

## Original Paper

# The Effects of Using Living Sea Animals on the Student's Emotional States

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### **Abstract**

*Using living animals in school lessons makes it possible for students to have an emotionally charged learning experience. With the example of Thornback rays (*Raja clavata*), the emotional affects of sea animals on students are investigated. Theoretical aspects can be found in the explanation of activity-oriented teaching, which is organised holistically and student-active. The preparation for and confrontation with the thornback ray was successfully adjusted to the individual needs of the students. The students collectively worked on research issues and the ray was presented as a research object. Besides the emotional adventures of touching a living ray, the students took notes of the most important growth characteristics of the ray. Hence the students encounter the ray as a living animal on different levels. To check the hypotheses of how a living animal influences the students' emotional state, the PANAS questionnaire is applied. PANAS serves as a snap-shot of the students' emotional state. Whilst there are no differences found concerning the negative affects, the positive affects show a significant difference between a lesson with and a lesson without a real object. If the lesson comprises a real object, the item attentive is chosen significantly more often than in a lesson without real objects. Additionally, the data was analysed with a t-test, whereat the students in the framework of an activity-oriented lesson show significantly more positive affects compared to a lesson without real objects. The study gives a comprehensive insight into the different emotions of students when confronting them with a real object.*

### **Keywords**

*activity-oriented teaching, student-centred lessons, student-active, emotional affects, PANAS*

## 1. Introduction

“It is only with the heart that one can see rightly; what is essential is invisible to the eye” is a quote from Antoine de Saint-Exupéry’s famous book *The Little Prince* (1946, p. 72). These simple words point to the importance of emotions. Triggering emotions of students is part of the concept of activity-oriented teaching. Learning and acting are very closely connected but combining them is not as easy as that. Activity-oriented teaching implies that besides acting other components are incorporated in the lesson as well. Activity-oriented lessons require an action situation, which Hilbert Meyer defines as limited in time, structured, and consciously organised interaction units by the teacher and the students that are meaningful and important (Meyer, 2003, p. 116). The action and the situation itself are complementary. Factors like time, room equipment as well as the relationship between teacher and student determine how an interaction is implemented.

The concept of activity-oriented teaching underlies a conception of the world, society, and man. Not only is a human being capable of being rational, but also of self-destruction. Therefore, one can, in principle, decide on his/her personal development. Learning is a holistic process during which the mind, heart, the hands, and all senses are involved. The curiosity of humans, which is expressed by asking questions and wondering, is a precondition for activity-oriented lessons. It is assumed that students have a general interest in the environment around them, which means they are not only self-focussed, but want to understand what surrounds them. The environment shall be experienced consciously and examined by experiments (Meyer, 2003, p. 403). In most cases, an action which the students can identify with represents a challenge to work on a problem. Regarding the *gifted* students of the “Kolumbus-Kids” project, these actions are not easy to choose because the students should be challenged both practically and cognitively. Since knowledge can be acquired easier when one understands the origin or process with an object itself, a high level of individual activity of the students is crucial (Berck, 2001, p. 131). Not only the biological background, but also how the scientist acquires his/her knowledge is part of activity-oriented teaching. Students learn with a real object and not only with the help of a model. The anatomy of a ray, for example, is easier to comprehend with a real object than with photos. Activity-oriented teaching allows the students to learn holistically with the mind, heart, the hands, and all the senses (Meyer, 2003, p. 409). When more senses are stimulated, the students remember what they have learned more easily because the brain is stimulated via several stimuli. The sensory perception helps the students to gather experiences and thereof create a conception of the world. When only single senses like the visual or auditory sense are stimulated, the students remember less. Only if they work on the problem themselves, they can memorise better. Apart from gaining knowledge, activity-oriented teaching is to strengthen the students’ social competencies as well as their interest in biology.

Emotions play an important role in activity-oriented lessons. However, it is very difficult to observe and define them thoroughly. Still, there are aspects of emotions like experiencing or the conscious

perception of a feeling, the processes which take place in the brain or neurone system and the observable expression that can be observed especially in the face (Izard, 1994, p. 20).

Apart from feelings, neurological processes like the facial expression are part of emotions. Regarding activity-oriented lesson, there is no action without an affect that is an emotional feeling. When someone is interested in a topic, he/she will deal with it more intensely and feel positive emotions like joy or happiness. Students who have their own pet, for example, will feel positively about real objects in a lesson. When a topic is connected with a negative emotion, the person avoids it and is anxious or aversive. Emotions are an important part of the personality development of the students. On the one hand, the genetic disposition of a person is responsible for the development of the quality of emotions. On the other hand, learning experiences are also part of the development of emotions. Depending on how the emotions affect the student and which emotion he/she unfolds is how he/she will develop (Izard, 1994, p. 27). Regarding the students of the “Kolumbus-Kids” project, the genetic disposition is determined, but the learning experiences can be made aware. The development of emotional intelligence begins during infancy and is indispensable for interpersonal skills. An adequate deployment of emotions makes it possible to take an individual path in life (Golemann, 2001, p. 244).

Biology is the science of life or living matter in all its forms and phenomena and has as the only subject the privilege to deal with real objects from the fauna and flora. Students get a morphological, physiological and behavioural insight into different species. The contact with living organisms is usually connected with emotional reactions: They directly appeal, demand attention or defence (Killermann, 2005, p. 156). This research contributes to the activity-oriented teaching and investigates the emotional affects of students caused by real objects. The purpose of this study was to find out how using living animals in school lessons influence the emotional affects of students.

## **2. Method**

### *2.1 Data Collection*

The data collection for this study took place within the framework of the “Kolumbus Kids” project at Bielefeld University, which is an enrichment programme for young, talented scientists that was initiated by project leader Prof. Dr. Claas Wegner. Students of the project participated anonymously in the different types of tests (PANAS I, PANAS II) to check the hypotheses. The students participated in an activity-oriented teaching unit consisting of seven lessons concerned with different sea animals, namely rays, starfish, and hermit crabs. The first PANAS test was completed by 11 students after a lesson without a real object. The second test (PANAS II) was conducted after a lesson with a living ray. Both tests are comparable because the only difference is that they were conducted at different times.

### 2.1.1 Instruments

Instruments for the empirical studies are PANAS (Positive and Negative Affect Schedule). The t-test is conducted to check the significance of the results.

PANAS is an instrument developed by Watson and Tellegen (1988), which makes it possible to describe the emotions of a single person at a specific point of time, and to sort these emotions into two categories (positive and negative affects). With respect to the students of the “Kolumbus Kids” project, PANAS can be applied to investigate the emotional impact of living animals in school lessons. A Positive Affect (PA) describes the extent to which a person is enthusiastic, active, and attentive (Krohne, 1996, p. 140). Features of a highly positive affect are concentration, commitment as well as energy. Compared with this, a highly Negative Affect (NA) is characterised by negative tension, irritability, nervousness and anxiety of the person. PANAS consists of twenty items; ten of them belong to the positive emotions, and the other ten to negative emotions (Krohne, 1996, p. 141). The items are as follows.

**Table 1. Items of PANAS (Tellegen, Watson, & Clark, 1999, pp. 297-303)**

Items (PA)		Items (NA)	
active	alert	distressed	irritable
interested	determined	upset	ashamed
excited	attentive	guilty	nervous
strong	proud	scared	jittery
inspired	enthusiastic	hostile	afraid

The positive and negative affects are independent from one another. Both the positive and negative affects are reflected upon collectively and individually. With a five-step scale from (1) “very slightly to not at all”, (2) “a little”, (3) “moderately”, (4) “quite a bit”, to (5) “very much” (Crawford & Henry, 2004, p. 6), the intensity of the affects is rated. In the empirical study, the version of the PANAS referring to the current emotions at a concrete moment during the teaching unit is applied.

A t-test is used to prove the significance of the results. It examines the difference between two mean values of two independent random samples. The following null hypotheses refer to hypothesis I that is: Using a living animal (ray) in the framework of activity-oriented teaching has the effect that students at this point in time show more Positive Affects (PA) than in a lesson without a real object.

Null hypothesis I<sub>0</sub>: Using living animals (rays, starfish, and hermit crabs) in the framework of activity-oriented teaching has the same influence on the Positive Affects (PA) like a lesson without a real object.

Null hypothesis  $H_0$ : Using living animals (rays, starfish, and hermit crabs) in the framework of activity-oriented teaching has the same affect in the Negative Affects (NA) like a lesson without a real object.

### 3. Results

PANAS I was conducted with 11 students, who participated in the test after a lesson with the topic “Preparing a poster dealing with rays” without real objects.

First, the items are listed according to their level of intensity (1-5, from “very slightly to not at all” to “very much”, see methods).

**Table 2. Tabular Overview of the Intensity of the Items of PANAS I**

Items	Points					Sum	Mean value
	1	2	3	4	5		
active	0	1	2	5	3	43	3.91
interested	0	0	3	5	3	44	4.00
excited	1	2	4	3	1	34	3.09
strong	2	2	2	1	4	36	3.27
inspired	1	7	0	1	2	29	2.64
proud	0	6	2	2	1	31	2.82
enthusiastic	2	2	3	2	2	33	3.00
alert	2	2	3	1	3	34	3.09
determined	0	2	3	2	4	41	3.73
attentive	1	3	1	3	3	37	3.36
distressed	8	1	1	0	1	18	1.64
upset	8	2	0	1	0	16	1.45

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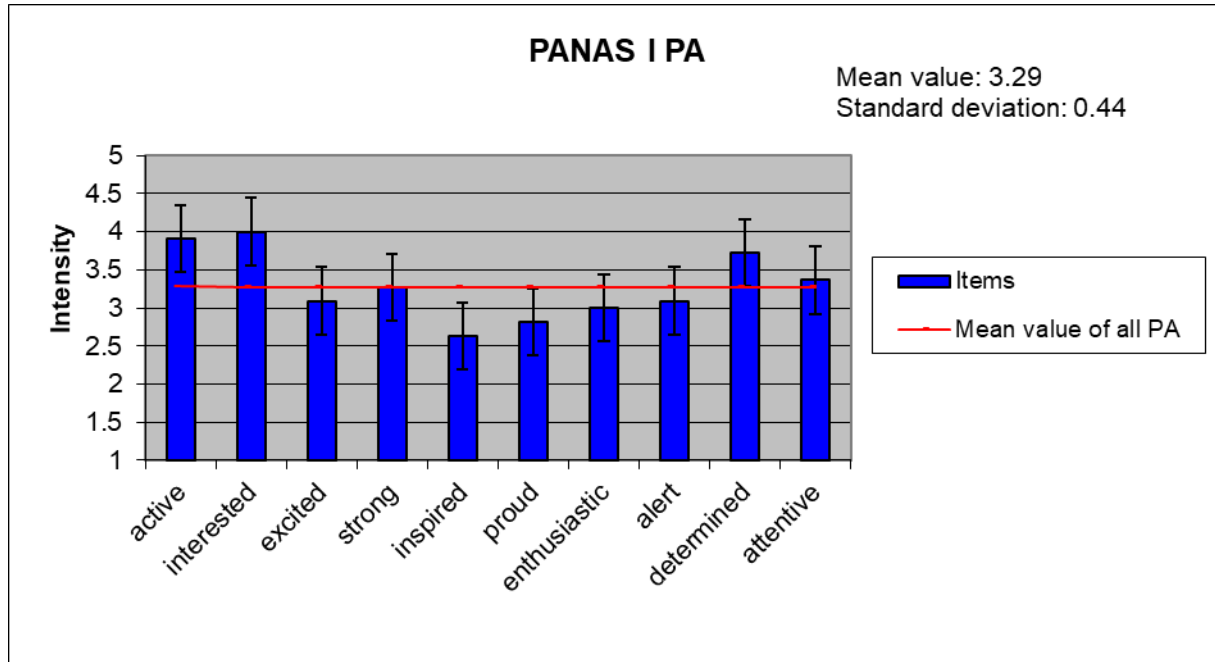
guilty	9	2	0	0	0	13	1.18
scared	10	0	1	0	0	13	1.18
hostile	7	2	2	0	0	17	1.55
irritable	6	3	1	1	0	19	1.73
ashamed	8	2	1	0	0	15	1.36
nervous	7	2	1	0	1	19	1.73
jittery	7	4	0	0	0	15	1.36
afraid	11	0	0	0	0	11	1.00

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The intensity of every single item of all participating students is listed on a scale of 1 to 5. The sum derives from multiplying the single values with the corresponding points, which means that the points are reckoned up with the number of students, who filled in the test. As an example, the item “active” is demonstrated:

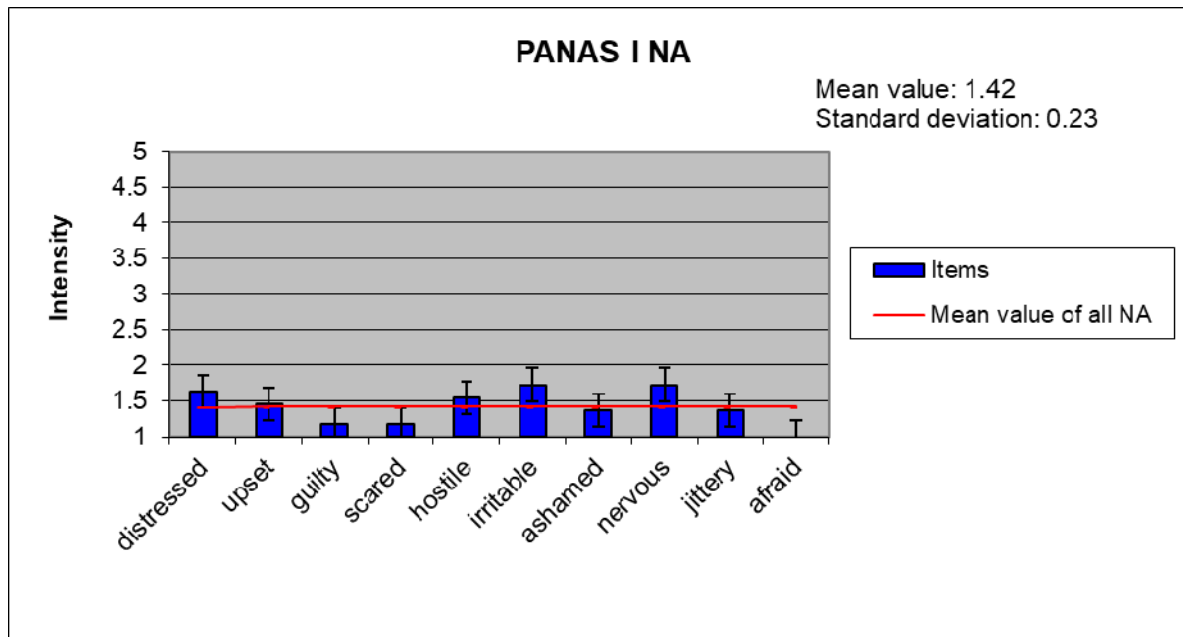
$1*0 + 2*1 + 3*2 + 4*5 + 5*3 = 43$ . The mean value is calculated by the division of the sum by the number of students, which is for the item “active”  $\frac{43}{11} = 3.91$ .

To get a better overview, the total population is plotted against the mean values of the single items. This is done in two graphics: The Positive Affects (PA) and Negative Affects (NA) are presented separately. In relation to the Negative Affects (NA), it is important to note that a low value represents a positive meaning because a low intensity of a negative affect indicates less negative emotions. The comparability is guaranteed because the intensity of the items on the y-axis are always shown on a scale from 0 to 5. The items can assign a minimal value of 1 and a maximal value of 5. The following figure shows the positive affects of PANAS I.



**Figure 1. Mean Values of the Single Items of PANAS I PA—The Red Line Represents the Mean Value of All PA. The Blue Bars Show the Intensity of the Items. The Characteristic of 1 to 5 Is Plotted on the Y-Axis and the Positive Items on the X-Axis**

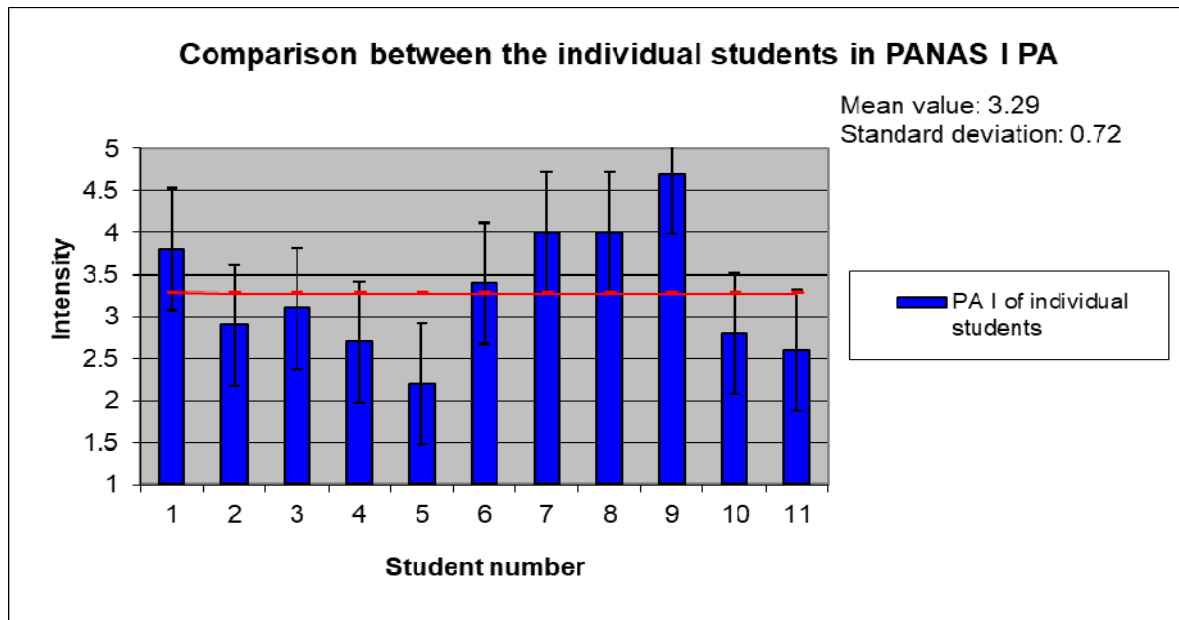
The mean value of all positive affects is 3.29. The items “active”, “interested”, “determined” and “attentive” are above, the items “excited”, “strong”, “inspired”, “proud”, “enthusiastic”, and “alert” are below the mean value. The lowest intensity is shown by the item “inspired” (2.64). The highest intensity can be noted for the item “interested” (4.00). The following diagram shows the intensity of the negative affects of PANAS I.



**Figure 2. Mean Value of the Single Items of PANAS I NA—The Red Line Represents the Mean Value of All NA. The Blue Bars Show the Level of the Intensity. The Level of the Intensity from 1 to 5 Is Plotted on the Y-Axis and the Positive Items on the X-Axis**

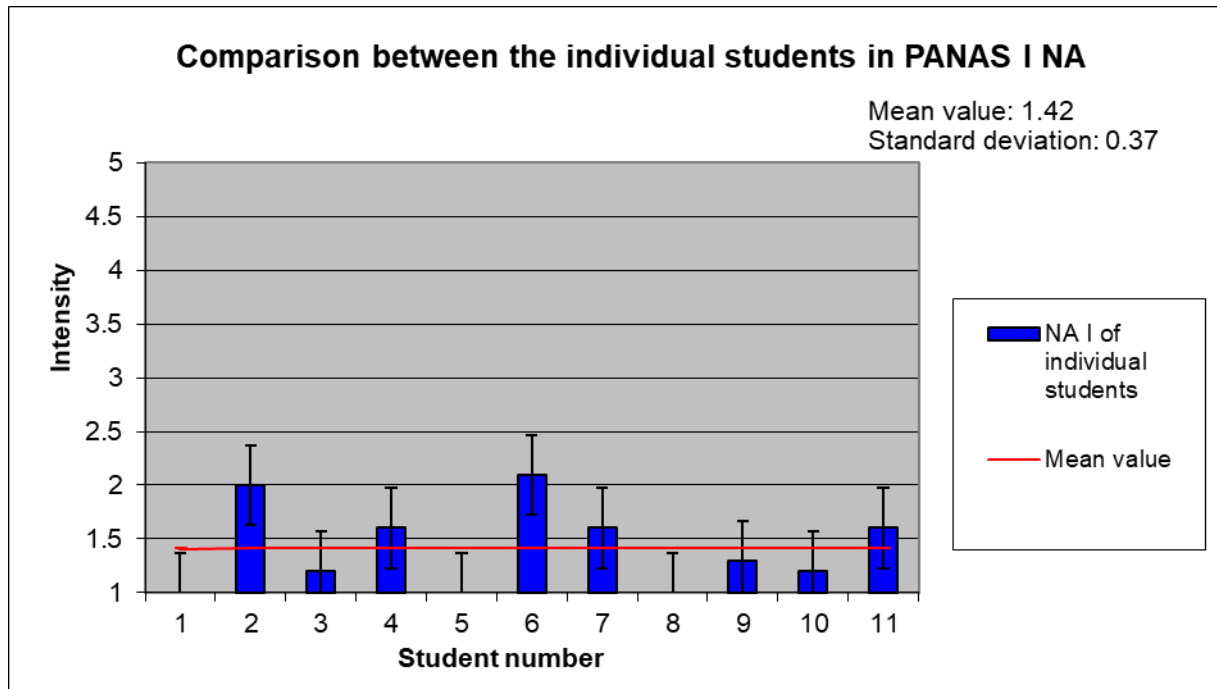
The mean value of all negative affects is 1.41 and thereby significantly lower than the mean value of the positive affects. The items “distressed”, “upset”, “hostile”, “irritable”, and “nervous” are above, the items “guilty”, “scared”, “ashamed”, “jittery” and “afraid” are below the mean value. The highest level of intensity is shown by the item “irritable” (1.73). The lowest level of intensity is shown by the item “afraid” (1.00). The following diagram shows the differing perceptions of the students and allows to compare the students to one another.





**Figure 3. Mean Values of the Single Students in PANAS I PA—This Diagram Demonstrates the Differences between the Students. For the Sake of Anonymity, a Number Is Assigned to Every Participating Student. This Number Is Maintained throughout the Study. The Mean Value of All Positive Affects of All Students Is 3.29**

The standard deviation is relatively high with a value of 0.72, which means that there are students who in total demonstrate a relatively high positive affect, and students who show a relatively low positive affect. Six students are below the mean value, though student number 5 has the lowest value of 2.2. Five students are above the mean value. Student number 9 shows the most positive affects with a value of 4.7. The following diagram is a comparable demonstration of the negative affects.



**Figure 4. The Intensity of All Negative Affects Is Plotted on the Y-Axis and the Individual Students on the X-Axis—This Diagram Demonstrates the Differences between the Students. For the Sake of Anonymity, a Number Is Assigned to Every Participating Student. This Number Is Maintained throughout the Study. The Mean Value of All Negative Affects of All Students Is 1.42**

The mean value of all negative affects of all students is 1.42 and is consequently lower as the mean value of the positive affects (3.29). The standard deviation of 0.37 is lower than the standard deviation of the positive affects. The variance is lower, which means that the students estimate their negative affects in a more similar manner than the positive affects. Six students are above the mean value; Student number 1, 5, and 8 achieve the minimal value of 1, which means they do not show any negative affects in the PANAS I in connection with the requested items. Five students are above the mean value; student 6 shows the highest negative affect of 2.1.

Eleven students participated in PANAS II, which was performed after a lesson with a living ray. The scale is the same as in PANAS I. The first step is a tabular overview of the items.

**Table 3. Tabular Overview of the Intensity of the Items of PANAS II**

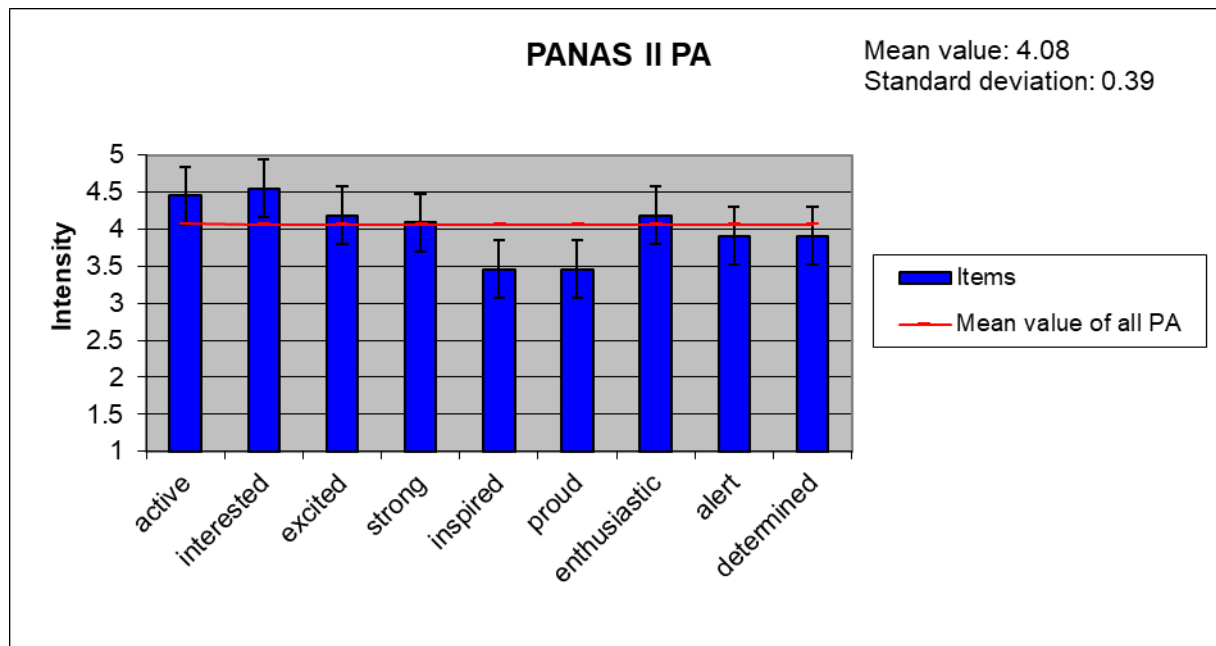
Items	Points					Sum	Mean value
	1	2	3	4	5		
interested	0	0	2	1	8	50	4.55
excited	1	1	0	2	7	46	4.18

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strong	0	1	2	3	5	45	4.09
inspired	1	2	2	3	3	38	3.45
proud	0	3	1	6	1	38	3.45
enthusiastic	0	1	1	4	5	46	4.18
alert	1	1	2	1	6	43	3.91
determined	0	1	3	3	4	43	3.91
attentive	0	0	1	2	8	51	4.64
distressed	8	3	0	0	0	14	1.27
upset	8	3	0	0	0	14	1.27
guilty	11	0	0	0	0	11	1.00
scared	8	2	1	0	0	15	1.36
hostile	9	1	1	0	0	14	1.27
irritable	6	5	0	0	0	16	1.45
ashamed	8	3	0	0	0	14	1.27
nervous	7	2	2	0	0	17	1.55
jittery	8	2	1	0	0	15	1.36
afraid	9	2	0	0	0	13	1.18

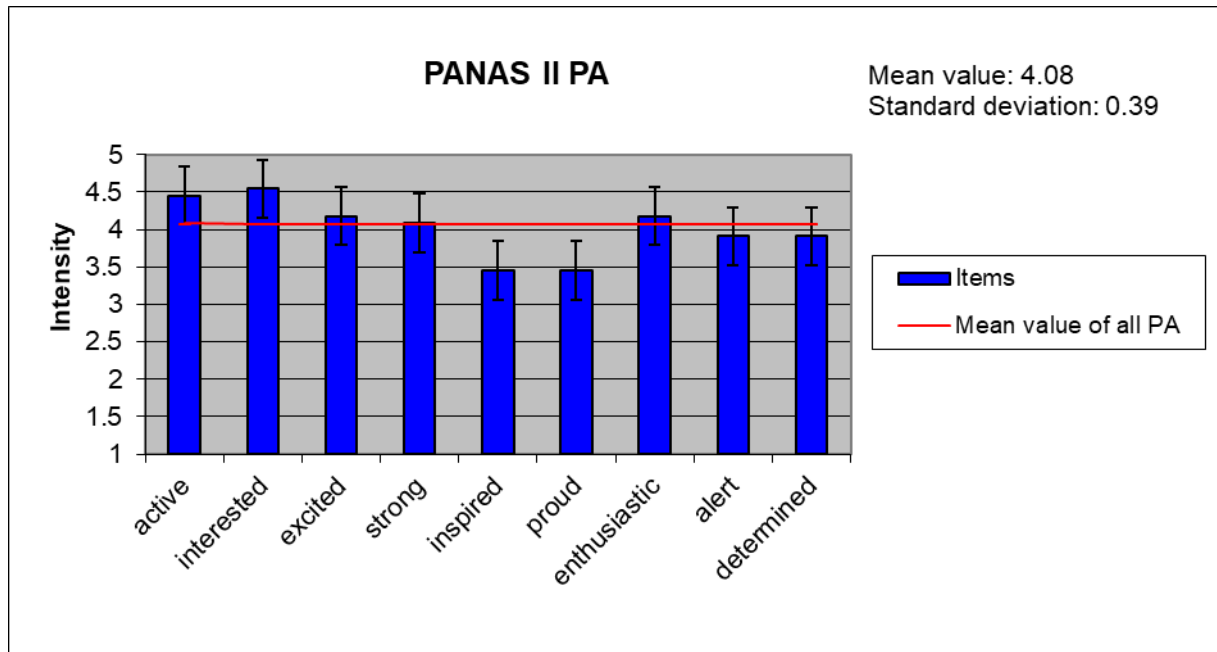
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For every item the level of intensity is demonstrated with points and the right column shows the mean values regarding every item. The following diagram shows the positive affects.



**Figure 5. Mean Values of the Single Items of PANAS II PA—The Red Line Represents the Mean Value of All PA. The Blue Bars Show the Level of Intensity. The Level of Intensity from 1 to 5 Is Plotted on the Y-Axis and the Positive Items on the X-Axis**

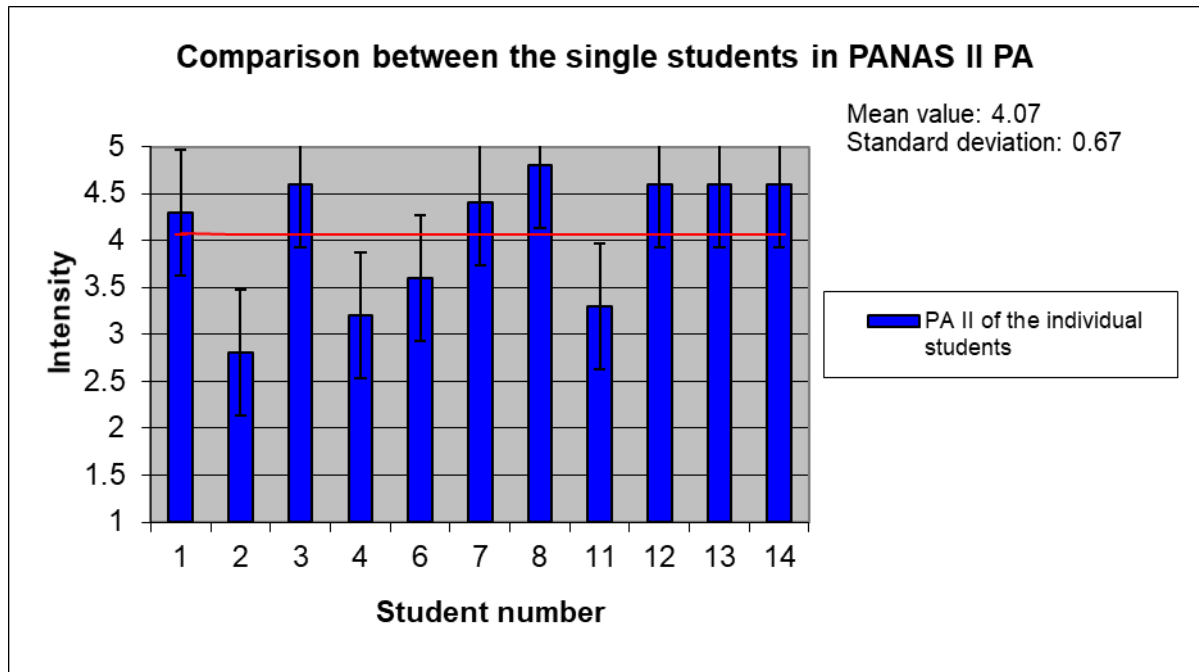
The mean value of all positive affects of PANAS II is 4.08 and thus 0.79 points above the PA of PANAS I (3.29). If there is a significant difference between the positive affect of PANAS I and II is discussed in the t-test part. The items “inspired”, “proud”, “alert”, and “determined” are below, the items “active”, “interested”, “excited”, “strong”, and “enthusiastic” are above the mean value. The highest intensity is shown by item “interested” with a value of 4.55. The lowest intensity is shown by the the items “inspired” and “proud” with a value of 3.45. The standard deviation is 0.39 and consequently lower than the PA of PANAS I (0.44). The negative affects of PANAS II are shown in the following diagram.



**Figure 6. Mean Values of the Single Items of PANAS II NA—The Red Line Represents the Mean Value of All NA. The Blue Bars Show the Level of Intensity. The Level of Intensity from 1 to 5 Is Plotted on the Y-Axis and the Negative Items on the X-Axis**

The mean value is 1.30 and compared to PANAS I NA lower (1.42). On average, less negative affects occur during the lesson with a real object (rays) than in a lesson without a real object.

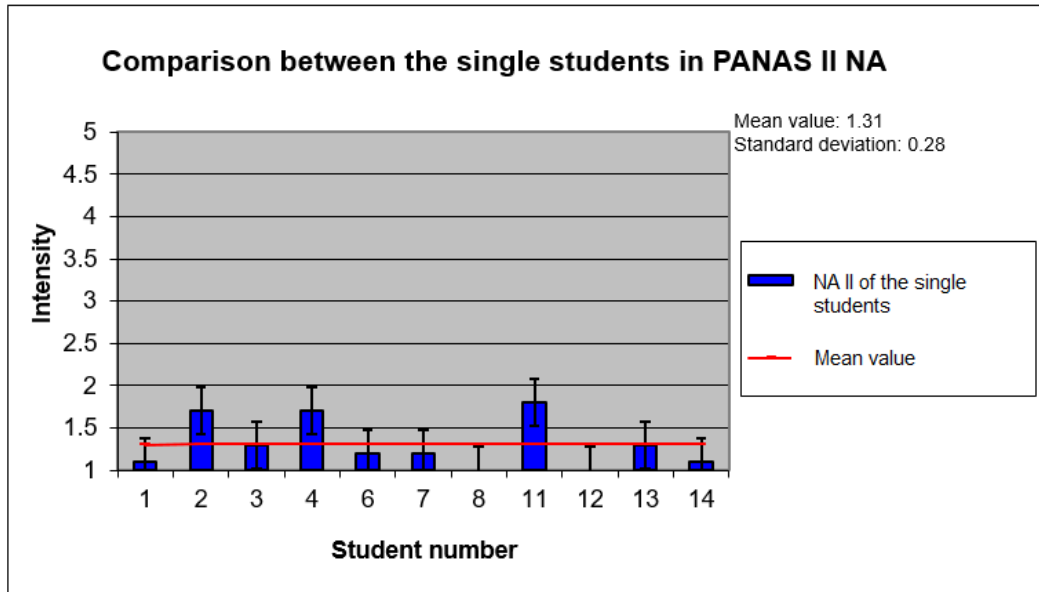
The items “distressed”, “upset”, “guilty”, “hostile”, “ashamed” and “afraid” are above the mean value. The minimum value of 1 is achieved by the item “guilty”, which means that no student felt guilty during the lesson with the living ray. The highest value of 1.55 is achieved by the item “nervous”. The standard deviation is 0.14 and is lower than the negative affects of PANAS I (0.23). The following graphic compares the intensity of all positive affects of every single student.



**Figure 7. Mean Values of the Individual Students in PANAS II PA—The Level of Intensity of All Positive Affects Is Plotted on the Y-Axis and the Individual Students on the X-Axis. Since Several Students Participated in PANAS I, But not in PANAS II, Which Is Also the Case Vice Versa, the Students Are Assigned to a Number Going up to 14**

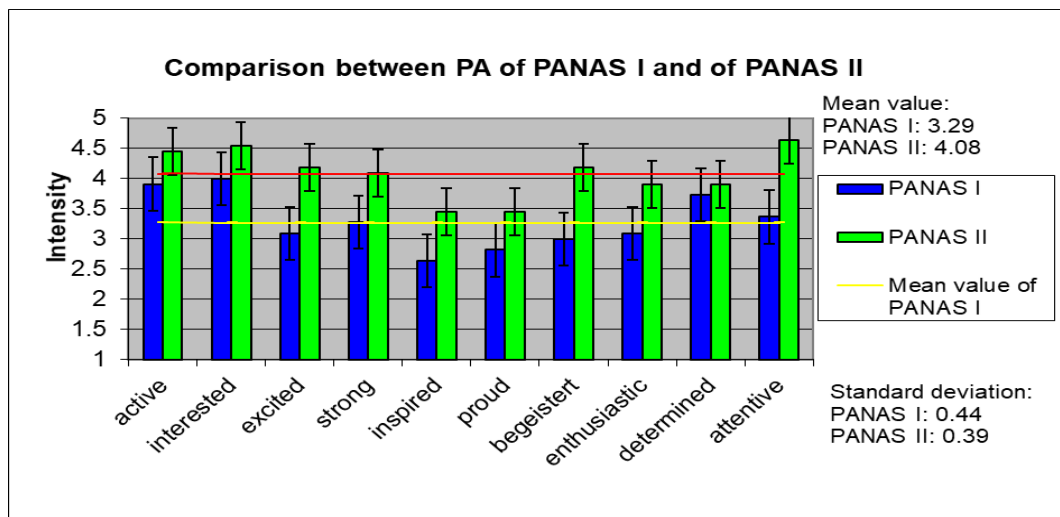
Student number 5, for example, attended only the lesson after which PANAS I was conducted, and student number 12, 13, and 14 only attended the lesson after which PANAS II was conducted. The mean value (4.07) is 0.78 points above the mean value of PANAS I. Students 1, 3, 7, 8, 12, 13, and 14 are above, students 2, 4, 6, and 11 are below the mean value. The standard deviation is 0.67.

The following diagram shows the comparison of the students participating in PANAS II in relation to the negative affects.



**Figure 8. Mean Values of the Single Students in PANAS II NA—The Level of Intensity of All Negative Affects Is Plotted on the Y-Axis and the Individual Students on the X-Axis**

The mean value of the students’ negative affects, who participated in PANAS II, is 1.31. The mean value of PANAS I is 1.42. Student number 1, 3, 6, 7, 8, 12, 13, and 14 are below, student number 2, 4, and 11 above the mean value. The standard deviation is 0.28. The following diagram allows a comparison between the level of intensity of the different items of PANAS I and II.



**Figure 9. Comparison between PA of PANAS I and of PANAS II—The Blue or Rather Green Bars Demonstrate the Level of Intensity. The Level of Intensity from 1 to 5 is Plotted on the Y-Axis and the Positive Items on the X-Axis**

A different level of intensity between PANAS I and II is found in the items “excited”, “enthusiastic”, and “attentive” because there is a difference of more than one point. A t-test is conducted for these items to prove if there is a significant difference. Only students who participated in both tests are included in the analysis.

The following null hypothesis refers to hypothesis I (see methods). Null hypothesis  $I_0$ : Using living animals (rays, starfish, and hermit crabs) in the framework of activity-oriented teaching has the same influence on the Positive Affects (PA) like a lesson without a real object. In relation to the positive affects it results in a comparison of PANAS I and II. The null hypothesis  $I_0$  can be rejected with a probability of 95%. The hypothesis I is therefore valid.

Moreover, the t-test is used for the null hypothesis  $II_0$ : Using living animals (rays, starfish, hermit crabs) in the framework of activity-oriented teaching has the same effect on the Negative Affects (NA) than a lesson without a real object. The results of the item “excited” and “enthusiastic” are not significant, whereas the result for “attentive” is significant (see Table 4). Therefore, the null hypothesis  $II_0$  cannot be rejected.

**Table 4. Tabular Overview of T-Values Calculated for Selected Items**

Item	t-value	Significant difference	Significance level for n = 8 (98.5%)
excited	1.40	No	2.31
enthusiastic	1.00	No	2.31
attentive	2.33	Yes	2.31

The sample size for the t-test is  $n = 8$ . A probability of 98.5% for the t-value of 2.31 is achieved by the item “attentive”.

#### 4. Discussion

Do real objects influence the emotional state of students? This essential question can be affirmed, however, it is necessary to closely examine the connection between emotional affects and real objects in lessons. The positive affects show a significant difference between a lesson with a living animal (rays) and without a living animal. Hypothesis I that is “Using a living animal (ray) in the framework of activity-oriented teaching has the effect that students at this point in time show more Positive Affects (PA) than in a lesson without a real object” therefore remains unaffected.

Especially the item “attentive” shows a significant difference when comparing lessons with or without real objects. Consequently, living animals like rays, starfish, hermit crabs can increase the students’ attention. Using real objects makes it possible to engage multiple senses of the students because they can touch the rays and observe the swim movement in the water. The affective orientation along real



objects like touching the rays supports a persisting motivation. At the same time, the cognitive confrontation like for example the analysis of the ray's swim movement increases the students' interest in real objects. Positive affects like interest and joy, which arise from the emotional engagement with the ray, support the students' development of intrinsic motivation in connection with the real object, but also with marine biology in general. This connection can be found in the theory part. Concerning the negative affects there are no significant differences between a lesson with or without real objects. Therefore, hypothesis II cannot be verified so that null hypothesis  $II_0$  remains unaffected.

The intensity of the negative affects are on average significantly lower than the intensity of positive affects, which means that the students' emotional state on the whole is positive. During the teaching unit it was observed that the students enjoyed the project "Kolumbus Kids" and the lessons themselves, which is reflected in the results of the distribution of positive and negative affects. The results show that using real objects can increase the students' interest. If the students can develop a long-lasting disposition for an object can only be shown with a long-term study.

The lesson quality is increased by using the living rays and students can gain experience in dealing with animals. Furthermore, it creates an emotional connection to biology by using real objects in the lesson (see introduction).

This result demonstrates that it is possible to influence emotions by external circumstances and that using living animals is interesting for students. This teaching approach increases the students' motivation towards biology, but also towards natural sciences in general.

The results represented above show a correlation between the emotional state and chosen items. A positive emotional attitude should be a precondition and aim of learning. Wherever possible, teachers should incorporate real objects into their lessons. For example, students could conduct experiments on the theme of luminescence or the chemical-ecological assessment of the sea by themselves. They are actively involved and therefore understand the theory more easily because it can be explained in an understandable way. Meyer states that students learn more effectively and memorize what they have learned better if they experienced something themselves or were part of the learning content (2003, p. 410). The approach of activity-oriented teaching makes it possible for the students to learn with all their senses and turns learning in an active and effective experience.

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