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Environmental Education – First Knowledge and Then the Habit of Environment Protection

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1. Introduction

It appears as an indisputable fact that every educated person – and the term "educated" is here used to mean not only people who completed any kind of university education, but any people that have a specific profession – should now be aware of the need for environmental protection and, as much as possible, of the reclamation of devastated environment, which is referred to as environmental engineering.

Thus, a fundamental question can be asked about the level of knowledge that an adult person representing a specific profession, and usually having their own family, including children, should have, knowledge that they could share with and use in discussions with others in their environment, both at work as well as within their own family, especially with the children whom they should raise to become broad-minded citizens.

Every citizen of a state based on the democratic system – and the political system of our home country is democratic (despite all its shortcomings) – is a potential or an active voter and this applies not only to the elections of new Parliament representatives, but also to the election of local authorities, that is Regional Parliaments, City Councils, Municipality Councils, and, to go even lower than that in the local government hierarchy, to Housing Estate Councils, Village Councils, etc.

In relation to the above, it is clear that such a person often faces the dilemma of assessing, learning about and considering the potential plans to be implemented (the so-called programs) of the politicians they

want to vote for, and those programs of future members of parliament, senators and city councilors often regard their attitude towards problems (including investments) connected with environmental protection.

The habit to protect and shape the environment in which we live (and shaping the environment is here used as a very broad concept) should constitute an element of the education of our children, possibly from the youngest age just after they acquire the necessary linguistic skills, in order to ingrain in them certain automatic environmental behaviors [1, 2].

Thus, even in the introduction to the present work, the Authors would like to suggest that, in their opinion, the educators that specialize in the broadly understood environmental education represent the part of pedagogy which is distinguished from general pedagogy and referred to as social pedagogy through their work and actions; the matter is described, among others, in the extensive work of Marynowicz-Hetka E. [3].

2. Research problems an hypotheses

The general problem is indicating the possibilities and the necessity to extend the knowledge of the learners in the subject, starting from primary school, or even in the kindergarten on an introductory level, knowledge that could be continuously expanded and deepened in the subsequent stages of education, **so that care about the environment could become a habit for the rest of the adult life**. Directly connected with the problem formulated above is the **research hypothesis that the permanent introduction of appropriately dosed, repeated, and deepened knowledge on environmental protection starting from primary school curriculum will make the rivers and lakes clean, the air unpolluted, the forests free of garbage, and the environmental control authorities, such as the National Inspectorate of Environmental Protection reduced by 50% of the current staff, as it will turn out in one of the future generations that the people have achieved such a level of environmental behavior that they no longer pose a threat to man's natural environment**.

3. Characteristics of the variables and indicators

In the case of the research presented in the present work, referred to as probe research involving answers to questions prepared in advance,

which means a form of testing performed on the learners as the research subjects, it can be assumed that every learner as a person with varying, and, thus, changeable, knowledge on environmental protection constitutes a variable which is referred to in mathematics as an independent variable or an independent variable parameter.

The indicator, that is the outcome variable of the knowledge on environmental protection of the learners in a particular class, is the arithmetic mean of the points calculated on the basis of correct answers provided to the questions asked in the test form against the maximum number of points to be earned.

4. Research methods, techniques, and tools

As it has already been mentioned above, the probe method commonly known as the survey method will be applied; thus, the survey will serve as the research tool.

The survey will be identical for all the students in the sixth grade of primary school which means students in the second stage of primary education.

Every survey will contain 10 short questions of the test type with three answers to choose from: a, b, and c, where only one of the answers is correct and the students will be asked to mark it with a circle.

The maximum number of points to be earned by one student is 10. The sum of all the points earned by the whole class is the number of points earned in every test multiplied by the number of students.

The following evaluation criteria were assumed:

- from 9–10 points the grade is “very good”,
- for 8 points, the grade is “good +”,
- for 6–7 points, the grade is “good”,
- for 5 points, the grade is “average+”,
- for 3–4 points, the grade is “average” (poor),
- for 0–2 points, the grade is “fail”,

The questions formulated by professor Tadeusz Piecuch, PhD Eng., for the purpose of the survey with the three answers one of which is correct are provided below.

Survey

1. What is dioxin?

a) an insect
b) a poison
c) a plant

2. What is composting?

a) waste solidification through adding cement
b) waste seasoning in piles with increased temperature that leads to the creation of humus
c) preparing the feed for animals out of food and plant waste

3. What is land rehabilitation?

a) processing animal and fish waste to produce animal feed
b) protective tree vaccinations
c) restoring the functional and natural values to areas devastated due to human activity

4. What is filtration?

a) retaining solid pollution on a porous barrier
b) sewage aeration
c) draining sewage to sedimentation tanks

5. What is viscosity?

a) grain resistance to impact
b) internal liquid friction
c) taste property of drinking water

6. What is a scrubber?

a) a special high-pressure container for spraying animals in order to disinfect (decontaminate) them
b) a separated area in a waste disposal site used for storing particularly hazardous waste
c) a tank of a tower type with an internal douche (shower) through which the stream of polluted air passes

7. What is coagulation and flocculation?

a) methods of selecting waste stored on waste disposal sites
b) processes of clumping together of small particles in the sewage into larger masses under the influence of the chemical reagents used
c) dissolving waste under the influence of the chemical reagents used

8. What is flotation?

a) the sewage flow process in the pipelines

b) the process of combining pollutant particles with air bubbles and moving those particles to the surface of the liquid
c) the process of disinfecting rooms after insects are found in them

9. What is the greenhouse effect?

a) the increase of the average annual temperature on Earth as a consequence of retaining the heat from solar radiation reflected from the Earth surface which is not emitted back into the space due to the air pollution which also causes the retreat of glaciers and rising sea level
b) the process of organic waste rotting on the waste disposal sites under the influence of sun rays
c) the process of excessive growth of forests and other plants as a result of heating by the sun

10. What is sorption?

a) dissolution of pollutants in water
b) pumping sewage into pressure tanks
c) absorption of sewage or air pollution by filtering it through special particles forming a solid phase (pillars with particles)

5. The area, the organization, and the execution of the research

The research area was the sixth grade class (a mixed class consisting of boys and girls) in the primary school no 6 in Koszalin.

The survey was conducted during the natural science lesson, that is from 9.50 till 10.35 in the presence of the natural science teacher who was also the tutor of the class.

Every student was presented with the survey. The rules according to which the survey was to be filled in were repeated twice which was followed with the question for the students to confirm that the survey was comprehensible to them.

The students took 30 minutes to fill in the survey handed out to them.

6. Analysis of the results of the authors' own research

The analysis of the results of the authors' own research was based on the evaluation of 3 indicators of statistical mathematics, as follows:

- arithmetic mean,

- standard deviation,
- confidence interval.

The calculation of the standard deviation y_{avg} was performed on the basis of the following formula

$$y_{avg} = \frac{\sum_{1}^{n} y_i}{n} \quad (1)$$

where:

S – the summation sign

y_i – the results of individual measurements (here – the answers provided by particular students)

n – the number of objects evaluated (here – the number of students evaluated)

The number of students in the sixth grade class evaluated that responded to the questions in the survey was n=27.

The authors realize that the size of the probe and the number of research objects constituted by 27 students is not big, or maybe even too small but it should, however, make it possible to gain basic understanding as to the relevance of implementing the concept of permanent environmental education that the Authors represent at the early stage of the research.

Particular students earned the following results (y_i), that is the number of correct answers for the boundary conditions from 0 to 10. (for 10 questions, the maximum number of points to be earned was 10 – one point for every correct answer).

Thus, the data obtained from the survey took the form of particular results y_i (that is – the correct answers provided by every student).

y_1=0, y_2=0, y_3=0, y_4=2, y_5=4, y_6=4, y_7=5, y_8=5, y_9=5, y_{10}=6, y_{11}=6, y_{12}=6, y_{13}=7, y_{14}=7, y_{15}=7, y_{16}=7, y_{17}=7, y_{18}=8, y_{19}=8, y_{20}=8, y_{21}=8, y_{22}=8, y_{23}=9, y_{24}=9, y_{25}=9, y_{26}=9, y_{27}=10

Substituting the results obtained from the survey into formula 1,

$$y_{avg} = \frac{164}{27} = 6.0$$

The value of the indication parameter, the so-called arithmetic mean of the number of correct answers that amounted to 6 for the maximum achievable value of 10, which means that in the grade scale assumed in the present methodology, the grade is "good".

On the basis of the survey results presented, it is possible to obtain the graph of the probability density function, or, in this case, of the frequency of the same answers (repeated answers) which is presented on figure 1.

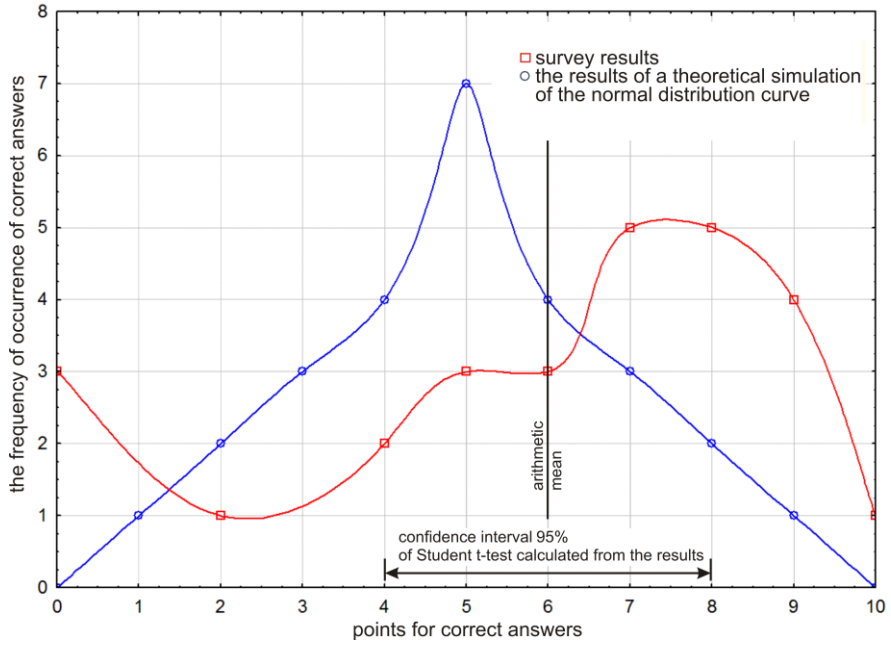

Fig. 1. The curve representing the frequency of survey results against the theoretical curve of Gaussian distribution
Rys. 1. Krzywa częstości wyników badań na tle teoretycznej krzywej rozkładu normalnego Gausa

In order to calculate particular indicators, that is the standard deviation and the confidence interval, it can be predicted that the results of statistical prognoses will be the more accurate, the closer the curve representing

the frequency of the same answers will be to the so-called normal distribution curve known in statistical mathematics as the Gaussian distribution.

The curve shows considerable deviation from the traditional profile of the standard distribution curve which was drawn fully theoretically as the background for the probability density curve – the frequency resulting from the survey conducted. Thus, it is easy to notice that the probability density curve is close to the theoretical curve representing standard distribution based on the random probe constituted by the research conducted in the form of a survey – a test – only in one sixth grade class which, however, represents all the sixth grade classes in the primary schools in our country; it represents all of the classes as the same curriculum is used across the country and that is why we can speculate that the random survey conducted among the students of the sixth grade of the primary school no 6 in Koszalin is an average typical probe on the scale of the whole country but also obviously affected by the observational error resulting from the limited size of the probe. The limited size of the probe is expressed with the number of only 27 male and female students who constitute a very small fraction of all the sixth grade classes of the Polish primary schools taught according to the same curriculum.

It must also be underlined that during the conversation with the tutor who was also the natural science teacher in the sixth grade class, the information that it was the best class (in the context of that school) was obtained; this may be the reason why the number of very good and good plus grades according to the grade scale assumed in the present methodology was relatively high.

This, in turn, makes it possible to provide the cause and effect explanation of the deviation of the tip of the result frequency curve obtained from the survey "to the right" in relation to the theoretical normal distribution curve which would probably be obtained if the survey were to be conducted in all the sixth grade classes in all the primary schools in Poland.

The mathematical statistical analysis conducted in the present work is based on professor Wiktor Oktaba's textbook [4]. Interpretations and discussions as to the possible shapes of the frequency curves are presented on pages 85 to 87 [4].

Another indicator of the statistical analysis conducted here is the so-called variance factor S^2.

Variance is calculated on the basis of formula 2:

$$S^2 = \frac{\sum_{1}^{n} y_i^2}{n} - y_{śr}^2 \qquad (2)$$

After substituting the survey results to formula 2 provided above

$$S^2 = \frac{1208}{27} - 36 = 8.7$$

the variance value equal to 8,7 is obtained and the root of the variance value constitutes another statistical analysis indicator assumed in the present work, that is – the so-called standard deviation.

Standard deviation is calculated on the basis of formula 3

$$S = \sqrt{S^2} \qquad (3)$$

After substituting the variance value 8,7 into formula 3, as follows

$$S = \sqrt{8.7} = 2.94$$

the standard deviation value equal to 2,94 is obtained, which should be practically treated as 3.0 questions from the arithmetic mean of correct answers that amounts to y_{avg}= 6.

Standard deviation is a measure of the so-called dispersion of the results in relation to the arithmetic mean, which in this case means the dispersion of the correct answers provided by the students between 6–3 and 6+3, that is between 3 and 9 of correct answers for the maximum number of 10 correct answers that constitutes the upper boundary condition.

The lower boundary condition is the number of 0 correct answers.

Such dispersion of the results should be treated as considerable; the score of as many as 22 male and female students ranges from 3 to 9 correct answers, and only 5 answers fall outside of this range (those answers are: y_1, y_2, y_3, y_4, y_{27}).

Finally, the last indicator applied in the statistical analysis of the results obtained is the so-called confidence interval indicator which is determined here on the basis of a 5 percent confidence interval by means of the Student's t-test, that is with 95% confidence level.

The confidence interval determined by means of the Student's t-test plus minus L is calculated on the basis of formula 4

$$\pm L = t_{\alpha} \cdot \sqrt{\frac{nS^2}{n(n-1)}} \tag{4}$$

where:

t_a – the value obtained from the Student's t-test for the 5% range, that is for 95% confidence

nS^2 – the sum of squared deviations of individual results from the arithmetic mean value

n – 1 – the number of the so-called degrees of freedom

Substituting the survey results obtained into formula 4

$$\pm L = 2.056 \cdot \sqrt{\frac{200}{27 \cdot 271}} = 1.0975$$

we can obtain the value of the confidence interval equal to 1.0975 of the confidence interval deviation to the bottom and to the top (below and above) the value of arithmetic mean predicted for the whole population which amounts to y_{avg}= 6 on the basis of the test probe conducted on the students of the sixth grade in the primary school no 6 in Koszalin.

As it cannot be stated in the humanities that the statistical number of correct answers within the confidence interval will amount to more than 1, that is 1.0975 of answers (approximately 1,1 answers) for the value close to the arithmetic mean, the number must be rounded to about two correct answers (nearly two correct answers) that fall within the same confidence interval.

Thus, the above means that in the range from 6–2 to 6+2 (t from 4 to 8), 95% of correct answers will be provided in the whole population of sixth grade students of Polish primary schools considering the uniform curriculum applied in the whole country.

While performing the statistical analysis, it is necessary to underline the fact that the interpretation of the results of such an analysis, that is – the interpretation of the statistical indicators (here, 3 specific indicators, that is – the arithmetic mean, the standard deviation, and the confidence interval), must be performed by a person that is professionally connected with the issues with respect to which the statistical analysis is conducted. The observation presented above applies to any profession,

whether it is connected with technology, chemistry, natural science or, as in the case of the present work, the humanities.

If we were to apply the statistical indicators calculated above, for example, to technical measurements, the values would be measurable directly (in grams, centimeters, in the units of speed, force, etc.). However, in the humanistic profession of pedagogy, and, thus, in this form of testing, it is difficult to state with respect to the answers to the questions which can only be "yes" or "no", that is – binary, that a given male or female student provided an answer that is, for example, only about 10% correct; that is why it is acceptable in this interpretation to rationally extend the confidence interval for the considerably high value of the standard deviation as a measure of dispersion.

While analyzing the survey results obtained against the grade scale assumed in the present methodology, that is – from the "very good" grade (9 and 10 points) to the "fail" grade (2.1 and 0 points), it must be noted that the average grade earned by the sixth grade students in the primary school no 6 in Koszalin was "good" (the point range for the "good" grade is 7 and 6) at the level of the lower value of the "good" grade.

It should, however, be noted in the present analysis that, according to the primary school curriculum followed in the country, both at the primary as well as at the secondary level, chemistry is not part of the curriculum as a separate subject as it is only introduced into the curriculum in the first grade of junior high school, that is – in the seventh grade. The generic subject of "natural sciences" which in a way prepares the students for their further education in the subject of biology also introduced to the curriculum in junior high school is taught.

The observation provided above is important for the analysis of the survey results conducted in the present work as the set of survey questions was based mainly on chemistry terms (to be more precise – physical chemistry terms), such as dioxin, coagulation, flocculation, flotation, sorption, or on technical terms, such as: composting, land rehabilitation, filtration, viscosity, scrubber, or the greenhouse effect.

The terms are, thus, not covered in any way in the primary school curriculum as there is no subject that would present chemical problems which could be covered by the subject of environmental protection.

What is of vital importance for the analysis performed in the present work, the terms used in the survey are very often repeated in the

media (the press, the radio, television, the Internet) during multiple discussions on the problem of environmental protection. The results of the survey conducted demonstrated, however, that children at this stage of development are able to acquire certain general, but necessary, knowledge regarding elementary concepts (processes, devices, phenomena) connected in this case with the methods or techniques used in the "treatment of the environment".

Finally, while analyzing the survey results, the good results obtained, that is the arithmetic mean of 6 correct answers for the maximum of 10 correct answers possible, should be treated with a certain level of criticism.

It can, after all, be assumed that due to the way in which the survey was formed with 3 alternative answers to every question, 1 of which was correct, some of the male or female students could simply select the correct answers in a random way without understanding the terms (like in the case of chance games, e.g. the sports lottery).

Of course, the probability of such a lucky guess cannot be overrated as it could be noticed even after the survey was finished that some of the male and female students knew for sure to which of the questions they provided correct answers. Out of 27 male and female students that participated in the survey, as many as 24 answered correctly to 2 questions, that is:

- what is dioxine,
- what is the greenhouse effect.

What is particularly important for the statistical analysis conducted above, it can, thus, be concluded that even if the students tried to randomly mark one of the answers, then the shape of the frequency curve – figure 4 – would be very similar to the full shape of the normal distribution curve.

Finally, it must be stated as a conclusion to the analysis of the survey conducted that a considerable portion of the male and female students of this particular sixth grade class of the primary school no 6 in Koszalin were interested and demonstrated visible curiosity with reference to the problems raised in the survey, for example, by asking for additional explanation or by asking for confirmation whether the answers they provided were correct, etc.

Of course, the role of the biology teacher and the tutor of the class as well as the role of the parents of the children and the way in which they raise the children that was not evaluated in the present work (as it was not possible) cannot be overlooked.

7. Research conclusions

Certain general conclusions can be drawn from the survey research conducted:

1. Using mathematical statistical analysis methods is possible and justified in the evaluation of the quality of the research performed in the form of survey testing.
2. The survey showed that a large portion of male and female students in the evaluated probe of 27 objects showed good, good plus, and very good knowledge of the basic terms used in the discussions (particularly in the media) about environmental protection with respect to environment rehabilitation.
3. The analysis of the survey results indicates that children at the level of secondary stage of education in the sixth grade of primary school are able to acquire and understand general specialized scope of knowledge regarding not only the ways of preventing the destruction of the environment but also the ways in which the environment can be treated.
4. The results of the research presented in the present work indicate that it is possible to continue the research in other, randomly selected primary schools in different cities in our country and that it is possible to extend the scope of the research to include the influence of the parents on particular behaviors of the children and their attitude towards the broadly understood problem of environmental protection.
5. The research hypothesis formulated in the present work is related in its present form to future generations which means that confirming or negating it is not possible for now and, thus, it should be treated as an important postulate that constitutes a specific conclusion resulting from the contents of the present publication

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Edukacja ekologiczna – najpierw wiedza potem nawyk ochrony środowiska

Streszczenie

Ogólnym problemem jest wskazanie możliwości i konieczności poszerzenia wiedzy uczniów, począwszy od szkoły podstawowej, a nawet wstępnie już od wieku przedszkolnego w takim zakresie – wiedzy stale powtarzanej i uszczegóławianej na kolejnych stopniach nauczania – tak aby dbanie o środowisko stało się nawykiem potem na całe dorosłe życie. Bezpośrednio z powyżej sformułowanym problemem wiąże się hipoteza badawcza, a mianowicie taka, że wprowadzenie już do programu szkoły podstawowej na trwałe, odpowiednio dawkowanej, powtarzanej z jednoczesnym pogłębianiem wiedzy o ochronie środowiska spowoduje to, iż wreszcie od któregoś z następnych pokoleń naszej społeczności rzeki i jeziora będą czyste, powietrze nie będzie zatruwane, lasy nie będą zaśmiecane, a instytucje kontrolne dla środowiska jak Państwowa Inspekcja Ochrony Środowiska, zredukowane zostaną o 50% obecnych etatów – gdyż okaże się, że ludzie osiągnęli taki poziom kultury zachowań wobec środowiska, iż przestali być zagrożeniem dla środowiska naturalnego człowieka.

W badaniach zastosowano metodę sondażową, zwaną potocznie metodą ankietową. Ankieta będzie jednakowa dla wszystkich uczniów klasy VI szkoły podstawowej, a więc uczniów na drugim etapie nauczania podstawowego.

Każda ankieta będzie zawierać 10 krótkich pytań typu testu, w którym zawsze będą trzy odpowiedzi a, b oraz c, przy czym tylko jedna z nich będzie odpowiedzią prawidłową, którą uczeń zakreśli kółeczkiem. Maksymalna ilość punktów możliwa więc do zdobycia, przez jednego ucznia wynosi 10. Suma

punktów zdobytych przez całą klasę to ilość punktów z każdej ankiety, wymnożona przez ilość uczniów.

Z przeprowadzonych badań można podać pewne bardzo ogólne wnioski:

1. Stosowanie metod matematycznej analizy statystycznej jest możliwe i zasadne do oceny jakości badań prowadzonych w trybie ankietyzacji.
2. Badania wykazały, że znacząca część uczniów i uczennic z badanej próby 27. obiektów wykazała dobrą, plus dobrą i bardzo dobrą znajomość podstawowych pojęć, używanych w dyskusjach (ogólnie w mediach) o ochronie środowiska w zakresie pojęć o jego naprawie.
3. Analiza wyników badań, wskazuje, że dzieci na poziomie drugiego stopnia nauczania w klasie VI szkoły podstawowej są w stanie przyswoić ze zrozumieniem zakres materiału ogólno specjalistycznego o sposobach nie tylko zapobiegania niszczeniu środowiska ale również o sposobie leczenia środowiska.
4. Badania w te pracy wskazują na możliwość kontynuacji tych badań w obszarach innych szkół klas podstawowych dobranych losowo w różnych miejscowościach naszego kraju oraz wskazują na możliwość poszerzenia tych badań o wpływ na określone zachowania dzieci i ich stosunek do szeroko rozumianej problematyki ochrony środowiska przez rodziców.