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Uncovering patterns of interest in useful plants

Frequency analysis of individual students' interest types as a tool for planning botany teaching units

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Abstract

The paper presented examines how useful plants can help counteracting "plant blindness" – a phenomenon leading people to overlook plants in everyday-life. Recent research indicates that people are most likely interested in useful plants, hence this group of plants could be used to trigger interest in botanical content in general. This study has investigated the structure of interest in five subgroups of useful plants (medicinal plants, stimulant herbal drugs, spice plants, edible plants, and ornamental plants). For this purpose, the FEIN-questionnaire (**F**ragebogen zur **E**rhebung des **I**nteresses an **N**utzpflanzen = Questionnaire acquiring interest in useful plants) was filled in by N = 1,299 pupils from grade 5 to 12. Data analysis shows (for all age groups and both genders) that medicinal plants and stimulant herbal drugs trigger high interest while spice plants, edible plants and ornamental plants raise only lower interest. However, mean values do not allow conclusions on an individual level (e.g. in a school class). In order to gain information about the interest structure in a specific target group teachers deal with in practice, we have analysed the interests on an individual level using frequency analysis of different interest types. Results show that stimulant herbal drugs seem to strongly polarize students, whereas medicinal plants are interesting for almost the whole sample. Eventually, medicinal plants turned out to be well suited to introduce botanical content by means of plants catching the interest of as many students as possible. Therefore, medicinal plants should be established as flagships counteracting plant blindness.

Keywords

Interest types; Medicinal Plants; Plant Blindness; Questionnaire; Students' Interest; Useful Plants

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1. Introduction

Teaching botanical content is one of the hardest tasks in biology lessons (Greenfield, 1955). A prominent reason for this fact is a phenomenon called “plant-blindness”, described about twenty years ago (Bozniak 1994; Wandersee and Schussler 2001). Plant blindness leads people to overlook plants in everyday life and therefore they do not gain knowledge about them (Wandersee and Schussler 1999; Schussler, Link-Pérez, Weber and Dollo 2010). Furthermore, studies on students’ interest in biological topics show that botanical issues are the most boring for students (Elster 2007; Lindemann-Matthies, 2005). During adolescence their interests shift from animal biology rather to human biology and the interest in plants decreases even more (Baram-Tsabari and Yarden 2007; Baram-Tsabari, Sethi, Bry and Yarden 2010; Osborne and Collins 2001; Tamir and Gardner 1989). Moreover, plants are often seen as inferior creatures compared to animals (Flannery 2002) and are perceived only as a kind of scenery for animal life (Schussler and Olzak 2008; Wandersee and Schussler 1999).

Though, according to educational psychology research pre-existing interests are an important key for connecting new information to existing knowledge (Hidi and Baird 1986; Hidi 1990; Krapp 1999) and interest is an important basis for the development of intrinsic motivation to deal with a subject and thereby gain deeper knowledge (Deci 1992; Deci and Ryan 1993). Therefore, students’ lack of interest in plants is a big challenge for biology teachers, especially when the high educational value of botanical knowledge is taken in to account. Knowledge about plants is an important prerequisite for the understanding of central biological concepts like evolution (Wandersee and Schussler 1999), lifecycles (Schussler and Winslow 2007) or the role of plants in ecological cycles like the carbon cycle (Wandersee and Schussler 1999). Without profound botanical proficiency students develop a restricted view on nature which may also affect their attitudes towards their environment or environmental problems (Dillon et al. 2006).

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Hence, plants have to be placed at the centre of humans' perception of nature. But how can biology education endeavour to accomplish this purpose?

The chosen approach in the present study is to start from students' interests. As educational science research (e.g. Deci and Ryan 1993; Hidi and Baird 1988; Krapp 1989) has extensively pointed out, it makes sense to distinguish between two different forms of interest. Whereas individual interest in a subject develops gradually, is composed of subject knowledge and values and is regarded as a long lasting preference for a certain topic, on the other side, situational interest is a specific state which has its origin in a certain stimulus. It occurs spontaneously in different situations and is of only short duration. Therefore, in our studies we focused on the more stable individual interests.

In our literature review we pursued the question whether there are any groups of plants which are interesting for students. These groups could then be used by teachers as gateways to botanical content. Unfortunately most studies on students' interest in biological topics do not investigate systematically the interest in different groups of plants (e.g. Wandersee 1986). Quite on the contrary, plants are rather treated as a homogenous group in these studies. For example in the international investigation of students' interest in science topics called "**R**elevance **o**f **S**cience **E**ducation" [ROSE] students were asked very general questions with regard to their interest in botanical topics, e.g. „How plants grow and reproduce“, „Plants in my locality“ (Schreiner and Sjøberg 2004). However, first hints that the group of useful plants could be worth examination came from (Mayer and Horn 1993) who showed that students prefer living organisms which are of value for human use. In addition Krüger and Burmester (2005) found that beside the "look of plants", the "usefulness of plants" is the most prominent category students use to put plants into order. Hammann (2011) partially supports the hypothesis that the group of useful plants is interesting for students by showing that students are highly interested in medical plants.

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Following this trace, we systematically explored the interest of students in useful plants. As recent research has shown that questionnaires are appropriate tools for examining students' interests (Urhahne, Jeschke, Krombaß and Harms 2004) we developed the FEIN-Questionnaire (**F**ragebogen zur **E**rhebung des **I**nteresses an **N**utzpflanzen = Questionnaire acquiring interest in useful plants) in order to explore the interest in different subgroups of useful plants in different age groups and genders. For this purpose, the FEIN-questionnaire was filled in by N = 1,299 Austrian students (age ranging from 10–18 years). Data analysis showed that the structure of interest in useful plants resulting from a PCA, followed the botanical differentiation into the five subgroups *medicinal plants, stimulant herbal drugs, spice plants, edible plants* and *ornamental plants* which all raise different degrees of interest (Sales-Reichartzeder, Pany and Kiehn 2011; Pany 2014). The means of interest of the whole sample show that medicinal plants were the most interesting group, followed by stimulant herbal drugs and spice plants. All three plant groups attracted above average interest of students of all age groups and both genders. Edible plants and ornamental plants attracted less interest (see Table 1). Furthermore, there were significant differences with regard to what degree different age groups were interested in the five plant subgroups. The interest in medicinal plants was high in younger students (10–12 years) and older students (17–19 years), but lower in the age groups between 12–16 years, whereas the interest in stimulant herbal drugs showed no significant differences between the four age groups. The interest in edible plants, ornamental plants and spice plants was significantly higher in younger students (10–12 years) than in the other age groups. Furthermore, ornamental plants showed strong gender differences in all ages, they are significantly more interesting for girls than for boys.

Table 1. Means (M) and standard-deviation (SD) of interest in different plant groups measured with the FEIN-Questionnaire; Means above 2.5 indicating above average interest. From: Pany (2014)

Plant group	M	SD
Medicinal plants	3.09	0.75
Stimulant herbal	2.90	0.88

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drugs		
Spice plants	2.56	0.78
Edible plants	2.43	0.78
Ornamental plants	2.32	0.89

As present research (Baram-Tsabari et al. 2010; Strgar 2007) has pointed out, it is important to gain as much information as possible about the interest profiles prevailing in the target group in order to connect the science curriculum and its content to students' interests. Baram-Tsabari and Yarden (2009) used for example cluster-analysis to identify groups of students with similar interests in a large scale study and proposed using such data as support for the choice of content in science classes. They actually called it a "shadow-curriculum" supposed to assist teachers in complying with their respective national science curricula.

Comparing the data presented above, it may be concluded that medicinal plants as well as stimulant herbal drugs are suited as gateways to botanical content meeting students' pre-existing interests, and hence could be recommended as exemplary content of school lessons. Both plant groups attract above average interest of students of all age groups and both genders. Nevertheless, this inference has to be treated with caution. As Valsiner (1986) has clearly pointed out, population data – as for example means or correlational data – do not allow conclusions on an individual level. However, most data on students' interest reported in science education literature, including our own investigations up to now, are calculations on population level (e.g. Elster 2007; Pany 2014; Sjøberg and Schreiner 2010). Hence, they allow drawing conclusions and making predictions only on this level and not on an individual level whereas direct information on an individual level is necessary for planning a botany lesson that is interesting for as many students as possible. While working in the classroom a teacher actually does not deal with a group of "mean students" but with a group of students each having diverse individual interests. Inspired by such reasoning, the present study analyses students' interest in useful plants

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on an individual level in order to get a suitable answer which subgroup of useful plants is the most promising key to counteract plant blindness in the classroom.

2. Material and Methods

2.1 Questionnaire

The FEIN-Questionnaire tests five scales which measure the interest in edible plants, spice plants, stimulant herbal drugs, medicinal plants and ornamental plants. Each of these plant groups is represented by three items; the whole questionnaire contains 15 items. The design of the items follows the ROSE-Questionnaire (=Relevance of Science Education), an instrument used in one of the largest international comparative studies investigating students' views on Science and Science Education in 41 countries (Schreiner and Sjøberg 2004). The items are formulated as headlines describing the object of interest, e.g. "plants to improve my room" or "plants curing a sore throat". Similar to ROSE the FEIN-questionnaire uses a four-stage Likert-scale (1-Not interested, 2-Rather not interested, 3-Rather interested, and 4-Very interested). Additionally, the following demographic data were collected in the questionnaire: sex, age, grade, school. Without any time pressure, filling in the questionnaires took approximately 10 to 15 minutes.

2.2 Survey Participants

From March to May 2010, fifteen secondary schools voluntarily participated in the present study, each of these located in a different Viennese district and two outside Vienna, altogether providing a representative cross section of secondary schools in and around Vienna. The questionnaires were filled in voluntarily during the students' biology lessons. A total of 1,417 students answered the questionnaire; 118 of them were excluded due to missing, double, or obvious hoax answers (e.g. zigzag patterns), which resulted in

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a final number of 1,299 participating students. These 1,299 questionnaires were filled in by 51% male and 49% female secondary school students. The sample was then divided into four subgroups: students between 10 and 12 years (age group 1), students between 13 and 14 years (age group 2), students between 15 and 16 years (age group 3) and students between 17 and 19 years (age group 4). Exact numbers are given in Table 2.

Table 2. Descriptive data of the investigated sample (n = 1,299)

Age group	Group 1: 10–12 y	Group 2: 13–14 y	Group 3: 15–16 y	Group 4: 17–19 y	**Total**
Male students	245	197	159	62	***663***
Female students	236	193	137	70	***636***
Total	**481**	**390**	**296**	**132**	***1299***
Percent of the sample	***37***	***30***	**23**	**10**	
Mean of age (y)	**11.2**	**13.51**	**15.53**	**17.55**	***14.40***

2.3 Data treatment and Statistics

In order to draw conclusions on an individual level, it was necessary to reduce the complexity of the data per participant, which consisted of five means of interest (one for each plant subgroup, each ranging from 1 to 4 in ten possible steps, resulting from the Likert-scale of the questionnaire).The method of complexity reduction was developed stepwise in order to reach a reduction level allowing meaningful conclusions from the data and therefore suitable as a basis for planning botany lessons. The challenge was to develop a procedure which takes into account the variation of the individual interest structure of each student but at the same time clusters the students to larger units, showing overlapping patterns of interest. So the aim of this procedure was to group the individuals in homogenous clusters of interest types – based on their individual interest structure. The process of complexity reduction and the development of this procedure are described in the following section.

Rank order

The first method of complexity reduction we applied was the calculation of the rank order of interest in the five groups of useful plants per participant. For this purpose, an interest rank order of the five subgroups (in order medicinal plants, stimulant herbal drugs, spice plants, edible plants and ornamental plants) for each participant was calculated, which resulted in a rank-order-code (e.g. 15342 means medicinal plants: first rank, stimulant herbal drugs: fifth rank, spice plants: third rank, edible plants: fourth rank and ornamental plants: second rank). In the end, the frequency of each rank-order-code in the sample was counted. This procedure still dealt with a number of possible combinations (5^5 = 3125) too large to give results which could be interpreted by identifying interest types (groups of students with similar interest structure) within the sample, because 394 of these possible combinations were actually realised in the population. Besides, these rank orders showed that only 1 % (13 of 1299 individuals) of the whole sample had an interest rank order identical with the one calculated from the means of the population (12345, see Table 1). Ninety-nine percent of the target group showed a deviating interest ranking (393 different rank-order-codes) of the five subgroups of useful plants. Remarkably, most of the rank-order-codes (211) were represented only by 2–5 individuals, 124 of the realised rank orders were represented by only one individual, which indicates a very high diversity of the population.

Therefore, it was inevitable to further reduce the complexity of the data. In a next step, categories were generated from the ten possible interest values for each subgroup resulting in three interest levels per useful plant subgroup: “high interest (values ranging from 3 to 4) – level 3”, “medium interest (values between 2 and 3) – level 2” and “low interest (values ranging from 1 to 2) – level 1” (exact values are given in Table 3). Transforming the data in this way, the number of possible combinations of the resulting rank-order-code now was 3^5 = 243, which led to 208 realised combinations (none of them representing more than 4.3 percent of the sample), which was still too much to allow conclusions which might be helpful in planning botany lessons.

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Because of these reasons we decided to take into account only those subgroups of useful plants which best allow to differentiate between the interest structures of different individuals. Chi-square-tests on the distributions of interests in the five subgroups were calculated in order to select only the subgroups of useful plants which clearly deviate from an equal distribution (see Fig. 1 a-e and Table 3 and 4) and therefore show a distinct pattern of interest. Following this procedure, only interests in the subgroups of medicinal plants, stimulant herbal drugs and ornamental plants were used to characterize interest types in the sample.

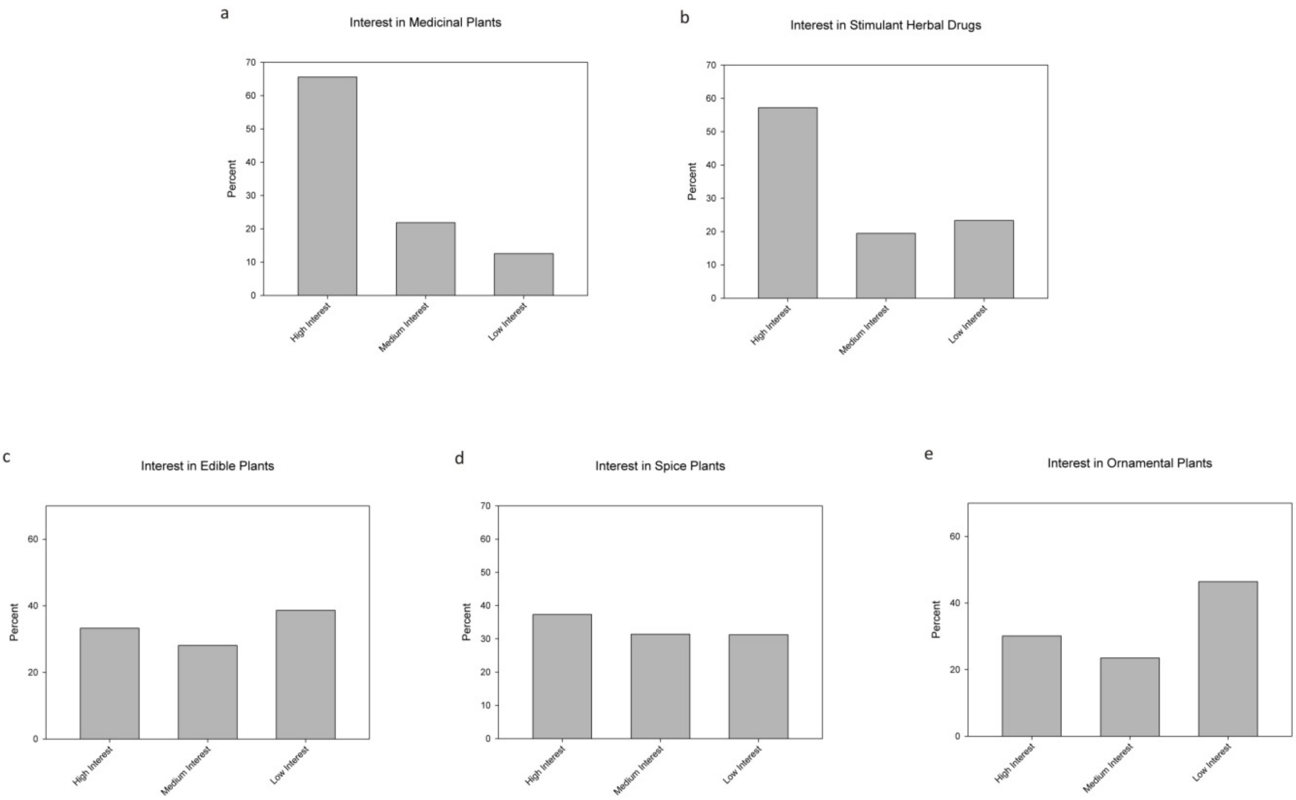

Figure 1. Frequencies (percent) of highly/medium/lowly interested students for all subscales of useful plants

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Table 3. Numbers of Individuals that have high/medium/low interest in the five subgroups of useful plants

	Medicinal Plants		Stimulant Herbal Drugs		Spice Plants		Edible Plants		Ornamental Plants	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
high Interest (3-4)	852	*65.6*	743	*57.2*	485	*37.3*	432	*33.3*	391	*30.1*
medium Interest (2<Interest<3)	284	*21.9*	253	*19.5*	408	*31.4*	365	*28.1*	305	*23.5*
low Interest (1-2)	163	*12.5*	303	*23.3*	406	*31.3*	502	*38.6*	603	*46.4*

Table 4. Chi-Square-Values for the distribution of high, medium and low interest for each subgroup of useful plants

	Medicinal Plants	Stimulant Herbal Drugs	Spice Plants	Edible Plants	Ornamental Plants
Chi-Square	625.085	335.797	9.372	21.677	108.656
df	2	2	2	2	2
Significance	<0.001	<0.001	<0.01	<0.001	<0.001

Now another rank-order-code was created that was based on the three students' interest levels in medicinal plants, stimulant herbal drugs and ornamental plants (see Table 5). This new code represents the characteristic interest type of each individual. For example, a code of "331" means this individual has high interest in medicinal plants and stimulant herbal drugs, but only low interest in ornamental plants. Finally, using these reductions of complexity, the possible combinations of the rank-order-code were reduced to $3^3 = 27$, which promised to be a number large enough to represent the variation within a target group, but small enough to allow meaningful conclusions for planning lessons. Subsequently, we calculated the frequencies of all these rank-order-codes in the sample to identify frequent interest types. All statistical analyses were performed using SPSS™ for Windows, Version 16.0.

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3. Results

When analysing the data, the ten most frequent interest types (representing 74.7 percent of the sample) were chosen to give an impression of the sample (see Table 5). As can easily be seen in table 5, there are approximately 12 percent of the sample (151 individuals) who have high interest in all subgroups. But on the other hand, most of the students (64 %) have low interest in at least one of the subgroups of useful plants (“331”, “313”, “131”, etc.). Moreover, five of the interest types are not evenly distributed among the four age groups within the sample (see Table 5 and 6), indicating different implications for teaching botany. All these results suggested going into more detailed data analysis.

Table 5. Characteristics of the ten most frequent interest types in the whole sample. Marked interest types (*) are not evenly distributed among the age groups within the sample

	Interest in…				
	Medicinal Plants	*Stimulant Herbal Drugs*	*Ornamental Plants*	*Frequency Percent*	
331	***high***	***high***	***low***	18.9	*
333	***high***	***high***	***high***	11.6	*
332	high	high	medium	8.9	
313	***high***	***low***	***high***	6.7	*
231	medium	high	low	6.2	
323	***high***	***medium***	***high***	5.5	*
311	high	low	low	4.8	
131	***low***	***high***	***low***	4.3	*
321	high	medium	low	4.2	
232	medium	high	medium	3.8	

Table 6. Chi-Square-Values for the distribution of the ten most frequent interest types among the four age groups within the whole sample

	331	***333***	***332***	***313***	***231***	***323***	***311***	***131***	***321***	***232***

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Chi-Square	12.008	15.385	4.443	22.003	7.465	8.156	3.169	10.198	4.813	2.215
df	3	3	3	3	3	3	3	3	3	3
Significance	0.007*	0.002*	0.217	<0.001*	0.058	0.043*	0.366	0.017*	0.186	0.529

Note: marked interest types (*) are not evenly distributed in the sample

In order to make the four age groups comparable in a clearly arranged way, we did not go on working with all of the ten interest types calculated from the whole sample but chose only those interest types which represent more than five percent of an age group (illustrated in Fig. 2). Comparing the frequency data of the rank-order-codes, one feature immediately catches attention: the most frequent type in all age groups is code "331" (students who have high interest in medicinal plants and stimulant herbal drugs, low interest in ornamental plants), covering between 15.3 % in age group 2 and 25.3 % of the sample in age group 3 (see Fig. 2). Another quite similar type, "332", which represents students with high interest in medicinal plants and stimulant herbal drugs and medium interest in ornamental plants, appears in only two age groups within the first five ranks (age group 1, rank four, 10 % and age group 3, rank two, 8.4 %). It can also easily be seen that type "333" (that means high interest in all three subgroups) represents the second largest group of students in the two lower age groups (16 % in age group 1 and 10.5 % in age group 2), losing importance in the higher age groups (6.4 % on rank 4 in age group 3 but again 10.6 % on rank three in age group 4).

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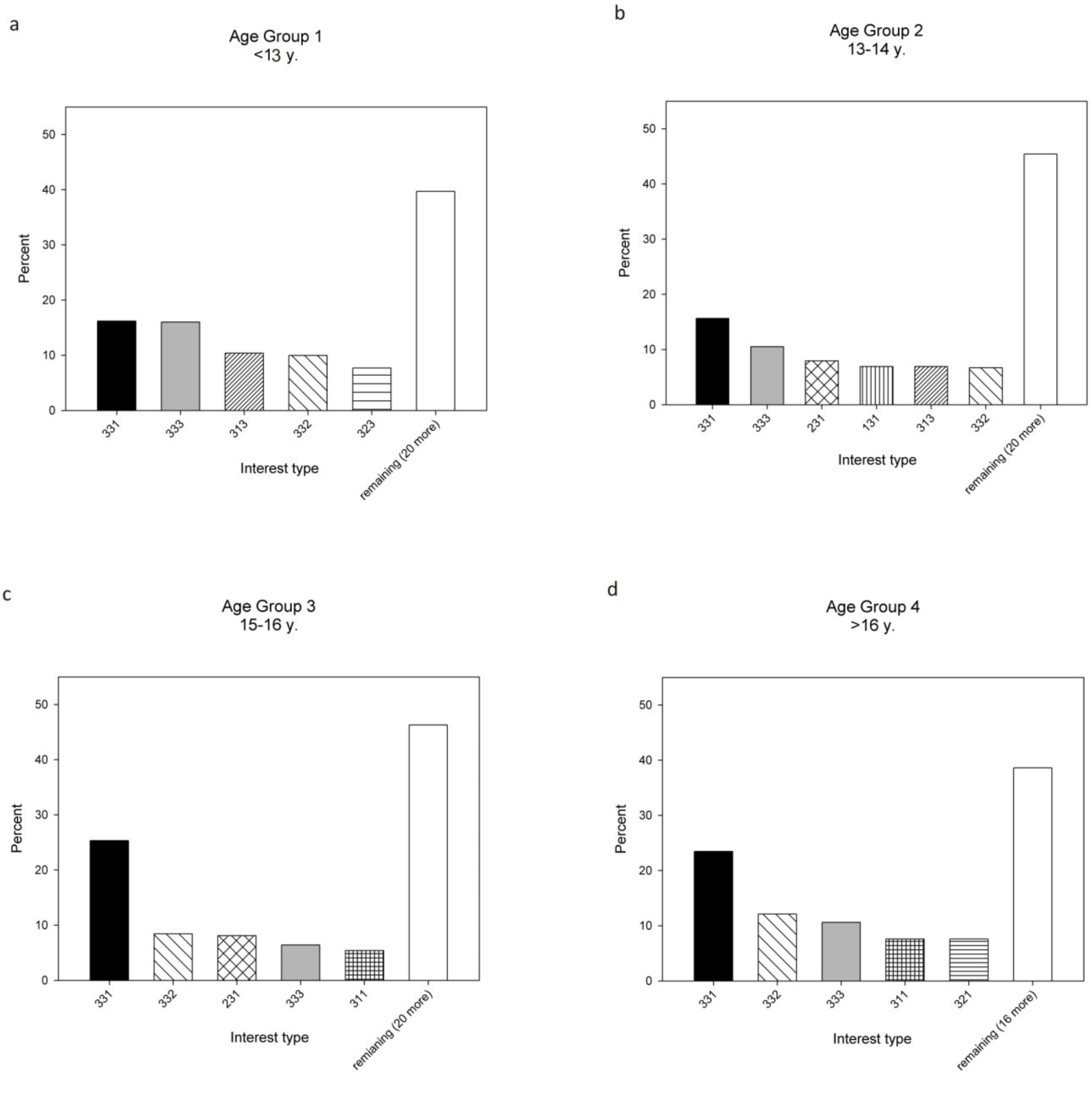

Figure 2. Frequencies of all interest-rank-order-codes representing more than 5 % of an age group

Another interest type is important in the two lower age groups: “313”, indicating students with high interest in medicinal plants and ornamental plants, but low interest in stimulant herbal drugs. This type can be found on rank three (covering still 10.4 %) in age group 1 and on rank five (representing 6.9 %) in age group 2. In higher age groups this interest

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type loses importance and can be found only on rank 13 in both age groups 3 and 4, representing only 2.4 % of each sample, which means that only few students can be found who show high interest in medicinal plants and ornamental plants while taking low interest in stimulant herbal drugs. The relatively important role of this interest type in age group 1 is supported by the appearance of a similar interest type (“323”, 7.7 %) which can be found within the first five ranks only in this age group, also indicating quite a large subgroup of students not interested in stimulant herbal drugs.

An interest type that can be found only in age group 2 within the first five ranks is “131” (students with low interest in medicinal plants and ornamental plants, but high interest only in stimulant herbal drugs, covering 6.9 % of the age group). With regard to the other age groups, this type is located only between ranks 8 and 16, covering just 1.5 to 4.1 % of the subsamples. In age groups 2 and 3 (on rank three each) a similar interest type (“231”) can be found which also represents students with high interest in stimulant herbal drugs and low interest in ornamental plants but at least medium interest in medicinal plants, covering approximately 8 % each.

Furthermore, a characteristic interest type for both higher age groups seems to be “311”, which represents students with specifically high interest only in medicinal plants, but low interest in stimulant herbal drugs and ornamental plants. This interest type can be found on rank 5 in age group 3 (5.4 %) and one rank higher, on rank four in age group 4 (7.6 %). It is remarkable that the codes of the five highest ranks in age group 4 start with a “3”, indicating students having high interest in medicinal plants. What also seems to be important is the distribution of type “111”, representing students with low interest in all plant groups. This interest type can be found on rank 14 in age group 1 (1.7 %), on rank 11 in age group 2 (3.1 %) and on rank 7 in age group 3 (4.1 %) but does not occur in age group 4 at all.

To sum up, it can be said that in all age groups medicinal plants are highly interesting for most of the students. Students of age group 1 are generally highly interested, which can be seen from the fact that all five first ranks contain the interest level “high – 3”at least twice. Both lower and higher age groups are characterized by specific interest types that are very prominent (“313” for lower age groups and “311” for higher age groups). In age groups 2 and 3 an opposing type can be found, ranking stimulant herbal drugs high and other plant groups low or medium (“131” and “231”). Moreover, there seem to be coincident appearances of high interest with regard to different plant groups, as the majority of students with high interest in ornamental plants (80 %) is also highly interested in medicinal plants, and 69 % of the students with high interest in stimulant herbal drugs also take high interest in medicinal plants. On the other hand, in many cases some interests seem to exclude each other, as only 36 % of the students who are highly interested in medicinal plants are also highly interested in ornamental plants, but 42 % of them show only low interest in ornamental plants and 51 % of the students who have high interest in stimulant herbal drugs show low interest in ornamental plants.

4. Discussion

In order to efficiently counteract plant blindness (Hershey 2002), educators should introduce botanical content using exemplary plants considered interesting by students (Hidi and Baird 1986). Such interesting teaching objects may be found in the group of useful plants (Krüger and Burmester 2005), which students differentiate in five subgroups. Some groups of useful plants (medicinal plants, stimulant herbal drugs and spice plants) are on average significantly more interesting for students than others (edible plants and ornamental plants) (Pany 2014). However, means of a population do not allow conclusions on single individuals (Valsiner 1986), which would be important for the planning of teaching lessons in class. Therefore interest-rank-order-codes were calculated to characterize each individual, containing the personal interest level of medicinal plants, stimulant herbal drugs and ornamental plants. The frequency analysis of these codes shows that interest type “331” (high interest in medicinal plants and stimulant herbal

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drugs but low interest in ornamental plants) is the most frequent in all age groups, while other interest types appear only in specific age groups or at least on different ranks in different age groups.

Because of the outstanding importance plants have in nature the recommendation frequently made in literature (e.g. Baram-Tsabari and Yarden 2009) to teach general biological phenomena above all in the context of animals for young students and human biology for older ones should not be unrestrictedly followed. Exactly these teaching traditions have been identified as one of the main reasons for plant blindness (Hershey 1996; Link-Pérez, Dollo, Weber and Schussler 2010). Quite on the contrary, it should be explored which botanical context students also might consider interesting in order to avoid the impression that plants are boring und not important.

As our results show there are indeed plant groups that are considered interesting by many students. Medicinal plants are clearly number one with regard to interest across all age groups and so they rather contradict findings on a more general level ("plants") that imply botanical content is not interesting for students (Elster 2007; Sjøberg and Schreiner 2010). Moreover, students' interest in medicinal plants does not follow the general trend of decreasing interest in biological topics with increasing age, as often described in the educational science literature of the last decades, (e.g. Kattmann 2000; Löwe 1987; Osborne and Collins 2001). Hence, medicinal plants can definitely be recommended as an appropriate gateway into botany or even into general biological content. This is all the more applicable as they may also have a relation to the context of human biology which is interesting above all for older students (Baram-Tsabari et al. 2010; Osborne and Collins 2000)

Of course there are some restrictions to our results as it is for example impossible to distinguish between the two scenarios that a topic is marked as "interesting" because it is a passion of the test person or only from a current mood. Moreover, students vary in their expression of enthusiasm, so "very interesting" for one person may mean the same as "interesting" for another (Thorndike and Hagen 1969). It has also been taken into account that a certain number of persons may have reasons to fake their answers due to social desirability (Bühner 2011). In addition to these general constraints of questionnaire-based data, we cannot presume that medicinal plants, although often marked as "very interesting" in the questionnaire, are indeed as interesting for students as animal- or human-related contents because there were no such items in the questionnaire.

Within this framework, the method of frequency analysis of interest types nevertheless makes it possible to study the characteristics of a population in detail without calculating means or using cluster algorithms blurring the variation of the sample. The interest types worked out in these analyses can therefore efficiently support teaching botany, assisting the development of a "shadow-curriculum" (Baram-Tsabari and Yarden 2009) based on detailed scale, individual level analysis. As the results show, there is a high diversity within the target group which is worth being taken into account when preparing botany lessons. Starting from analysis with a "mean student", which seemed to allow clear conclusions for school, it could be shown that there is not "the one and only way" of choosing exemplary plants.

Most of the frequent interest types in all age groups show high interest in medicinal plants. Therefore choosing exemplary medicinal plants for imparting botanical content (even the general structure of plants or flowers) should be standard for biology lessons in- and outside school. Although ornamental plants are seen as highly interesting by a subgroup of the sample, they should preferably be used only as additional examples. The majority of students with high interest in ornamental plants (80 %) are also highly interested in medicinal plants (e.g. interest type "313"), which cannot be said vice versa (e.g. interest type "311" or "331") as only 36 % of the students who are highly interested in medicinal plants are also highly interested in ornamental plants. Furthermore, ornamental plants have additional disadvantages (e.g. significant gender differences), pointed out in former studies (Pany 2014).

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Moreover, stimulant herbal drugs no longer seem to be on one level with medicinal plants. Quite on the contrary, especially in lower age groups, there is a large subgroup in the population who clearly is not at all interested in stimulant herbal drugs, although they are highly interested in both other plant groups (interest type “313”). Choosing exemplary plants from only stimulant herbal drugs therefore could lead to a reduction of their interest in botanical content. Obviously, stimulant herbal drugs seem to polarize: on the one hand they are indeed very interesting for many students; on the other hand there is a subgroup in the sample – especially in lower age groups – which definitely shows low interest.

However, it should be marked that for interest types with low or medium interest in medicinal plants and ornamental plants stimulant herbal drugs are often the most interesting plant group (e. g. “131”, “231”, “121”, etc.). These interest types appear especially in age groups 2 and 3, where students’ interests are generally on a lower level than in age groups 1 and 4. Stimulant herbal drugs can therefore be used to trigger interest within parts of the target group who cannot be motivated otherwise. These results should be used as a basis for further research exploring the role of stimulant herbal drugs with regard to different age groups in order to clear up their special role in the subgroups of useful plants to reveal their potential usability as keys to botanical content.

This study intensifies the knowledge of the structure of interest in useful plants. It could be shown that allegedly clear recommendations for teaching botany derived from a “mean student” should be treated with caution. Although medicinal plants are still the leading group for many students, our analysis on an individual level showed that there are groups of students who have significantly high interest for other subgroups of useful plants and hence should be captured by presenting additional plants from other subgroups. The selection of examples should only be reduced to the group of medicinal plants when there are logistic constraints, if one has to choose only one or two exemplary species for reasons of availability or price.

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In order to sustainably implement botanical content in education, plants like sage (*Salvia officinalis*), hawthorn (*Crataegus* spp.) or marigold (*Calendula officinalis*) can be preferentially recommended as impressive examples. Offering additional plant species belonging to stimulant herbal drugs (such as tobacco *Nicotiana tabacum*) and ornamental plants (such as primroses *Primula* spp., especially for lower age groups) may help considering pre-existing interests of most students and build a gateway into botany. What still remains unexplored and a field open for prospective studies are, for example, experimental designs which explore the reactions of different interest types on various educational settings in order to test and secure the hypothesis that interesting study objects also raise higher interest in botanical content. In summary, dealing only with exemplary plants that correspond to students' interests can be an opportunity to prevent them from perceiving plants only as a lifeless scenery for animals and to facilitate students to develop a more comprehensive view of nature, without disregarding a vast majority of the organisms forming the basis of life on earth.

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