Promotion of Plant Awareness within the Project faNutec

Nicklas Müller[1], Doris Elster[2]

Institute for Science Education, University of Bremen, Germany[1]
Institute for Science Education, University of Bremen, Germany[2]

Abstract

The great challenges of our age incorporate issues directly and indirectly connected to the environment. Examples of direct challenges are environmental quality and biodiversity changes. Other problems include individual's lack of awareness regarding agriculture, nutrition and global hunger [1]. Green school movements seem to be an educational transformative anchor to sensitize and education children and adolescents for these global challenges [2].
The project faNutec (pupils farm using the latest technical possibilities) is a cooperative project of the Waldschule Hagen in Lower Saxony (subject connection Biology and Robotics) and the Institute for Science Education – Biology at the University of Bremen in Germany. The project is based on the Farm.Bot (https://farm.bot). This is a robot operating on a 3D rail system with programmable control technology for autonomous management of small areas. This enables secondary school pupils to try out technical possibilities of agriculture. With this new methodological approach, great potential is seen in creating the basis for the development of sustainability awareness among the students.
In the 2023 pilot study, a questionnaire was used to measure the PAD index (Plant Awareness Disparity; 25 items) [3] in a sixth grade (N = 27). In addition, the questionnaire contained further 56 items to measure interest in botanical content, biology lessons, and interest in technical equipment and the Farm.Bot. After evaluating the questionnaires, 11 students were selected to conduct guided interviews. The aim was to interview students who achieved a particularly high or low PAD index in order to find out possible reasons for the PAD index. The maximum PAD index is 100 and the minimum is 25. The larger the index, the lower the plant awareness disparity. The evaluation of the questionnaire has shown that there are large differences in the PAD index achieved among sixth-grade students. The lowest index is 45 (subject KA11EL), the highest is 84 (subject TA09AN). The mean value of the indices is 65.1 (SD = 9.4). The evaluation of the interviews has not yet been completed.

Keywords: *Biology Education, Technology Education, Plant Awareness*

1. Introduction

Many studies have already shown that the interest and appreciation of school children in western industrialized countries in botanical content is lower than in zoological or human biology topics [4,5,6]. The reasons for this include the lack of communication options with plants, the misconception that plants cannot move and the fact that plants have no eyes. An underrepresentation of plants in the school curriculum as well as in textbooks and the media also contributes to the low interest and appreciation. Wandersee and Schussler therefore coined the term plant blindness already in 1999 [7]. Plant blindness describes the phenomenon that school children hardly notice plants in their environment and have little knowledge of the species. In addition, they have little expertise of, for example, the reproductive mechanisms of plants. Knowledge about the importance of plants for the biosphere is usually only limited. Furthermore, many school children do not perceive plants as living beings. It has already been proven that there is a direct connection between people's appreciation for nature and their commitment to protect nature [8]. Therefore, the appreciation of plants should be specifically promoted in a school context. However, in order to evaluate teaching interventions or projects, an instrument is required that can be used to check their effectiveness [3]. Therefore, the concept of plant blindness was further developed.

2. Plant Awareness Disparity

The term plant blindness has come under increasing criticism in recent years because it is not a didactic construct that can be tested. In addition, the term plant blindness could suggest that plants can only be perceived with the sense of sight. Finally, the term can be perceived as discriminatory by

people with visual impairments [3]. Therefore, Parsley developed the didactic construct of Plant Awareness Disparity (PAD). PAD consists of the four components Attention, Attitude, Relative Interest and Knowledge (Fig. 1.). The “Attention” component describes the phenomenon that many people do not notice individual plants in their everyday lives and, for example, do not recognize plants as living beings. A possible explanation for a strong ability to perceive plants is that the human brain finds it easier to recognize a moving animal than a single plant in a collection of (green) plants [9, 10]. This probably has evolutionary reasons, as animals always pose a greater danger in human development. The component “Attitude” describes the lack of positive attitudes towards plants, which can be observed among students. The “Relative Interest” component describes the fact that many people find animals more interesting than plants, which can be proven by many studies. However, it should be noted that within botany there are contexts that are perceived as more interesting than others. These primarily include drug plants, medicinal plants or plants with a striking appearance or special functions (e.g. carnivorous plants) [3, 4, 5]. The “Knowledge” component does not mean botanical expertise, but knowledge about the meaning and importance of plants for humanity and the planet [3].

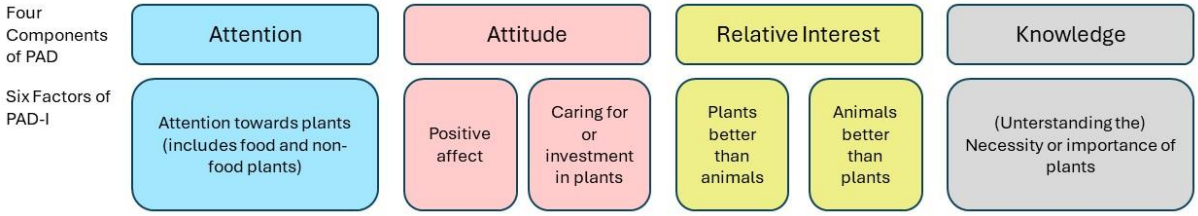

Fig. 1*. The four components of the Plant Awareness Disparity and the six factors of the Plant Awareness Disparity Index [3]*

2.1 Plant Awareness Disparity Index

In order to be able to specifically reduce the plant awareness disparity through interventions, an instrument is required that can be used to measure the PAD. Therefore, Parsley et al. developed the Plant Awareness Index (PAD-I) [3]. The index consists of six factors, which aligns conceptually with the four components of PAD (Fig. 1) and can be determined by using a questionnaire. The questionnaire consists of 25 Likert items (Tab. 1). To calculate the index, the answer options are linked to scores. (completely disagree = 1, somewhat disagree = 2, somewhat agree = 3, completely agree = 4). Three items are negative items (No. 14, 15 & 16). These items are reverse coded. Therefore, the maximum score is 100 and the minimum score is 25. The higher the score, the lower the plant awareness disparity

3. faNutec

The faNutec project (*Schülerinnen und Schüler **fa**rmen unter **Nu**tzung neuester **tec**hnischer Möglichkeiten - pupils farm using the latest technical possibilities)* is a cooperation project lasting two years (April 2023 - April 2025) between the Waldschule (Forrestschool) in Hagen, an independent high school in Lower Saxony, and the biology didactics department at the University of Bremen. With a funding from the DBU (German Federal Environmental Foundation), a robot was able to be purchased that is used to cultivate an approximately 2x3 meter bed. In an interdisciplinary approach, the wooden shelter and then the robot were built over the course of two project weeks. The robot is the Farm.Bot Genesis MAX v1.6. The robot can not only independently plant seeds in the bed in previously programmed locations but can also water or dig up the bed independently. Since this robot is 100% open source-based, all technical drawings, plans and codes are freely viewable and can be copied or changed. The programming and maintenance of the robot is carried out by a technology club in which students interested in technology can take part. A sixth-grade class at the school acts as a project class and tests the use of the robot in everyday school life. The students work with teacher to develop a planting plan and determine when which plant should be planted or sown in the bed. The information is then transferred to the robot using an app. The Robot then plant the seeds independently and also take over watering at predetermined periods. These are set in such a way that watering takes place

during class breaks, if possible, so that all interested school children in the playground can watch the robot. The first plants will be sown in spring 2024 and will be cared for and monitored throughout their entire growth period.
One goal of the project is to evaluate if a participation in the faNutec project can lead to a reduction of the plant awareness disparity. According to the literature, there are various strategies to increase interest and appreciation of plants. This includes engaging with real plants outside of the classroom. The independent cultivation of plants from seed to harvest seems to have a great influence. Food plants are particularly suitable for this, as the importance of plants for people can be highlighted. The perception and documentation of plant growth processes using scientific methods and technical or digital instruments can also have an influence on the interest and appreciation of plants [11]. All these strategies are implemented in the project.

4. Research Methodology

In order to determine the Plant Awareness Disparity Index of the children in the project class, the 25 items from the pilot study were translated into German and converted into a pre-test. They are supplemented by further items from studies on the development of interest in botanical topics and technical devices or robots, which were adapted to the faNutec project [5,11,12,13]. Except for the first item (“Name five living creatures”), these are exclusively 4-point Lickert items. Since the questionnaire is very long, it was divided and used on two different days at the beginning of the new school year (August 2023). A total of 27 students took part in the survey. After evaluating the questionnaires and calculating the PAD-I, interviews were conducted with students (n = 11). An attempt was made to recruit students for the interview who had achieved either a very high or low PAD-I in the questionnaire in order to find out possible causes for the characteristics of the index.
The questions in the interview are partly based on the items in the questionnaire. In addition, the interview guide contains questions that are intended to identify possible causes for a high or low level of the index. To this end, initial hypotheses from the pilot study were taken up and converted into questions. Parsley et al. [3] suggest that a plant mentor might have an impact on the index (interview question: Is there anyone outside of school who teaches you about plants?). After the children in the project class have worked on the robot for a year, both the questionnaire and the interviews will be conducted again to check whether a participation in the project can reduce the plant awareness disparity.

5. Findings and discussion

At this point, the results of the questionnaire and interview evaluation are presented. The mean value is used to display the results. However, it must be pointed out that the significance is limited due to a small sample. In order to increase the significance of these quantitative values, an attempt is made to support conclusions from these results with qualitative data in the form of quotes from the interviews. The evaluation of the questionnaire showed that there are large differences in the achieved PAD-I among sixth grade students (Fig. 1). The lowest index is 45 (subject KA11EL), the highest is 84 (subject TA09AN). The mean of the indices is 65.1 (SD = 9.4). The evaluation of the pre-interviews cannot provide any possible causes for the different characteristics of the indices at this point. Parsley et al. [3] for example, suspected that plant mentors in private settings could have a high influence on the PAD index. But all participants, both those with a high and those with a low index, stated in the interviews that there are people outside of school who teach them something about plants. Access to green spaces also does not seem to have a demonstrable influence on the PAD index among these subjects, as they all grow up in a rural area and all children stated in the interview that they had a garden at home.

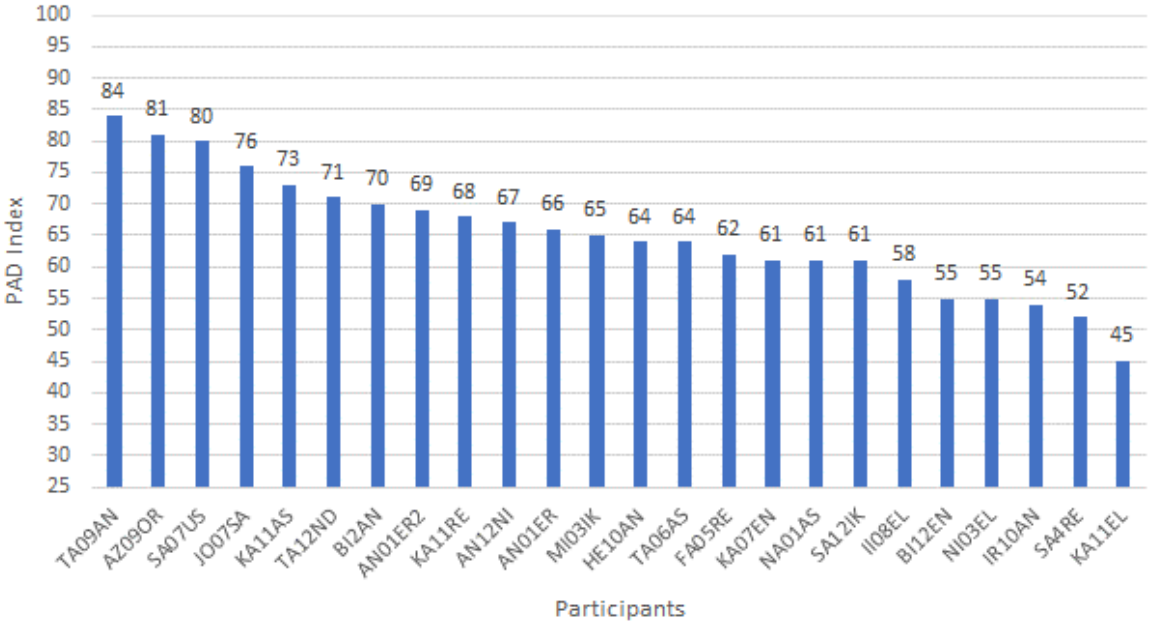

Fig. 2. *The results of the PAD I evaluation (n = 24, M = 65.1, SD = 9.4) (pre-test). For 3 participants the PAD-I could not be calculated.*

Since the PAD-I was published in 2022, there are no studies that were carried out under similar conditions (e.g. similar age of the participants) as in the faNutec project. A comparison of the results is therefore hardly possible. It will only be possible to gain meaningful knowledge of these results by comparing the results with the post-test, which is intended to determine the influence of participation in the project. However, it is interesting to take a closer look at the evaluation of the factors of the index. The six items assigned to the factor “Understanding the Necessity or importance of plants” are the six items with the highest agreement of all PAD-I items. Item 7 “Plants are important because they produce oxygen.” received an average score of 3.92. The participants therefore seem to be fully aware of the benefits of plants. This can also be confirmed by the analysis of the interviews, as all test subjects emphasize the importance of plants for people and the planet.

I: (...) do you think plants are important for planet earth?
B: Yes, very important.
I: Why?
B: Because without plants, for example, oxygen comes from plants. And that is important for breathing. And it is also important for the earth that the planet stays cool. So I would say yes. (SA04RE_Interview_I_10.11.2023, Pos. 75-78)

It is also noticeable that the items of the factors “Plants better than animals” and “Animals better than plants” from the main component “Relative Interest” differ significantly. While the score values of all items of the factor “Plants better than animals” are on average below the scale mean of 2.5, the score values of all items of the item “Animals better than plants” are above it. Thus, interest in plants generally seems to be lower than interest in animals. This thesis can be supported by another task from the questionnaire. The students were asked to write down five living creatures. Only seven children named one plant, one child named two plants, all other participants only named five animal species. The sunflower is mentioned twice as a plant species. The other mentions that were included in the “Plants” category were: “Flower”, “Plants” and “Tree”. This response behaviour is consistent with the findings in the literature [12]. Two participants even describe in the interviews that they don't really perceive plants as living beings, even though they know better.

B: Um, so plants. It's just that, for me, they aren't really living beings.
I: Why?
B: So actually they are living beings. But somehow, they just stand there. For example, you can't go for a walk with them like you would with a dog or something like that. Or can´t clean them. So you can

wipe them off with a rag, but that doesn't help. And I think it's cool with animals because you can interact with them like that. (BI12EN_Interview_I_14.11.2023, Pos. 98-100)

All interview participants also reported that they generally find animals more exciting than plants. The reason given by the students is that more interaction is possible with animals and plants do not appear to move.

I: Do you find animals more interesting than plants?
B: Yes.
I: Why?
B: Because you can do a lot more with animals. Especially with pets. (V03EN_interview_I_27.11.2023, items 83-86)

I: And then why don't you find plants that interesting?
B: Because plants, for example, cannot move. (IL08EL_Interview_I_14.11.2023, items 89-90)

It is also interesting that several participants are aware of the ability of plants to move, but the movements are too slow for them. Two students reported that they would find time-lapse recordings of plant growth and movement interesting.

I: And then why don't you find plants that interesting?
B: Because plants, for example, cannot move. Yes, but what I also think is nice with plants, for example, is when you watch a video or when you record it yourself. So you play it and then you always see how the plant develops.
I: Ah, okay, like a time lapse then?
B: Yes, exactly.
I: Okay, so things with plants sometimes just take too long for you?
B: Yes, exactly. (IL08EL_Interview_I_14.11.2023, items 89-94)

The evaluation of the questionnaires also indicates that there is interest in the robot and the project in general. On a four-point Likert scale, the item “I find the FarmBot project interesting overall” receives an average score of 3.54. The average scores for the items “I find it interesting to cultivate the bed with the robot” and “I am interested in how robots work” are 3.38 and 3.17, respectively. Interest in the project was also predominantly expressed in the interviews.

I: Okay. Do you find working with the Farm.Bot interesting?
B: Yes, definitely. It was really cool to plant that and do it with a robot. (FA05RE_interview_I_27.11.2023, items 114-115)

Table 1. The results of the 25 PAD-I Items.

Components of PAD	Factors of PAD-I	Nr.	Item	M	SD
Attitude	Caring for or investment in plants	1	I enjoy caring for houseplants.	2,73	0,80
		2	I enjoy caring for plants in an outdoor environment.	2,98	0,74
		3	care about the plants that are in my neighbourhood.	1,63	0,86
Knowledge	(Understanding the) Necessity or importance of Plants	4	Plants are important because they help reduce the effects of climate change.	3,83	0,37
		5	Plants are an important source of food for the world.	3,75	0,43
		6	Plants are important to ecosystems.	3,75	0,43
		7	Plants are important because they are a source of oxygen.	3,92	0,28
		8	Plants are important because they are a source of new medicines.	3,67	0,55
		9	Animals need plants in order to survive.	3,88	0,33
Relative Interest	Plants better than animals	10	I think plants are more useful to learn about than animals.	2,02	0,77
		11	I think plants are more interesting to learn about than animals.	1,71	0,68
		12	If I had to choose, I would rather keep houseplants than animal house pets.	1,23	0,54
		13	When I go outdoors, I am more likely to notice the individual plants around me than any animals in the environment.	2,13	1,02
	Animals better than plants	14	Learning about animals interests me more than learning about plants.	3,27	0,85
		15	Animal conservation is more interesting to me than plant conservation.	2,94	0,79
		16	I think animals are more interesting than plants, in general.	3,15	0,91
Attitude	Positive Effect	17	I enjoy going outdoors because of all the plants in the environment.	2,65	0,70
		18	I would enjoy visiting a botanical garden.	3,11	0,69
		19	I have a lot of good memories about plants.	2,29	0,98
		20	Being around plants makes me feel happy.	2,25	0,78
		21	In general, I think plants are very interesting organisms.	2,46	0,91
Attention	General attention towards plants	22	I notice the crops that are grown near where I live.	3,29	0,73
		23	When I take a walk outside, I notice the plants around me.	2,35	0,68
		24	When I am in a wooded area I notice individual plants, not just the forest as a whole.	2,35	0,80
		25	I notice all the plants in my environment, not just those that I eat.	2,29	0,68

6. Conclusion

As already mentioned, the significance of the results presented is limited without the post-test. However, the evaluation of the individual factors in the pre-test showed that the students' interest in plants is low. Both the results of the PAD-I questionnaire and the interview results showed that there is greater interest in animals. The lack of or only slow movement and development of plants is cited by students as one of the reasons why animals are more interesting. In order to demonstrate the development and ability of plants to move, the suggestion of two students is taken up and a timelapse of the growth period is created using the camera built into the robot. The first data recording can also show that there is a general interest in the project and working with the robot. The post survey is intended to check whether interest in cultivating the bed with the robot will also lead to an increase in interest in the plants.

Furthermore, it can be noted that the 6 items of the factor “Understanding the Necessity or Importance of Plants” of the “Knowledge” component are the 6 items with the highest agreement. The analysis of the interviews also showed that the students are aware of the importance of plants for the biosphere.

A possible reason for this could be that the topic of climate change has been addressed more frequently in the media since 2018. Media attention increases particularly through “focusing events” such as global climate protest movements (e.g. Fridays for Future), important publications or climate

summits, although it must be mentioned that attention decreases again due to other global issues such as conflicts or wars [14]. Nevertheless, the more frequent discussion of climate change in the media can have an influence on knowledge about the importance of plants for the biosphere. It is also conceivable that the implementation of education for sustainable development in everyday teaching will lead to the importance of plants for the biosphere being integrated more frequently into lessons. Another reason could be the location of the school. The school is very rural, surrounded by lots of green spaces and forests, and all interview subjects report that they have a garden at home. In order to be able to statistically determine the influence of the school or the location of the school, the use of the PAD-I questionnaire is planned in other schools in the area and in Bremen, the nearest large city.

REFERENCES

[1] United Nations (UN). (2015). Transforming our World – Agenda 2030 for sustainable development. New York: United Nations.
[2] Elster, D. (2020). Eco-Schools Movement in Germany in the Light of Educational Reforms. In: Gough, A., Lee, J.CK., Tsang, E.P.K. (eds) Green Schools Globally. International Explorations in Outdoor and Environmental Education. Springer, Cham.
[3] Parsley, K. M., Daigle, B. J., & Sabel, J. L. (2022). Initial Development and Validation of the Plant Awareness Disparity Index. In: CBE life sciences education 21 (4), ar64.
[4] Elster, D. (2007). In welchen Kontexten sind naturwissenschaftliche Inhalte für Jugendliche interessant? In Plus Lucis (Vol. 3, pp. 2–8).
[5] Tessartz, A. & Scheersoi, A. (2019). Pflanzen? Wen interessiert's? Advance online publication.
[6] Wandersee, J. H. (1986). Plants or animals—which do junior high school students prefer to study? Journal of Research in Science Teaching, 23(5), 415–426.
[7] Wandersee, J. H., & Schussler, E. E. (1999). Preventing Plant Blindness. The American Biology Teacher, 61(2), 82–86.
[8] Balding, M., & Williams, K. J. H. (2016). Plant blindness and the implications for plant conservation. Conservation Biology: The Journal of the Society for Conservation Biology, 30(6), 1192–1199.
[9] Parsley, K. M. (2020). Plant awareness disparity: A case for renaming plant blindness. PLANTS, PEOPLE, PLANET, 2(6), 598–601.
[10] Feldman, J. (2003). What is a visual object? Trends in Cognitive Sciences, 7(6), 252–256. https://doi.org/10.1016/S1364-6613(03)00111-6
[11] Tessartz, A. (2022). Interesse an Pflanzen fördern Eine Design Based Research-Studie mit Kindern und Jugendlichen [Bonn]. DataCite.
[12] Amprazis, A., Papadopoulou, P., & Malandrakis, G. (2021). Plant blindness and children's recognition of plants as living things: a research in the primary schools context. *Journal of Biological Education*, *55*(2), 139–154.
[13] Langfeldt, C. (2022). Das Interesse von Schülerinnen und Schülern am Thema „Ökosystem Wald" sowie an themenbezogenen Arbeitsweisen. Advance online publication. (75-96 Seiten / Zeitschrift für Didaktik der Biologie (ZDB) - Biologie Lehren und Lernen, Bd. 26 (2022)).
[14] Bundeszentrale für politische Bildung (2024, March 6). Klimawandel in den Medien. Bundeszentrale für Politische Bildung. https://www.bpb.de/themen/klimawandel/dossier-klimawandel/546135/klimawandel-in-den-medien/#node-content-title-1