INTEREST AND LEARNING IN BOTANICS, AS INFLUENCED BY TEACHING CONTEXTS

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Abstract. Knowledge concerning flora and fauna species is a prerequisite for the development of a meaningful relationship between human beings and their environment and, on a conceptual-procedural competence level, results in the informed management of biotopes and ecosystems. However, graduates generally have little interest in flora, the ecological producers responsible for much of our livelihood. The understanding of nature and biodiversity throughout the general populace in Germany is currently not sufficient to guarantee sustainable modes of action and environmental conservation in Germany (Nature Awareness Study). What didactic organization of botanics training courses can serve to stimulate the situational interest (interestedness) and competence of future teachers with regard to botany? Previous research studies have shown that, in comparison with other topics (e.g. zoology, human biology), there is likely to be little lasting interest in botany topics. The low level of interest for botanics exhibited by both teachers and students, the insufficient knowledge accumulated by graduates, and the lack of interest in achieving effective sustainability all interact to create a "vicious circle". To disrupt this circle, a teacher training course based on practical contexts, hands-on science, and interaction with nature and specific species was developed by taking into account the theory of intrinsic motivation. Over the course of a semester, knowledge acquired by student teachers increases significantly. Interest generated through context-oriented organization can be high, while stress and effort are low. However, the resulting long-term personal interest may increase only slightly.

Keywords: Biodiversity, Botanics, Lerning in contexts, Motivation, Interests

INTRODUCTION

Biodiversity in the Context of Sustainable Development Education (SDE)

Ekardt (2011) has defined sustainability as a long-term and globally maintainable way of life and economic activity. Sustainable development education (SDE) is concerned with the manifold ways in which human activity interacts with nature. A large number of international programs, as well as national strategies within Germany, have been implemented for the preservation of biodiversity.

The emphasis on human activity within the concept of *species knowledge* is reflected in its definition as *biotope management* (Blessing & Hutter, 2004; Hutter & Blessing, 2010). Thus, species knowledge is much more than the simple learning of the names and characteristics of individual organisms; it means achieving the highest level of conceptual and procedural competence (Bybee 1997, Weinert 2002) involving human interaction with species in real situations and the sustainable management of biotopes and ecosystems.

While the loss of animal species may be more readily apparent, plants and other organisms also suffer from accelerated extinction: "…plants form the basis of most animal habitats and all life on earth, although animals frequently steal the spotlight when the specter of extinction is raised" (Wandersee, 2001). Successful SDE-oriented education programs have been examined in an initial series of empirical studies (Ramadoss & Poyya, 2011; Hagenbuch et al., 2009; Kostova, 2007; Jahnke, 2011; Schaal et al., 2012). Research studies demonstrate that frequent work in the field as well as active learning in school via inquiry-based study of species and their diversity can promote increased appreciation of the richness of species and its importance (e.g. Lindemann-Matthies, 1999, 2002).

Awareness of Biological Diversity and Knowledge of Species

In a representative national study carried out in Germany in 2009, Rädiker and Kuckartz (2012) examined awareness concerning biological diversity in terms of three components: knowledge, attitude and behavioral willingness. In this so-called nature awareness study with 2000 subjects, knowledge about biological diversity was identified as the "bottle neck", although an increase in knowledge alone is not sufficient for a change in behavior with regard to biodiversity. In 2009 only 22% of the German population met the test's criteria for the three components listed above, as required for the realization of the national strategy for conservation of biodiversity.

Results of other research projects concerning knowledge of species proved to have a sobering effect. For example, Klingenberg & Brönnecke (2011) found that more than half of the tested adults could not correctly identify the leaves of trees such as beech (*Fagus sylvatica*) or linden (*Tilia*) and, therefore, concluded that only a minor degree of cumulative or cross-linked knowledge had been generated.

The term plant blindness has been introduced to indicate lack of primary knowledge concerning local plants (Wandersee, 2001). According to their theory plants represent an anonymous green mass which normally does not move, look at us through eyes or threaten us. Thus, plants tend to generate little interest (Wandersee 2001, Hershey 1996). Interest in plants is significantly lower than interest in animals or human biology (e.g. Löwe, 1992; Vogt et al., 1999), as confirmed by the international *Relevance of Science Education* (ROSE) study involving 15-year-old students in Europe.

If teachers wish to introduce biodiversity and environment protection in an enthusiastic educational program, then it is imperative that they themselves possess the necessary interest, knowledge, and didactic competence (pedagogical content knowledge, PCK). In any event general requirements for successful teaching are solid professional skills and knowledge, personal charisma, and authenticity (Wilhelm, 2007).

Empirically, three main types of biology teachers have been identified and can be distinguished on the basis of their attitude toward biology science and education: the conventional practitioner, the innovative professional, and the innovative pedagogue (Neuhaus & Vogt, 2005).

Didactic Design Possibilities

What elements of instruction stimulate the situational interest of student teachers in their confrontation with the subject material? Studies have shown that context-oriented instruction, i.e., learning environments embedded in situations relevant to students, leads to enhanced situational interest and achievement (e.g. Elster, 2007). The term *context* is used here to represent a topic or aspect which is helpful in making accessible the structured knowledge and domain-specific systematics of a particular area of science. These contexts must be chosen to encompass a representative segment of the concepts involved in the natural sciences.

Interest and Interestedness

The person-object theory of interest developed by Krapp & Prenzel (1992) differentiates between situational interest (*interestedness*, an often temporary state) und a more lasting individual or personal *interest* (as a general personal trait). Interests are assumed to be specific person-object relationships which emerge from an individual's interaction with the environment (Krapp, 2005). Interest consists of intrinsic emotion- and value-related valences (Schiefele & Krapp, 1996). Many studies showed an important influence of interest on the level of learning, academic performance and the quality of learning experience (Schiefele et al., 1993). Self-regulated learning can improve the intrinsic motivation (cf. Deci & Ryan, 1985, 2000).

Previous research has frequently highlighted that an inquiry-based approach and field work are important and essential elements of teaching and learning about biodiversity and ecology. (e.g. Ramadoss & Poyya Moli, 2011; Schaal et al., 2012).

RESEARCH QUESTION AND RATIONALE

In view of the fact that the level of interest exhibited by teachers will have a significant influence on the learning process for students, it is important to clarify how prospective teachers themselves can become interested in the local flora and what are their dispositions toward botanic subject material.

What didactic design will be found to be interesting for the participants, at least for the moment? Which factors are suitable for generating a high level of learning motivation? In short, what didactic design promotes interestedness?

Our hypothesis is that context- and problem-oriented learning situations promote interestedness and that there is a strong correlation between intrinsic motivation and the degree of self-determination or autonomy.

Modulation of interest will be a slow process but temporary interestedness can be converted to lasting personal interest.

Our hypothesis is that the depth of species knowledge will increase, and that the relevant terminology will be learned despite context orientation. But we suspect, that a context-oriented seminar design will not achieve equal levels of interestedness or acquired knowledge for all participants.

METHODS

Research Study Design

The study described below was carried out over the spring/summer semester 2012 at the University of Education Heidelberg, Germany. Subjects of the study were student teachers who were being trained as biology teachers. Their mean age was 22 years.

The study was organized with a classical before-after design to assess lasting interests and knowledge gained through the intervention provided by a series of 10 seminars.

It was shown that the self-assessment of students with regard to their open responses to known plants (free naming of species) can be trusted. Subjects were asked to list the names species that were known to them, and they could correctly name these species, but not others, when viewing original samples (Jäkel & Schaer, 2004). Thus, the free naming of plant species which were recognized outdoors during the walk to the University, for example, served as an indicator of species knowledge.

The subject's knowledge of concepts and terminology was also measured by self-assessment in before-after testing. A good correlation (Spearman's rank correlation ρ) between actual knowledge and self-assessment was previously found for human biology (Jäkel, 2012) and botanics.

In a preliminary test all subjects were asked to assess their knowledge of plant species and a variety of technical terms (xylem, epidermis, anthocyanin, chlorophyll, sorus, etc.).

At the beginning of this study the student teachers filled out a questionnaire designed to measure their interest in a variety of biological topics such as human biology, botany, zoology, molecular biology, ecology, conservation, etc. (n = 22 items, Cronbach's α = 0.856). For comparison, the questionnaire was repeated 14 weeks later after completion of the seminar series.

In addition, after each seminar (two hours per week) a short questionnaire for the measurement of intrinsic motivation (Deci & Ryan, 2000) was employed (validity given by Cronbach's $\alpha > 0.719$). This instrument assesses participants' interest/enjoyment, perceived competence, effort, value/usefulness, experienced pressure and tension, and perceived autonomy while performing a given activity.

Table 1

Botanics Course Content, 2012

Seminar		**Topics**
Nr.	**Date**	
1	26.04.	Introduction into the field of botany with two examples: bear's garlic (*Allium ursinum*) and anemone. Fundamentals of plant and flower morphology.
2	03.05.	Presentation of examples of two plant families: Brassicaceae, Lamiaceae.
3	10.05.	Presentation of the red campion *Silene dioica* as an example of a dioecious plant; use of a magnifying glass to study the seeds of several *Caryophyllaceae*; plants organs and identification; anthocyanin as flavanoid pigment in vacuoles of red onions; examination of the stinging hairs of the nettle (*Urtica dioica*).
4	24.05.	Identification of plants from *Fabaceae* family; familiarization with various legume fruits.
5	14.06.	Microscopy of vascular bundles in maize (*Zea mays*) and the genus *Ranunculus*, as examined in fresh and fixed cross sections of stems.
6	21.06	Presentation of self-devised didactics for the theme light and plants; testing with school children, age 8 – 15, under outdoor learning situations.
7	28.06.	Evaluation of the teaching situations from the previous week; introduction to the family *Asteraceae*: plant pigments; plant identification.
8	05.07.	Introduction to the carrot or parsley family Apiaceae (*Umbelliferae*): identification of examples, examination of seeds with a stereo magnifier, sensory tests (taste and odor).
9	12.07.	Introduction to gymnosperms: presentation of leaves and seed cones from native conifers.
10	19.07.	Microscopy of wheat grains; study of other grains or fruits; extraction of gluten from wheat flour.

A problem- and inquiry-oriented style was adopted for the course work. The seminar included activating self-determined exercises as well as direct instruction. The use of a dichotomous identification key, for example, was introduced with a collectively discussed example. Basic biological techniques were learned through appropriate examples, e.g., the use of special literature for the identification of plants. The result of a previous study was applied here, namely, that biodiversity can be better understood through the study of a small rather than a large number of species (“less is more”). Instruction alternated with autonomous study.

The application of microscopy, in particular the preparation of drawings, has proven to be unpopular among students. Motivation can be increased when microscopy alternates with other methods (Jäkel, 2012).

The series of seminars outlined in Table 1 integrated a broad range of contexts (edible plants, tasting of spices, phenomena with an “aha” effect, interesting “horror” stories, etc.) and alternatives (cf. Jäkel, 2005), indoor study and outdoor excursions, and a didactic design exercise for the teaching of school children. The student teachers were given the opportunity, with a large degree of autonomy in content and methods, for developing “light and plants” didactics for small groups of school children. Constructive feedback was provided to the student teachers frequently during their planning phases and after sessions with the school children.

RESULTS AND DISCUSSION

In the following all statistical analyses were performed using IBM SPSS 20.

Which activities lead to the best results in the Intrinsic Motivation Inventory (IMI)?

The results for the Intrinsic Motivation Inventory (IMI) (Deci & Ryan 2000) obtained after each of the ten seminars listed in Table 1 are summarized in Figure 1 (total of 9 items, Cronbach’s $\alpha = 0.719$).

The results show for each seminar date that the perceptions of interestedness, competence, and autonomy were relatively high (3.5 – 4.5) while the stress factor remained relatively low (1.5 – 2). This does not necessarily mean that long-term levels have been developed in the person-object relationships. Interest research (Löwe, 1992) has shown that generally at the beginning of a new learning phase interestedness is high and declines somewhat during the learning period. This behavior is apparent as a minor trend for the periods of seminars 1 – 5 and 6 – 10, whereby the downward trend up to seminar 5 is broken by a surge in interestedness with the particularly demanding seminar 6. Seminars 3 and 8 also represent minor exceptions to the downward trends, whereby interestedness was stimulated by the introduction of a magnifying glass or stereo magnifier for examining exotic structures (e.g. seeds from Caryophyllaceae) or the use of taste and smell as sensory inputs (fruits and leaves of herbs and legumes).

The levels for the three indices interestedness, competence, and autonomy all reached their highest levels for the challenging seminar 6. In this case the student teachers were asked to design a didactic program in botanics with the theme “Light and Plants” and to test this program with school children, outdoors in the University’s ecological biotope (hands-on science) on June 21 (summer solstice). Thus, the perception of autonomy reached a maximum due to the requirements of designing a teaching program and using it to generate motivation and interest in others. The prospective teachers were challenged in a direct career-oriented manner; therefore, their perceived competence also reached a maximum level.

The identification of species using the expert literature (e.g. seminar 4) proved to be less popular because it is tedious and difficult to learn. However, competence in this area is of key importance for biotope management and science-oriented teaching. A low level of autonomy and the lowest levels of competence and interestedness were found for seminar 5, the examination and comparison of vascular bundles in plant stem cross sections. Other practical but more problem-oriented microscopy exercises received higher ratings, e.g. seminar 3, the study of nettle stinging hairs or pigment in red onions. This situation is analogous to that known for microscopy in the context of human biology (Jäkel, 2012).

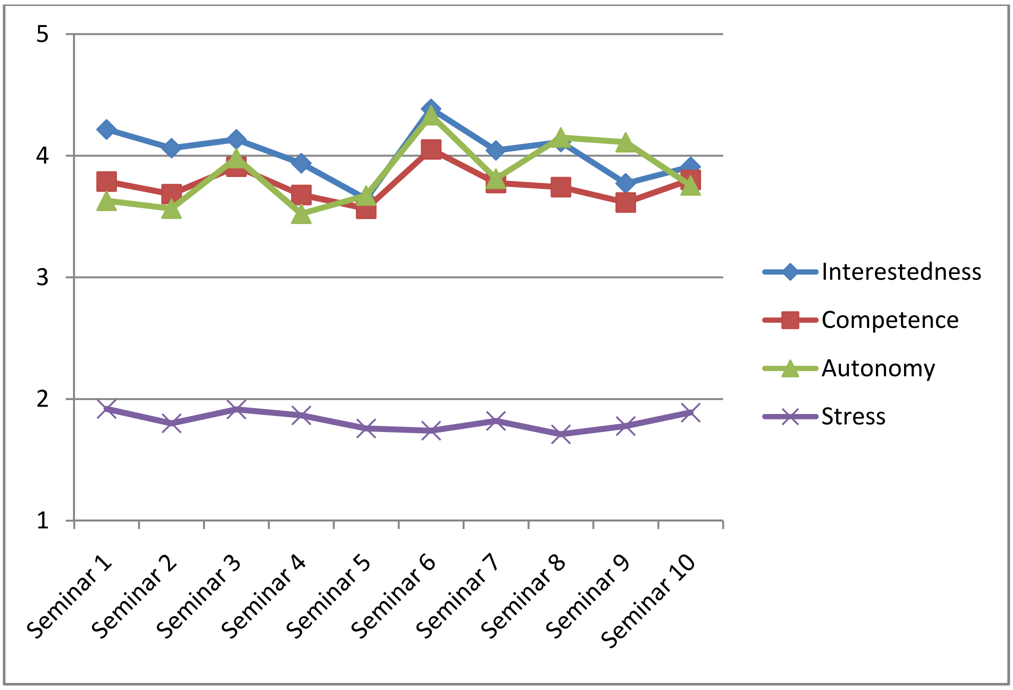

Figure 1. Analysis of the IMI questionnaires for seminars 1 – 10 (Table 1); vertical scale shows mean response (*n* = 66 – 82) on a 5-point Likert Scale: 1 (no agreement) to 5 (full agreement). Legend: four symbols are for the general categories of situational interest, perceived competence, perceived autonomy of the learning process, and feeling of stress.

Discrimination of Biology Teacher Types

It is our intention to utilize the knowledge acquired concerning the effectiveness of various biodiversity learning situations for the improvement of the education and advanced training of biology teachers.

With regard to biology as a science, biology instruction and school in general, there are, according to Neuhaus & Vogt (2005), various types of biology teacher, among them the pedagogic-innovative type, who chooses to primarily stimulate active, self-motivated learning among school children. Up to now a discrimination between teacher types has not been made with respect to their interest in particular biological subject areas. If these types exhibit different long-term interests in botanics, for example, then it is necessary to investigate whether or not the various teacher types profit in a similar way from problem- or context-oriented learning.

Figure 2 presents the results of an ordinal multidimensional scaling (MDS) analysis concerning interest in six fields of biology, as expressed by the subjects of our study. The students were asked to fill out a self-assessment questionnaire containing 22 items, and related responses (rankings) were appropriately combined to generate a set of indices representing interest (see Methods). In the two-dimensional plots shown the distances between the various fields (object points) represent proximities in terms of interest.

Initially, students with a strong interest in botany also tended to be interested in ecology and field biology, while other students expressed a predominant interest in either zoology, human biology or molecular biology. Following the seminar series, the basic clustering of interests did not change significantly. In future studies it will be of interest to determine whether or not all pre-service biology teacher types according to Neuhaus & Vogt (2005) can benefit from context-oriented education in botanics and how the learning process in this domain can be optimized for the various types.

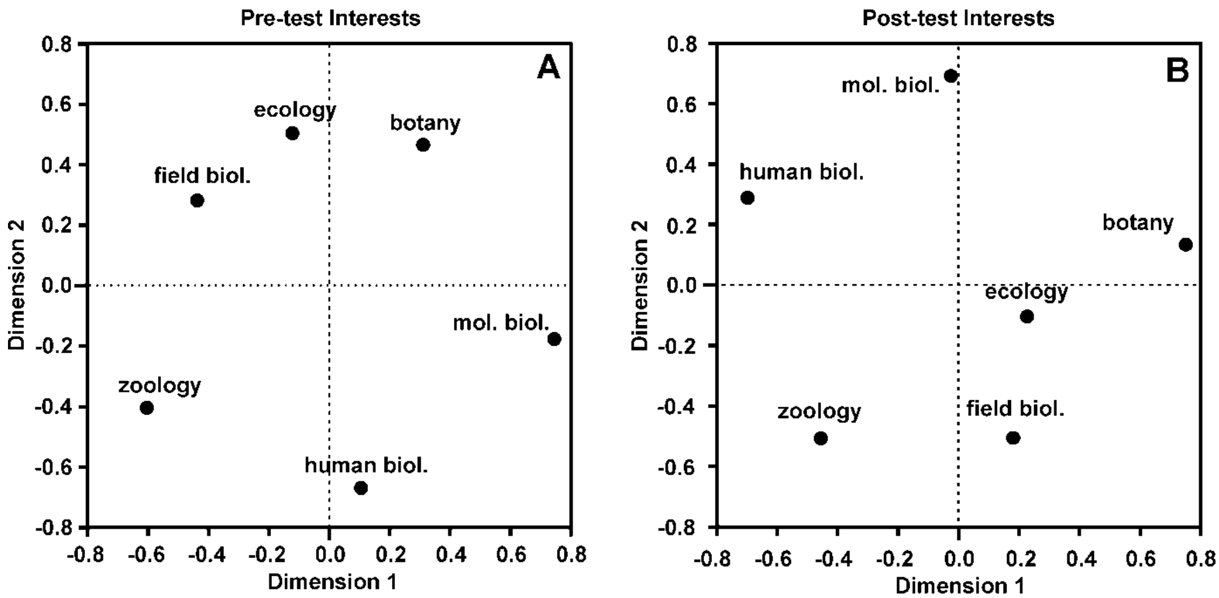

Figure 2. Multidimensional Scaling (MDS) analysis of student teacher interest in various areas of biology (PROXSCAL, SPSS), comparing results of pre-test questionnaire (**A**) and post-test questionnaire (**B**) after seminar series.

Did Interest in Botanics increase?

The results summarized in Table 2 indicate that the interest of students in six fields of biology did not change in a statistically significant manner over the 14-week period of this study. For each field the mean pre- and post-test scores differed by less than the standard deviation. However, the mean scores for botany, ecology, and field biology did exhibit the largest decreases (increase in interest) in comparison with other areas. In particular, botany had the lowest pre-test interest (rank 6) but improved to rank 5, ahead of molecular biology, for the post-test evaluation. Thus, although the relatively short intervention (seminars of Table 1) resulted, on the average, in an improved interest in botany, ecology and field work, the effect or success of the program was not statistically convincing.

Table 2

Pre- and post-test measures of interest in six biology fields: mean (SD) of summed indices. A total of 22 items were evaluated (Cronbach's α = 0.856) on an 8-step scale of agreement (1 = highest, 8 = lowest).

	Botany	**Zoology**	**Human Biology**	**Molecular Biology**	**Ecology & Environment**	**Field Biology**
Pre-test (*n* = 70)	3.68 (1.63)	2.52 (1.46)	2.65 (1.69)	3.64 (1.57)	3.43 (1.65)	3.21 (1.69)
Post-test (*n* = 62)	3.33 (1.51)	2.35 (1.07)	2.90 (1.60)	3.63 (1.54)	3.02 (1.29)	2.81 (1.33)

Cognitive Growth Resulting from the Botanics Study Module

The intervention represented by the botanics seminar series resulted in a significant improvement in the students' ability to recognize specific plants outdoors along their route to the University. The comparison of pre- and post-test data obtained 14 weeks apart showed clearly that after intervention the number of taxa listed by the students as a group increased by a factor of 2.5 and identification was more precise (see Table 3). The post-test list contained completely different plant families or individual species of local wild plants as well as the genus *Arum* with its characteristic funnel-shaped flower. The student teachers were also asked to designate which plants they found interesting. (see Table 4). Typically, children and novices will be interested in those plants which present noticeable or exotic features. This was also the case for our pre-test student group. Furthermore, several plants that were initially not recognized were termed post-test as interesting, e.g., *Arum maculatum*, *Daucus carota* or *Cichorium intybus*.

Table 3

Recognition of plant species outdoors by pre service student teachers along their way to the University.

Pre-test (*n* = 81), 33 Taxa		**Post-test (*n* = 66), 84 Taxa**	
Plant	Number of Students	**Plant**	Number of Students
Clover	10	Dandelion	25
Daffodil	8	Daisy	15
Cherry	15	Chicory	33
Birch	10	White Clover	16
Dandelion	60	Wild Carrot	12
Daisy	44	Ribwort Plantain	5
Tulip	31	Brown Knapweed	8
& others		Fleabane	5
		Red Clover	5
		Common Ragwort	3
		& others	

Table 4

Plants designated as interesting by two or more student teachers. Several additional plants were listed by individual students.

Pre-test (*n* = 81), 33 Taxa		**Post-test (*n* = 66), 84 Taxa**	
Plant type	**Number of Students**	**Plant type**	**Number of Students**
None	24	Composite (*Asteraceae*)	10
Carnivores	7	Legume (*Fabaceae*)	7
Orchids	9	Wild Arum (*Arum maculatum*)	6
Roses	6	Tree	6
Tulips	7	Medicinal	4
Flowering	5	Chicory	4
Poisonous	2	Mint (*Lamiaceae*)	4
Medicinal	3	Mustard (*Brassicaceae*)	4
Edible	3	Herb	4
Tree	3	Sunflower	4
Nettle	3	Wild Carrot	3
Magnolia	3	Rose	3
Cactus	5	Meadow Sage (*Salvia pratensis*)	2
Early Flowering	5		
Dandelion	3		
Cherry	2		

Nearly all of the student teachers assessed their knowledge of botanic terminology (cell or tissue types, cell organelles, contents of organelles) as significantly improved following the seminar series (see Table 5). While conclusions concerning specific learning situations are not possible, it is apparent that the basic organization with context-oriented didactics and emphasis on human utilization of natural resources exerts a positive influence on the learning process for topics in botany and biodiversity. Following the seminars the student teachers felt more competent in these fields so that they are more likely to employ similar inquiry-based approaches in their own teaching careers.

Table 5

Students' self-assessment of knowledge of botanic terminology (Likert scale: absolute number of responses).

	Anthocyanin		**Xylem**		**Chloroplast**		**Epidermis**	
	Pre-test	**Post-test**	**Pre-test**	**Post-test**	**Pre-test**	**Post-test**	**Pre-test**	**Post-test**
Never heard	49	2	39	1		1	1	1
Heard, cannot define	24	1	23	2	1		13	2
Have idea of meaning	4	7	9		33	8	28	6
Can definitely explain	1	51	7	57	44	52	36	52

CONCLUSION

Learning methods which included responsibility and experience in outdoor field activities resulted in the highest degree of situational interest. In this study, a combination of indoor and outdoor activities was employed for cognitive background. We have shown that a context-orientated design of training in botanics can stimulate interest in plants, a prerequisite for success in establishing sustainable development. However, further positive interventions are necessary to achieve a long-term change in personal interest in botanics.

REFERENCES

Blessing, K.; Hutter, K. P. (2004). Umweltbildung und nachhaltige Entwicklung – Konzepte gegen die Wissenserosion in Sachen Natur. [Conservation of Natur and Sustainable Development Education]. *Naturwissenschaftliche Rundschau 57 (12), 670- 673.*

Bybee, R.W. (1997). Toward an Understanding of Scientific Literacy. (Eds. W. Gräber, W.; C. Bolte, C.), *Scientific Literacy*. Kiel: IPN (pp. 37-68).

Deci, E. L., & Ryan, R. M. (1985). The general causality orientations scale: Self-determination in personality. *Journal of Research in Personality, 19,* 109-134.

Deci, E. L. & Ryan, R. M. (2000). The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behaviour. *Psychological Inquiry, 11*(4), 227–268.

Deci, E. L. & Ryan, R. M. (2003). Intrinsic Motivation Inventory. Retrieved Nov 19th 2009 http://www.psych.rocherster.edu/SDT/measures/intrins.html.

Elster, D. (2007). Zum Interesse Jugendlicher an naturwissenschaftlichen Inhalten und Kontexten – Ergebnisse der ROSE-Erhebung. (Eds. H. Bayrhuber et. al.), *Ausbildung und Professionalisierung von Lehrkräften*. Internationale Tagung der Fachgruppe Biologiedidaktik im VBIO, Essen (pp. 227-230).

Hagenbuch, B. E., Bynum, N., Sterling, E., Bower, A. H., Cigliano, J. A., Abraham, B. J., & et al. (2009). Evaluating a multi-component assessment framework for biodiversity education. *Teaching Issues and Experiments in Ecology*, 6.

Hershey, D. R., (1996). A Historical Perspective on Problems in Botany Teaching. *The American Biology Teacher*, Vol. 58 (6).

Hutter, K.P.; Blessing, K. (Eds.) (2010). Artenwissen als Basis für Handlungskompetenz zur Erhaltung der Biodiversität. *Beiträge der Akademie für Natur- und Umweltschutz Baden-Württemberg*. Band 49. Stuttgart.

Jäkel, L. (2005). Alltagspflanzen im Fokus. Botanisches Lernen in Zusammenhängen – eine didaktische Herausforderung. *Praxis der Naturwissenschaften - Biologie in der Schule*, 54 (3), 15-22.

Jäkel, L. Schaer, A. (2004). Sind Namen nur Schall und Rauch? Wie sicher sind Pflanzenkenntnisse von Schülerinnen und Schülern? *IDB* Münster 13, 1-24.

Jäkel, L. (2012). Working with the microscope as a problem solving process. In C. Bruguière, A. Tiberghien & P. Clément (Eds.), E-Book Proceedings of the ESERA 2011 Conference: Science learning and Citizenship. Part: Pre-service science teacher education, co-ed. D. Psillos & R. M. Sperandeo, Lyon, France: European Science Education Research Association. ISBN: 978-9963-700-44-8.

Jahnke, K. (2011). Mobile Umweltbildung in Deutschland. Analyse und Wirkung angewandter pädagogischer Konzepte im Kontext der Bildung für nachhaltige Entwicklung. Hamburg: Verlag Dr. Kovac.

Klingenberg, Brönnecke (2011). Was blieb von Schule?-revisited: biologische Basiskenntnisse Erwachsener. (Ed. Bogner), *Didaktik der Biologie – Standortbestimmung und Perspektiven.* Int. Tagung der FDdB. Univ. Bayreuth (pp. 134 – 136).

Kostova, Z. (2007). A system Approach to Environmental Education. *Bulgarian Journal of Science and Education Policy* (BJSEP), 1 (1), 149-171.

Krapp, A. (2005). Basic needs and the development of interest and intrinsic motivational orientations. *Learning and Instruction*, 15, 381-395.

Krapp, A.; Prenzel, M. (1992). Interesse, Lernen, Leistung - Neuere Ansätze der pädagogisch-psychologischen Interessenforschung, Münster: Aschendorf.

Lindemann-Matthies, P. (1999). Children´s Perception of Biodiversity in Everyday Life and their Preferences of Species. Dissertation Universität Zürich.

Lindemann-Matthies, P. (2002). The Influence of an Educational Program on Children´s Perception of Biodiversity. *The Journal of Environmental Education*, 33 (2), 22-31.

Lindemann-Matthies, P. (2005). 'Loveable' mammals and 'lifeless' plants: how children's interest in common local organisms can be enhanced through observation of nature, *International Journal of Science Education*, 27, 655-677.

Löwe, B. (1992). Biologieunterricht und Schülerinteresse an Biologie. Weinheim: Dt. Studienverlag.

Neuhaus, B. & Vogt, H. (2005): Dimensionen zur Beschreibung verschiedener Biologielehrertypen auf Grundlage ihrer Einstellung zum Biologieunterricht. *ZfDN* 11, 73-84.

Rädiker, S.; Kuckartz, U. (2012). Das Bewusstsein über biologische Vielfalt in Deutschland: Wissen, Einstellungen und Verhalten (Awareness of biological diversity in Germany: Knowledge, attitudes and behaviours). *Natur und Landschaft*, 87 (3), 109-113.

Ramadoss, A. & Poyya Moli, C. (2011). Biodiversity conservation through environmental education for sustainable development –a case study from Puducherry, India. *International Electronic Journal of Environmental Education*, 1(2), 97-111.

Schaal, S.; Grübmeyer, S.; Matt, M. (2012). Outdoors and Online – inquiry with mobile devices in pre-service science teacher education. *World Journal on Educational Technology,* 4 (2), 113-125.

Schiefele, U. & Krapp, A. (1996). Topic interest and free recall of expository text. *Learning and Individual Differences*, 8, 141-160.

Schiefele, U., Krapp, A., & Schreyer, I. (1993). Metaanalyse des Zusammenhangs von Interesse und schulischer Leistung (Meta-Analysis of the Relationship between Interest and Academic Achievement). *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie*, 25, 120-148.

Schiefele, U. (2000): Befunde, Fortschritte – Neue Fragen. (Eds. U. Schiefele, K-P. Wild), *Interesse und Lernmotivation*. Münster: Waxmann (pp. 227-241).

Vogt, H.; Upmeier zu Belzen, A.; Schröer, T.; Hoek, I.; (1999). Unterrichtliche Aspekte im Fach Biologie, durch die Unterricht aus Schülersicht als interessant erachtet wird. *ZfDN* 5 (3), 75-85.

Wilhelm, M. (2007). Was ist guter Naturwissenschafts-Unterricht? – *Chimica didactica* 98, 33, 67-86.

Wandersee, J. H., & Schussler, E. E. (1999). Preventing plant blindness. *The American Biology Teacher* 61, 84-86.

Wandersee, J. H., & Schussler, E. E. (1998). Plants or animals: Which do elementary and middle students prefer to study? A working paper. Baton Rouge: 15° Laboratory, Louisiana Sate University.

Wandersee, J. (2001). Toward a Theory of Plant Blindness. *Plant Science Bulletin* 47, 2-12.

Weinert, F. E. (Hrsg.) (2002). Leistungsmessung in Schulen. (2 ed.), Weinheim: Beltz.