Figure 5) are presented with mind maps. As described in the methodological part of this paper, the mind maps illustrate the categories formed on the basis of the associations given by the prospective teachers. In addition, the legends for each figure show the total number of associations (na), the number of different associations (nv), and the richness of the associations (na/nv) for each stimulus word. A more in depth consideration of the results follows in the subsequent discussion within the context of literature.

4.1. Stimulus word Wadden Sea

![Figure 1. Category mind map for the stimulus word Wadden Sea. Total number of associations (na) = 829, number of distinct associations (nv) = 271, richness (nv/na) = .33.](image-url)
4.2. **Stimulus word mud**

Figure 2. Category mind map for the stimulus word *mud*. Total number of associations (na) = 610, number of distinct associations (nv) = 195, richness (nv/na) = .32.

4.3. **Stimulus word tides**

Figure 3. Category mind map for the stimulus word *tides*. Total number of associations (na) = 608, number of distinct associations (nv) = 141, richness (nv/na) = .23.
4.4. Stimulus word national park

![Mind map for national park with statistics: Total number of associations (na) = 514, number of distinct associations (nv) = 121, richness (nv/na) = .24.]

4.5. Stimulus word UNESCO World Heritage Site

![Mind map for UNESCO World Heritage Site with statistics: Total number of associations (na) = 359, number of distinct associations (nv) = 71, richness (nv/na) = .20.]
5. Discussion

The results presented are discussed in the following, subdivided according to the respective stimulus words. The categories are considered in terms of content (question 1). In addition, references are made to the subject-area-related analyses in order to consider the second question in detail. Within the discussion, a reference is made to the presented association studies (Schmaing and Grotjohann 2021a; 2021b), which are already available for the selected terms and which have been conducted with secondary school students (question 3). In the context of this process, it is not the intention of this study to discuss every single category from the mind maps, but rather the focus is on selected categories and on significant results. On the mind maps (Figures 1, 2, 3, 4, and 5), all the categories formed are shown without any form of restriction.

Furthermore, studies are considered that have examined the associations of tourists of different age groups. Regarding the term Wadden Sea, there is only one study from the Schleswig-Holstein Wadden Sea National Park (Gatje, 2007). The stimulus words mudflat hiking tour and tides have never been considered in any field of study so far except for the two studies above from the present project. Association studies on the term national park have mainly been used to investigate the acceptance of national parks within the population (Kment, 1991, 1994; Mose, 2009). However, the studies conducted do not refer to the Wadden Sea but to other national parks. Other studies include studies on the Swiss National Park (Haller, 2008) and the Bavarian Forest National Park (Job et al., 2019; Nationalparksverwaltung Bayerischer Wald, 2011). Association studies on the specific term UNESCO World Heritage Site have likewise not yet been conducted in connection with the Wadden Sea. The existing studies on this topic area have so far been used in the field of tourism research and usually refer to cultural World Heritage sites. An overview of the results of selected studies can be found in Quack and Wachowiak (2013). Nevertheless, it is possible to at least make overarching comparisons to the results of the present study. In addition, connections are made to other word association studies with other natural science topics to allow for in-depth discussion and to highlight the contribution of the present results to the scientific discourse in general.

In the discussion, the respective category under consideration that is to be taken from the representations is indicated with quotation marks in the case of a literal citation. Mind maps can be used for illustration.

5.1. Stimulus word Wadden Sea

The category system for the very open stimulus word Wadden Sea is, as anticipated, broadly diversified due to the diverse associations (Figure 1). The students mention subject-related, subject-didactic as well as completely non-subject-related associations and references to (personal) experiences with the Wadden Sea. From a subject-area-related perspective, the “ecosystem” and its characteristics, such as “biodiversity” and “high dynamics” are described, and various “plants” and “animals” are mentioned. While the category with a botanical reference comprises only the associations “algae” and “salicornia”, significantly more concrete animal species are mentioned. In no case was a scientific species name mentioned. In another word association study with prospective biology teachers with a content-related reference to biodiversity, it is equally clear that the respondents in this group often have a basic knowledge of the technical terms but are not familiar with the comprehensive concepts (Dickrell, 2010a). The lack of scientific terms specifically mentioned by the respondents is in line with this finding, so the result obtained in the current study should not be considered surprising.

In other studies with a reference to the Wadden Sea, the great significance of the term “lugworm” was found in this respect both among students from secondary schools and among vacationers (Gatje, 2007). This general subject-area-related view of stimulus words was also found in a physics didactic study. In that study, prospective physics teachers were asked about the topic “electric field” using a free word association method and expressed subject associations in a comparable manner (Türkkan, 2017). The category “slug” and the many associated versions, such as “sludgy” or “mud” are also consistent with the findings from word association studies with secondary school students. In addition, associations have emerged that reflect an experiential thematization. This becomes clear, for example, in the categories “tourism” or “vacation” with reference to the naming of concrete “places” as well as in the category “riding” as well as with the remarks on “mudflat”. In this regard, the “sink in” and the experience of participating in an excursion with “rubber boots” or “barefoot” is mentioned.

Although in general, mainly “positive descriptions” could be identified, the topic of “disgust” does not seem to be irrelevant for the prospective biology teachers. The Wadden Sea and its associations were described as “dirty” or even equated with “filthy”, and its “dirt” was thematized. In contrast, students from secondary schools did not have a meaningful number of comparable associations. This kind of aversion can be judged as surprising due to the chosen field of study and the expected professional interest associated with it as presented in the introduction (Urbanke, 2006). However, it has been shown that disgust, for example, with animals, also plays an important role for prospective biology teachers (Tomazic et al., 2017). With the category “nature conservation”, the relevance of the protection of this “worth protecting” ecosystem is emphasized. In this context, with “national park” and the “World Heritage Site”, two terms are mentioned which will be considered in detail in the context of further investigations and discussed in the further course of this work within the context of other studies.

Likewise, the category “tides” could already be formed for this stimulus word along with initial content descriptions, such as “ebb”, “flood”, “moon”, and “tideway”. The meanings of the following stimulus words were determined based on the selection panel’s expertise as well as on the previous data. Another definitional approach to the Wadden Sea can be seen with the category “waterless seabed”. For example, the Wadden Sea is described as an “area that is dry at low tide”. Here again, the central significance of the subject area tides for the general description of the Wadden Sea becomes apparent. This is accompanied by the category “dangerous”, which also mentions the weather phenomena (“fast fog” and “thunderstorms”) outlined in the technical analysis. This aspect is also taken up by the secondary school students, and the dangers of the ecosystem or the dangers associated with entering the Wadden Sea are made explicit. This is particularly evident in the associations for the stimulus word mudflat hiking tour.

In line with the dual role of students as learners in the university and (prospective) teachers in school as discussed in the introduction, the categories “school” and “for children” can be identified. Under these categories, the possibility of a “class trip” to the Wadden Sea or the “North Sea” and the Wadden Sea as an “out-of-school learning place” or potential subject to be taught in the subject “Biology” are mentioned. The out-of-school and educational potential of the Wadden Sea is indicated by the associations provided by the prospective biology teachers.

In contrast to many inland secondary school students, the prospective biology teachers are familiar with the Wadden Sea. Associations that would be evaluated as contrary were not mentioned at all. Other studies suggest that the degree of familiarity with a marine ecosystem is an important prerequisite for awareness (Aunkamah-Yeboah et al., 2020). Therefore, this aspect can be considered as fulfilled as a prerequisite for the implementation of in-school and out-of-school education by the respondents concerning the Wadden Sea ecosystem.

5.2. Stimulus word mudflat hiking tour

While a great aversion to mudflat hiking tour was identified in part among the secondary school students in other studies, this is not the case among the prospective biology teachers surveyed in this study. Rather, the “fun” of mudflat hikes is emphasized, and they are described as an “experience” and “adventure” (Figure 2). Other research has found that
primary experiences with nature have positive effects on health in many ways (Gebhard, 2012). With these associations, this potential is also considered by the prospective biology teachers. In this way, references to the Wadden Sea as an out-of-school learning place can be made again. Moreover, the possibility of informal learning at the Wadden Sea is suggested by the respondents. Especially because many people spend their vacations at the North Sea and at the Wadden Sea, this aspect seems to be very relevant for the topic under investigation. Further research projects should empirically explore the meaning of informal learning at the Wadden Sea - independent of in-school and out-of-school learning.

As with the previous stimulus word, associations of the “sludge” category are mentioned while the stimulus word is definitionally indexed. From a subject-area-related perspective, a mudflat walk is described with the association “walking on the mudflat” and again the options “barefoot” and “rubber boots” are mentioned. As the experts anticipated when selecting this stimulus word, the experience-oriented “exploration of the ecosystem” is emphasized centrally, and the aspects “exploring organisms” and “watch” are mentioned among other aspects. The second association describes a scientific approach, which can be applied at the Wadden Sea or during a mudflat hike. To implement this, one needs the “equipment”, which should be taken along during an “excursion”. “Bucket[s]” can be used to transport wadden creatures, “digging fork[s]” or “spades” can be used to dig out the wadden creatures. In connection with this, the meaning of “mudflat guide” or “expert” for the participating “group” is mentioned. In addition to this essentially science-oriented exploration of the Wadden Sea, the function of “recreation” or the mudflat hike as an occupation for “free time” is presented. These remarks correspond in particular to the characteristics discussed in the context of edutainment. Also with these associations, the postulation previously derived from the results can be supported by additional research on informal learning.

As with the students from secondary schools living directly at the Wadden Sea, the surveyed prospective teachers emphasize the function of “knowledge transfer”, naming the associations “explained leadership”, “learning”, and “determination of animals/plants”. With the latter, a scientific approach is again addressed. In this respect, it is not surprising that additional associations are named which suggest a concrete reference to the topic area “school”. Mudflat hikes can therefore be carried out with the “school class”, for example, within a “class trip”. In this context, the requirement for mudflat excursions is immediately emphasized since they “must be well done” in order to fulfill objectives. In terms of the motivation to protect the mudflats, knowledge is of central relevance (Postma, 2006). In this respect, the association “knowledge transfer” goes hand in hand with a subject-didactic postulation, so that once again the role of university students as (prospective) teachers can be illustrated. In addition, out-of-school learning again comes into focus. Therefore, in further studies, this target group should be surveyed as to whether or not they would conduct a mudflat hiking tour with their school classes in their future careers. In this way, the results of the present study could be discussed in a broader context and implications for the practice of out-of-school learning at the Wadden Sea could be identified.

Other associations illustrate the great and often underestimated potential dangers of mudflat walks. These are described as “dangerous” and, for example, “cuts” or “streams” are named as dangers, but also the need for trained mudflat guides is explained. For the secondary school students, comparable associations had a lower meaning. In addition, the associations of different “animals”, such as “crabs”, “mussels”, “snails”, and “barnacles” were named. These associations are also in line with the conclusions drawn for the previous stimulus word. In addition to these renewed exploratory expressions, there are associations that relate to the general function of walking at the Wadden Sea. During low tide, it is possible to “hike to an island” or to “walk around” an island.

Compared to the associations to the previous stimulus word, “disgust” also has meaning in mudflat hiking tours so that, once again, the findings of the literature can be corroborated (Tomazic et al., 2017). Thus, in general, this aspect seems to be directly related to the experience of the mudflats for some university students and can even be interpreted as an inhibition to enter the mudflats. There were also university students among the surveyed who had “never done” a mudflat hike. This again indicates heterogeneity in terms of personal experiences with the Wadden Sea. This aspect should also be taken into account in subsequent research in order to be able to draw more concrete conclusions in this area. Future research should examine which conditions are necessary for prospective teachers to actively choose to go on an excursion to the Wadden Sea with a school class in their future profession.

Further evidence for this form of heterogeneity is the association “Baltic Sea”, which was also mentioned for the previous stimulus word. Since there is no Wadden Sea at the Baltic Sea, the corresponding association can be considered unrelated to the subject. These unrelated associations were frequently mentioned by students from secondary schools living in inland areas. While the participants’ unfamiliarity with the Wadden Sea, which was also found, could be used as an explanatory approach for this group of people, this is hardly possible for students of biology. However, it can be inferred from another word association study that prospective teachers’ cognitive structures are less strong for biological concepts than for other natural sciences (Atabek-Yigit et al., 2016). This is an indication of the presence of conceptions of prospective teachers that are not comprehensible in terms of the subject matter, which provides insight into the second research question.

### 5.3. Stimulus word tides

The associations to the first two stimulus words are characterized by a high diversity of responses and describe different levels, partly with a subject-didactic focus. The stimulus word tides suggests mainly a content-based approach. The student teachers, like the secondary school students, highlight “ebb” and “flood” as tides (Figure 3). Low tide is described as “water goes”, high tide as “water comes” and with the processes “outflowing water” and “running up water”. In addition, there are many associations which discuss this phenomenon technically. Another study used a word association test to find that prospective biology teachers’ conceptions of global warming are superficial (Dikmenli, 2010b). The present study, in contrast, demonstrates the potential of this method to provide in-depth access to a topic area. Comprehensively, the meaning of the “moon” is mentioned and the terms “pull”, “moon phases”, and “moon cycle” are mentioned. The “earth” is also presented as central to the process with the associations of “magnetic field”, “earth rotation”, and “centrifugal force”. However, no consideration of the sun was made with the associations. The technical terms “tide” or “tide range”, “spring tide”, “low tide”, “high tide”, and “tideway” are mentioned. Following up on these technical explanatory statements, associations can be made that discuss a description of the consequences of the various constellations. The “movement of water masses” or general “changes” occur. Above all, the “duration/postponement” is carried out. The tides are “twice a day”, “every 6 h” in a “rhythm”, and “every day later”. Corresponding information can be obtained from a “tide calendar” or “tide schedule”. In addition, the effects for shipping, such as for the “ferry[s]”, are also addressed. The relevance of technical expressions, which has also been highlighted in association experiments with students from secondary schools, can be confirmed (e.g., Bogner and Wiseman, 1997; Dieter and Bogner, 2019; Duit, 1986). As shown, the breadth of subject associations to this stimulus word is great. The findings of the present study demonstrate the possibility of using word association tests to diagnose prospective science teachers’ subject-area-related conceptions (Yilmaz, 2019).

As with the two stimulus words considered previously, the “dangers” posed by the tides are again described in detail. From this, a great deal of consideration and general awareness of them can be outlined. “Fog”, “sea fog”, “thunderstorms”, “flood”, and “drowning” are presented as dangers. Even the term “fear” is mentioned. This underscores the need for experts to accompany people on a mudflat hiking tour especially with a school class. As can be seen from the theoretical part of the paper, various legal requirements are particularly relevant. Teachers have to observe
many different regulations in order to go on a mudflat hiking tour with a school class and a local guide. In contrast, the tides are also described as a “force of nature” and a “natural spectacle”, so that a certain fascination is expressed in addition to this fundamental respect for them. This aspect is strengthened with the associations “childhood”, “swimming”, “walk in the mudflats”, and “fun”, and an experience-oriented conception of the term is recognizable. The latter association could also be evaluated as an indication of the underestimation of the danger potential emanating from the tides. Taking into account the prospective teachers’ aspirered career, the aspect of “teaching” is again addressed with this stimulus word, and from a subject-didactic perspective, the considered process is judged as “difficult to explain”. These associations result in part from the great need for didactic reduction, which must be carried out by the teachers, for example, within a teaching context. This finding should also be consid-
ered in subsequent studies. In this context, it is important to determine how the ecosystem and, in particular, the tides can be addressed in lessons in a way that is appropriate for the target group. For this purpose, not only the perspective of the teachers but also that of the learners should be examined. For example, it is possible to determine the acqui-
sition of knowledge as a result of the corresponding lessons.

Once again, associations that are foreign to the subject are mentioned. While these are present in large numbers, especially among secondary school students from the inland and can be justified by the unfamiliarity with the Wadden Sea, they can hardly be understood from a subject-area-rela-
ted point of view when mentioned by the prospective teachers. The association “not in Baltic Sea” is not obvious but contradicts the fact that tides exist there as well. Although these are not immediately recognizable or perceptible at first glance in the Baltic Sea due to the significantly lower tidal range, there are nevertheless no starting points from the technical conception as to why there could be no tides in the Baltic Sea. The results of other word association tests with prospective teachers also show that the teachers’ conceptions are sometimes very far from correct scientific conceptions (Kurt, 2013a, 2013b; Zan et al., 2015). In this respect, misconceptions can be diagnosed with this methodological approach. With regard to the second research question, exemplified by this result and the results already discussed for the other stimulus words, it should be noted that some prospective biology teachers possess con-
ceptions about the Wadden Sea ecosystem that can be considered incorrect within the theoretical framework of conceptions held by ex-
erts in the subject area.

5.4. Stimulus word national park

Just like secondary school students and tourists (Wöflle et al., 2016), student teachers highlight the relevance of “nature conservation” in relation to the stimulus word national park with associations that can be seen as central and as an objective (Figure 4). In this context, “species conservation” as well as “bird protection” should be mentioned. The national park offers “protected areas” with a “retreat for endangered animals”. From a technical perspective, these associations are subject-related, as they reflect the elementary objectives of national parks. Based on the previous stimulus words and taking the general context of the survey into account, the association of the national park “Wadden Sea” with the places “Cuxhaven” and “Borkum” as well as the descriptions “North Sea” and “dunes” is also evident. In addition, the reference to another national park” is also made. Among others, the national park “Eifel” is mentioned. In front of a historical perspective, associations assigned to the categories “USA” and “Yellowstone” are also mentioned. As with the secondary school students from the inland, the meaning of the reference to the origins of national parks is also under-
ed by the university students.

Other associations are used to describe the “rules for people” which result from the regulations for protecting the Wadden Sea or the ecosystem protected by the national park. The national park “may not be entered” or “entering not always allowed”. The latter category reflects the zoning concept of the Lower Saxony Wadden Sea National Park.
This demonstrates the apparent need for school education and national park centers to carefully consider how this term is communicated in their educational offers.

5.5. Stimulus word UNESCO World Heritage Site

As presented in the theoretical part, there are not only World Natural Heritage Sites but also World Cultural Heritage Sites. Therefore, associations belonging to the category “culture” are not surprising, even though the stimulus word clearly places an emphasis on the UNESCO World Natural Heritage Sites. The UNESCO World Heritage Site is exemplified with the associations “Naumburg Cathedral” and the “Hamburg Speicherstadt” as well as with the associations “history” and “monuments”, which came up in this context (Figure 5). In addition, there are references to the “Wadden Sea”, for example, the year the Wadden Sea was designated as a UNESCO World Heritage Site “2009” and the “trilateral cooperation” between the participating countries “Denmark”, “Germany”, and the “Netherlands”. Therefore, the conclusions made about the previous stimulus word are also relevant to this stimulus word. It is not possible to consider the results from this study without considering the context of the survey. References to other World Heritage sites were also made by secondary school students. The local proximity to the nearest World Heritage Site was important and seems to have a significant influence on the associations. There was no indication of this among the teachers.

In addition, as the experts anticipated when selecting this stimulus word, a level of comparison with the previous stimulus word is apparent. As with the students from secondary schools, “nature conservation” is mentioned centrally and the respective sites or ecosystems are presented as “threatened” and, at the same time, as “landscape worth preserving”. Another study found that most visitors value World Heritage sites for their ecological meaning (Hazen, 2009). In further biology didactic studies, this aspect should be considered in addition to exploring to what extent the ecological importance of the Wadden Sea ecosystem is a reason for visiting it. The previously discussed conclusions for the design of informal learning studies can be directly related to this. This is accompanied by the “rules for people”, which are again were limited to the mention of a no-entry rule. As discussed in the theoretical section of the work, no legal consequences for protection at the national level follow directly from the designation as a World Heritage Site. From a technical point of view, the association “do not enter” can therefore only be understood to a limited extent. The category “is not protection” shows the inconsistency between the individual associations that prevails in some areas but is understandable from a subject-area-related perspective. As is the case with the previous stimulus word, associations are mentioned that capture the “relevance” of this protected status or World Heritage sites. These are “important”, “indispensable”, “special”, “unique” as well as “to be treated respectfully” and “to be valued”. The associations expressing uniqueness have already been demonstrated several times in other studies (Quack and Wachowiak, 2013). However, there was a reference to World Cultural Heritage Sites. It can be concluded that there is a need to differentiate between these two forms of World Heritage Sites in future studies and implement appropriate comparisons at different levels.

In response to the considered stimulus word, according to a literal derivation, the association “nature” came up. The categories “animals” and “plants” can be singled out as close in content. Another literal derivation is shown by the association “heritage”. Likewise, the category “international” can be explained but is also a connecting point for the associations regarding “promotion”. Inclusion in the “World Heritage List” is accompanied by various forms of “support”, including “donations”. Another form is assistance with “research”. The category “science” was also generally presented as relevant to the associations. Since the respondents are in the academic part of their teacher training at the university, these associations are not surprising. For this, as with the other stimulus words, there is again a reference to the context of “school” and the “UNESCO school”.

At a higher level, associations can be found whose aim is to formally describe, among other things, the responsibility of “politics” or that of UNESCO as an “organization”. In this context, the stimulus word is associated with the term “award” and the sites are categorized as “officially recognized”. The possibility of withdrawing this protective designation, as discussed in the technical analysis in the theoretical part, is evidenced by the association “conditions”. Nevertheless, UNESCO World Natural Heritage sites are “worth seeing” and “known worldwide”, so they are the focus of “tourism”. At this point, it becomes apparent how many associations the prospective teachers have with this stimulus word that are not directly related to the Wadden Sea.

Even in response to this stimulus word, technically foreign associations have emerged. For example, the category “no dirt” in particular is hard to comprehend and technically unjustifiable from a subject-area standpoint. The association “park” is equally surprising and reinforces the conclusions already drawn in answering the second research question. For more in-depth findings on potential influencing factors for the subject-area-related incorrect conceptions, subsequent studies could pay special attention to the age of the respondents. Likewise, the influence of previous courses taken at university on this subject area could be investigated. Associations that can be categorized under city parks are very significant among secondary school students in relation to the stimulus word national park. The association “I have never heard of it” also indicates that even some of the university students have no knowledge of this conservation term, and thus it does not seem to be as well known as the term “national park”. The other word association studies with students from secondary schools confirm this difference regarding the level of awareness regarding the two considered protection designations. The result is nevertheless astonishing since this protective designation is also familiar in the context of natural sciences and should therefore be known to prospective biology teachers.

6. Conclusion

The present study provides insight into the conceptions of prospective biology teachers on the topic of the Wadden Sea. Ultimately, the presentation and the subsequent discussion of the results show that various associations were evident at different levels. The students named associations from their learner perspective as well as from their prospective teacher perspective. In addition to a large number of subject-area-related associations, some associations were also presented that must be evaluated as conceptually incorrect from a subject-area-related point of view. In the discussion, many comparisons were made with the results from the two studies that focused on secondary school students’ associations. Finally, the richness of the associations to the individual stimulus words is considered. This indicator as well as the values for the calculation of this can be taken from the legends of the mind maps (Figures 1, 2, 3, 4, and 5). It is noticeable that the stimulus word Wadden Sea has the highest richness with a value of .33. Thus, respondents named the most different associations as measured by the total number of associations given for this word. This indicates that this term is associated with associations from various areas. The lowest value is evident for the stimulus word UNESCO World Heritage Site. This is .20 and reinforces the conclusions stated in the discussion of this term.

Further research on the Wadden Sea in biology education should include the group considered in this study. Research projects could address the extent to which the Wadden Sea can be meaningfully included in teacher training in both school and out-of-school contexts. Further implications have been provided in the discussion of the results. Considering that the respondents are all studying biology, some incorrect associations seem surprising. Although the Wadden Sea as a UNESCO World Heritage Site and National Park in Germany has a supra-regional reputation and should be known by this specialist audience, this study was able to reveal deficits in this respect. This suggests that in the
corresponding courses of studies in the teaching profession, there has been an insufficient thematization of marine biological contents in relation to the Wadden Sea. Precisely because this ecosystem is so special, university courses should address corresponding content both in theory and on site in practice. Only in this way is it possible for future teachers to deal with the Wadden Sea in a meaningful way with their students in science lessons or in the context of an excursion.

Declarations

Author contribution statement

Till Schmaing: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Norbert Grojohann: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data.

Funding statement

This work was supported by Universität Bielefeld [DE 811307718].

Data availability statement

Data will be made available on request.

Declaration of interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Acknowledgments

We acknowledge support for the publication costs by the Open Access Publication Fund of Bielefeld University and the Deutsche Forschungsgemeinschaft (DFG).

References

Abdulla, A.A., Obura, D., 2013. Marine Natural Heritage and the World Heritage List: Interpretation of World Heritage Criteria in marine Systems, Analysis of Biogeographic Representation of Sites, and a Roadmap for a Addressing Gaps, IUCN. URL: https://portals.iucn.org/library/digital-library/2013-033.pdf (last access: 17.01.2022).

Abric, J.C., 2003. La recherche du noyau central et de la zone murte des représentations sociales [The search for the central core and the silent zone of social representations]. In: Abric, J.C. (Ed.), Methodes d'etude des representations sociales [Methods of Studying Social Representations]. ERES, Toulouse, France, pp. 59–80.

Adle, B.A., Hall, C.M., 2017. Who visits World Heritage? A comparative analysis of three cial, university courses should address corresponding content both in

Brunckhorst, H., 1995. Biosphärenreservat Schleswig-Holsteinisches Wattenmeer [Schleswig-Holstein Wadden Sea biophere reserve]. In: Standsige Arbeitsgruppe der Biosphärenreservate in Deutschland. Biosphärenreservate in Deutschland: Leitlinien für Schutz, Pflege und Entwicklung [Biosphere Reserves in Germany: Guidelines for Protection, Maintenance and Development. Springer, Berlin, Heidelberg, pp. 113–119.

Burger, J., 2001. Schülervorstellungen zu ‘Energie im biologischen Kontext’ – Ermittlungen, Analysen und Schlussfolgerungen: Ein Beitrag zur Veränderung von Lernorientierungen im Biologieunterricht der Sekundarstufe. In: Ergebnisse und Befunde der Arbeitsgruppe ‘Schülerorientierte Lernumgebungen’ 17.01.2022). URL: https://portals.iucn.org/library/efc/pub/2305865/2305868/0044.pdf (last access: 17.01.2022).

Davey, M., Gilliepie, J., 2014. The great barrier Reef world heritage marine protected area: valuing local perspectives in environmental protection. Aust. Geogr. 45 (2), 131–145.

Dieser, O., Bogner, F.X., 2019. Intervention impact on young students’ associations about Wolf and Lynx. Soc. Anim. 27 (5-6), 544–574.

Dijkema, K.S., 1991. Towards a habitat map of The Netherlands, German and Danish Wadden Sea. Ocean Shorel. Manag. 16 (1), 1–21.

Dikmenli, M., 2010a. Biology student teachers’ conceptual frameworks regarding biodiversity. Education 130 (3), 479–489.

Dikmenli, M., 2010b. Biology students’ conceptual structures regarding global warming. Energy Educ. Sci. Technol. Part B: Soc. Educ. Stud. 2 (1), 21–38.

Doring, N., Bortz, J., 2016. Forschungsmethoden und Evaluation in den Sozial- und Humanwissenschaften [Research Methods and Evaluation in the Social and Human Sciences]. Springer, Berlin, Heidelberg.

Dudley, N. (Ed.), 2013. Best Practice Protected Area Guidelines Series: Bd. 21. Guidelines for Applying Protected Area Management Categories including IUCN WCBA Best Practice Guidance on Recognising Protected Areas and Assigning Management Categories and Governance Types. IUCN.

Dutt, R., 1986. Energievorstellungen (Energy concepts). Naturwissenschaften im Unterricht Physik/Chemie [Sci. Class Phys./Chem.]. Springer, Berlin, Heidelberg.

Erdmann, C., 2005. Besucherbefragung im Nationalpark Eifel und in seiner angrenzenden Region: Juni bis November 2005 - Kurzfassung des Endberichtes [Visitor Survey in the Eifel National Park and its Bordering Region: June to November 2005 - Summary of the Final Report].

Fischer, P., 2013. Taschenbuch für Wasserretter: Ratgeber für Ausbildung und Praxis [Pocketbook for Water Rescuers: Guidebook for Training and Practice. ecomed. Freie und Hansestadt Hamburg, 2009. Herzlich Willkommen in Unserem Nationalpark: Nationalpark Hamburgisches Wattenmeer [Welcome to our National Park: National Park Hamburg Wadden Sea]. URL: https://www.nationalpark-wattenmeer.de/wp-content/uploads/2020/10/brosch_npw_web.pdf (last access: 17.01.2022).

Glatz, C., 2007. Das sozio-ökonomische Monitoring im Nationalpark Schleswig- Holsteinisches Wattenmeer [Socio-economic monitoring in the Schleswig-Holstein Wadden Sea National Park]. In: Biosphärenreservat Vessertal-Thüringer Wald, Tagungsreihe: Naturschutz im Nationalpark Thüringer Wald und im Biosphärenreservat Vessertal-Thüringer Wald, 2006 [Conference Series: Nature Conservation in the Thuringian Forest Nature Park and the Vessertal-Thuringian Forest Biophere Reserve, 2006]. URL: https://alpenverein-ilmenau.de/formulare/hr/Benachrichtiger.pdf (last access: 17.01.2022).

Gebhard, U., 2012. Zur Bedeutung von Naturerfahrungen für die seelische Entwicklung, Wohlbefinden und Gesundheit [On the importance of nature experiences for mental development, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Werteentwicklung, well-being and health]. In: Jung, N., Molitor, H., Schilling, A. (Eds.), Leben: Die Bedeutung der Natur für seelische Gesundheit und Warte...
Kment, E., 1991. Die Assoziationstechnik - Eindrücke zum geplanten Nationalpark

Job, H., Fließbach-Schindlerfeld, M., Bittinger, S., Herling, A., Woltering, M., 1993. Akzeptanz der bayerischen Nationalparks: ein Beitrag zum soziökonomischen Monitoring in den Nationalparks Bayerischer Wald und Berchtesgaden. Würzburger geographische Arbeiten: Band 122 [Acceptance of Bavarian National Parks: A Contribution to Socio-Economic Monitoring in the National Parks Bayerischer Wald and Berchtesgaden National Parks]. Würzburg Geographische Musik: Band 122. Würzburg University Press.

Hassen, H., 2009. Valuing natural heritage: park visitors' values related to World Heritage sites in the USA. Cur. Issues Tour. 12 (2), 165–182.

Hofstede, J., 2005. Danish territory, Danish identity. Oxford Univ. Press, pp. 185–205.

Johe, M., Fliessbach-Schindlerfeld, M., Bittinger, S., Herling, A., Woltering, M., 2009. ‘Akzeptanz der bayerischen Nationalparks’. In: Koster, E.A. (Ed.), The Oxford Regional Environments Series 6. The Physical Geography of Western Europe. Oxford Univ. Press, pp. 185–205.

Kalkalpen: Ablauf und Ergebnisse eines Pilotprojektes in der Gemeinde Großrinderfeld [Discover the Moon Anew]. Springer, Berlin, Heidelberg, pp. 169–178.

Krüger, D., Parchmann, I., Schecker, H. (Eds.), Methoden in der naturwissenschaftsdidaktischen Forschung [Methods in Science Didactics Research]. Springer, Berlin, Heidelberg, pp. 169–178.

Krüger, D., Parchmann, I., Schecker, H. (Eds.), Methoden in der naturwissenschaftsdidaktischen Forschung [Methods in Science Didactics Research]. Springer, Berlin, Heidelberg, pp. 169–178.

Kurt, H., Ekici, G., Aktas, M., Aksu, O., 2013. Determining biology student teachers' professional knowledge: structure and learning opportunities. J. Sci. Teach. Educ. 26 (3), 291–318.

Kurt, H., 2013b. Determining biology teacher candidates' conceptual structures about the Wadden Sea – a universally outstanding tidal wetland. Wadden Sea Ecosyst. (29), 7–23.

Kuphal, E., 2013. Den Mond neu Entdecken [Discover the Moon Anew]. Springer, Berlin, Heidelberg, pp. 81–125.

Kurt, H., Jordens, J., 2014. Offene Aufgaben codieren [Coding open tasks]. In: Krüger, D., Parchmann, I., Schecker, H. (Eds.), Methoden in der naturwissenschaftsdidaktischen Forschung [Methods in Science Didactics Research]. Springer, Berlin, Heidelberg, pp. 81–125.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.

Kurt, H., 2013b. Determining biology teacher candidates’ conceptual structures about energy and attitudes towards energy. J. Baltic Sci. Educ. 12 (4), 399–423.

Kurt, H., 2013a. Biology student teachers’ cognitive structure about ‘Living thing’. Educ. Res. Rev. 8 (12), 871–880.
Wölfle, F., Preisel, H., Heinlein, V., Türk, S., Amberger, A., 2016. Abschlussbericht zum Sozioökonomischen Monitoring 2014-2015: Besuchermonitoring und regionalwirtschaftliche Effekte im Nationalpark Eifel [Final Report on Socio-Economic Monitoring 2014-2015: Visitor Monitoring and Regional Economic Effects in the Eifel National Park]. URL: https://www.dshs-koeln.de/fileadmin/redaktion/Aktuelles/Meldungen_und_Pressemitteilungen/Abschlussbericht_zum_Soziooekonomischen_Monitoring_2014-2015_14622002621.pdf (access 17.01.2022).

Woodworth, R., Schlosberg, H., 1965. Experimental Psychology: Revised Edition. Holt Rinehart & Winston.

Yilmaz, E., 2019. Cognitive structure determination of prospective science teacher via word association test. Asian J. Educ. Train. 5 (3), 422–428.

Yüce, K., Şahin, E.V., Koçer, O., Kana, F., 2013. Motivations for choosing teaching as a career: a perspective of pre-service teachers from a Turkish context. Asia Pac. Educ. Rev. 14 (3), 295–306.

Zan, N., Zan, B.U., İnci Morgil, F., 2015. The word cloud illustration of the cognitive structures of teacher candidates about education concept. In: Uskov, V.I., Howlett, R.J., Jain, L.C. (Eds.), Smart Innovation, Systems and Technologies. Smart Education and Smart E-Learning. Springer International Publishing, pp. 357–370.