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# Do Future Primary Science Teachers Feel Confident to Transform Scientific Ecological Knowledge into School Knowledge? A Case Study in Bulgaria

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Abstract: This study presents the students' confidence to transform scientific ecological knowledge "animal diversity" into school knowledge, at lesson level as a part of the school subject "Human and Nature" which is learned in Bulgarian primary schools – 4<sup>th</sup> grade. The students are future primary teachers. During the course "Ecological Education" a methodology was developed and implemented, aims at making students feel better and building their confidence about teaching science in primary school. A data matrix was designed and used by the lecturer, which consists of two components: an individual student activity level during the "Ecological education" training course and a self-assessment of student's confidence in preparation of model "goals – learning resources – learning strategies" at the lesson level. All data were collected between February and May2017. The obtained data were analyzed through aStructured Observation and Self-assessment questionnaire for student's confidence. The results of this study are based on a sample of 25 students and 22 of themhave confidence to transform scientific ecological knowledge "animal diversity" into school one. These students, as future primary science teachers, are able to provide adequate professional decisions, according to the enforced changes in the normative framework for primary school science education and the development of scientific literacy.

Keywords: students' confidence, scientific ecological knowledge, methodology, science education in primary school, scientific literacy

#### 1. Introduction

The acquisition of science knowledge in primary school has always been a subject of discussions in Bulgaria – predominantlyin terms of the educational achievements of children. Out of doubt is the importance of teaching outcomes, but this leaves a number of open questions, related to the extent to which the knowledge is "appropriated" by the children, does it contribute to new personality formations, i.e.by what skills it is measured, is it a marker for a change in attitude to nature, etc.

Numerous studies of researchers have addressed the needs of children to seek evidence through their own senses, to test their ideas, and to take into account the ideas of others (Elstgeestetal., 1993); to engage in science by applying a set of scientific skills, performing practical activities (Varley et al., 2008); to understand the world by discovering it, by making decisions on importantissues (Tytler, 2007); to explore the scientific process by asking questions, generating scientific hypotheses, conducting experiments (Sotiriouetal., 2012).

All this is a valuable experience that children should accumulate in the process of knowledge acquisition, including the science one. For the "primary school age" period, this experience is gained through the development of scientific literacy. It turns out that this is a territory preferred and desired by the primary school children – it is here that a set of scientific skills is required and the children are enthusiastic about their formation (Smith *etal.*, 2012; Varley*etal.* 2008).

The Bulgarian community of teaching scientific literacy, represented by B. Toshev, A. Tafrova-Grigorova, E. Boyadjieva, M. Kirova has an outstanding contribution to the promotion of policies and good educational practices in

the field of science education and development of scientific literacy of children in particular. For the scientific literacy A. Tafrova-Grigorova writes that it is a set of characteristics – understanding of scientific concepts, principles and processes, appreciation of the benefits and harm from the achievements of science and technology, and their impact on the environment and people's lives, as well as application of scientific knowledge in real life situations to solve problems and to acquire new knowledge (Tafrova-Grigorova, 2013;Tafrova-Grigorova*et al.*,2011).

The value of children's scientific literacy stems from the fact that "Bulgaria is one of the small in territory European countries, but the wealth and diversity of its fauna is on one of the first places in Europe. On the territory of this country, including the Bulgarian Black Sea area, there are not less than 65 000 animals, the vast majority of which are invertebrates" (Golemanski& Popov, 2007).

Since 01.08.2016 the new Law for Preschool and School Education has entered into force in Bulgaria. According to Article 77.2,3"General education shall be acquired through the study ofgeneral educational subjects. The objectives, content and characteristics of generaleducation and the general educational subjects under paragraph 2 shall belaid down in the State education standard for the general education"<sup>32</sup>.

In the document, the level of ecological knowledge, skills and attitudes is a dimension of child's interaction with nature and social environment, also the consequences of this interaction. Once formed, scientific literacy will meet the demands of transformation in thinking at the individual / public level — the expectations here are addressed to a pedagogically competent teacher who has a certain professional-personal profile with a quality of attitude to the subject of his professional work (Angelova, 2015;Boneva,

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2015, Mihova, 2015;Rasheva-Merdjanova, 2007;Rasheva-Merdjanova, 2014).

Many researches show that students' confidence correlated with academic performance(Shoemaker, 2010; Atherton, 2017). The students' confidence is important for their academic success (Telbiset al.,2014; Shaukat& Bashir, 2015). Therefore, when the students build their confidence and feel better, they will be able to teach science in primary school according to the normative changes for development of scientific literacy.

The aim of this study was to determine the extent to which students as future primary science teachers feel confident to transform the ecological scientific knowledge of animal diversity into school one – at lesson leveltitled "Life in the Plains and Lowlands". The lesson is a part of the school subject "Human and Nature", which is learned in Bulgarian primary schools  $-4^{\rm th}$  grade.

## 2. Material and Methods

Object of this study are 25 students in 2nd year of Bachelor'sProgramme "Preschool and Primary School Education" at "St. Cyril and St. Methodius University" of Veliko Turnovo – Vratsa Branch. The study is based on a course "Ecological Education" conducted during the academic year 2016-2017, between February and May 2017. In this study, the following data collection methods were used (Cohen*etal.*,2007;Cohen*etal.*,2008; Zainal 2007), namely:

- Structured observation accordingto Cohen *et al.*, "A structured observation is very systematic and enables the researcher generate numerical data from the observations. Numerical data, in turn, facilitate the making of comparisons between settings and situations and frequencies, patterns and trends to be noted or calculated"(Cohen*et al.*,2007:398).
- Self-assessment questionnaire for student's confidence in preparation of model "goals - learning recourses learning strategies" at lesson level. For make students feel better and building their confidence to transform the scientific (ecological) knowledge into school one, a methodology was developed and implemented by the lecturer. The specificity of the methodology is expressed in the pedagogical modeling of the relationship "goals learning resources – learning strategies", for carrying out a process of science education in primary school and the development of scientific literacy. Active collaborative learning environment was emphasis in the methodology, in particular(Bonwell&Eison, 1991;Bruffee, 1984):
- Problem solving and decision making;
- Participation in a debate;
- Participation in a discussion;
- Task-based learning.

Upon completion of the course, students are assigned with to prepare a model of the relationship "goals – learning resources – learning strategies", using the example of the implemented methodology at lesson level. The lesson titled

"Life in the Plains and Lowlands" (Naidenova*et al.*, 2014) is a part of the school subject "Human and Nature"  $-4^{th}$  grade. In this study, the degree of confidence of students is presented by matrix which consists of two components:

- 1) Individual student activity level during the "Ecological education" training course.
- 2) Self-assessment of student's confidence to prepare ofmodel "goals learning recourses learning strategies" at lesson level.

## 3. Results and Discussions

The development of scientific literacy in primary school children is a response to the changing realities in "human – nature" relationships since the beginning of the new century. The problem of the animal diversity should be placed on a preserving qualitatively basis new resources, equilibrium in nature and establishing a balanced relationship in order to maintain its unity and indivisibility (Golemanski, 2002; Sallisetal., 2006, Hagan & Whitman, 2006). Undoubtedly, education has an important role here – it is the "tool" to formation of a scientific literacy, by acquisition of science knowledge, forming of skills and attitudes that would allow future generations to solve environmental problems. It is about empowering individuals and increasing their capacity to transform social structures to a change that will create a sustainable society and future (Kopnina, 2012; Ferreira, 2009).

By the example of animal diversity, the scientific literacy of children refers to *understanding* of concepts as the basic elements of this knowledge, to *application* of knowledge in the study of problems in real life situations related to the environment, to *assessment* of the benefits of its utilization in terms of protection of environment and human health.

Therefore, future primary science teachers will have a regulatory and soldering role in implementing the overall educational process and, in particular to development of scientific literacy of primary school children."Ecological Education" is a course of Bachelor's degree programme "Preschool and School Education". The course is 30 hours, according to the Ordinance on the State Requirements for Higher Education and the Ordinance on the Application of Credit Accumulation and Transfer System in Higher Schools in Bulgaria. New syllabus was developed by the lecturer for the academic year 2016-2017. The syllabus includes ecological and professional-pedagogical training to prepare students as future primary teachers.

The ecological training is structured in the first part of the syllabus. Emphasis is placed on contemporary ecological issues, the solution of which requires the overcoming of consumer attitude towards nature in accordance with the principles of sustainable development. The knowledge "animal diversity" is analyzed through the prism of mutual influence and the unity of nature in its dimensions: living and non-living matter. The professional-pedagogical training of students is structured in the second part of the syllabus. Ecological knowledge, in particular "animal diversity" is presented as change students' attitudes towards the surrounding environment and its objective regularities.

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These trainings are the essence of students' professional competencies as future primary science teachers — i.e. scientific knowledge in their subjective form — the expedience, and objective content — the conditions and means. With this in mind, a methodology of "Ecological Education" course was developed and implemented for modeling the relation "goals — learning resources — learning strategies". The methodology is aimed at:

- Analysis of the goals (normative documents) regulating the science knowledge of animal diversity in primary school and development of scientific literacy in particular; the accent is put on the application of categorical apparatus of philosophy, logic, psychology, pedagogy, with a view toprecisely formulating the goals of process of science education in primary school at lesson level and a prognosis for their realization;
- Development of learning resources based on a critical analysis of the actual learning content (textbooks) in the "animal diversity" aspect and the subsequent selection and structuring of the knowledge; resources complement the learning content and are presented in the form of a theoretical-cognitive text to present basic notions, objective regularities, leading ideas, as well as instrumental-practical text, guiding to the used tasks, rules, principles in development of a literacy;
- Development of learning strategies, in particular innovative learning methods based on the constructivist approach to primary school learning inquiry-based learning, role-playing, experiments; the applied of these strategies is aimed at achieving better results of "animal diversity" knowledge acquisition, including by providing feedback in the "goals expected results" direction.

Regulatory role of new normative documents with different degrees of subordination is outlined in the methodology: Law on Pre-school and School Education, State Educational Standard for General Education, Educational Program of school subject "Human and Nature" – 4<sup>th</sup> grade, etc., referring to the mechanisms for learning science in primary school and development of scientific literacy among children.

The developed and implemented methodology correlates with the competencies of the future primary teachers to organize education in a way that influences the cognitive but also affective components of pupil's psyche and structure the whole block of his subjectivityin the formation of scientific literacy. Active and collaborative learning of students, in particular: problem solving and decision making, participation in a debate, participation in a discussion, Taskbased learning help students to identify environmental problems, evaluate problem-solving strategies and develop science-based solutions. Students able to demonstrate the ability to integrate and apply appropriate information from various sources to create important arguments. Active learning has a potential to build confidence and make students feel better through the applied methodology. Therefore, the active and collaborative learning influence students' confidence to transform scientific ecological knowledge into school one.

Why this it animportant? The available learning resources – textbooks and teaching aids on the school subject "Human

and Nature" – 4<sup>th</sup>grade, do not provide adequate professional decisions for teacher, according to the enforced changes in the normative framework for primary school science education and the development of scientific literacy.

The analysis of textbooks shows the predominant presence of separate, isolated facts that remain without consequence for knowledge acquisition (animal diversity included), mainly descriptive presentation of concepts and partly problems related to the disruption of environmental equilibrium and environmental protection. At the same time school aids / appliances do not provide an effective decision — learning strategies for knowledge acquisition and the development of children's scientific literacy.

The problems outlined require confidence of students as future primary science teachers for adequate, effective solutions aiming at science education in primary school. The level of student's confidence to transform scientific knowledge into school one is illustrated by the following matrix – Table 1.

In the analysis of the component "Individual student activity level", based on a Structured observation, a four-step rating scale from 4 to 0 was applied, in which each of the variants of activity participates equally with the other variants because it is aimed to prepare a model in its entirety. A Structured observation schedule was used: student to student, student to students, student to lecturer, students to lecturer, lecturer to student, lecturer to students, student to self (Cohen et al., 2007: 399).

**Table 1:** Matrix for determination of the degree student's confidence

confidence	
Components of a student's confidence	Model of the
	relationship "goals –
	learning resources –
	learning strategies"
1. An individualstudent activity level during the course training "Ecological education" (active and collaborative learning)	Student activity
<ul> <li>problem solving and decision making</li> <li>participation in a debate</li> <li>participation in a discussion</li> <li>Task-based learning</li> </ul>	
2.Self-assessment of student's confidence based on a model "goals – learning recourses – learning strategies".	Level of student's confidence
<ul><li> goals</li><li> learning resources</li><li> learning strategies</li></ul>	

The maximum level of activity of the student, determined by problem solving and decision making, participation in a debate, participation in a discussion and Task-based learning, is rated with 4; respectively  $\theta$  indicates the absence of any activity by the student during the training course. The survey results are based on a sample of 25 students.

The distribution of the students by activity level shows the following results: 15 of all students have a maximum level of activity 4 on the four-step rating scale, which means that they have been involved in all the above-mentioned

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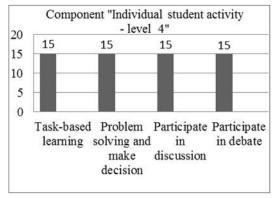
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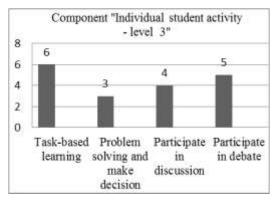
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activities: problem solving and decision making, participation in a debate, participation in a discussion and Task-based learning – Figure 1.

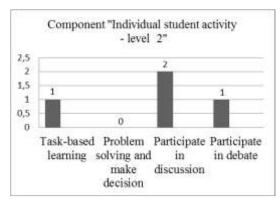


**Figure 1:** Distribution of students by component "Individual student activity level 4"

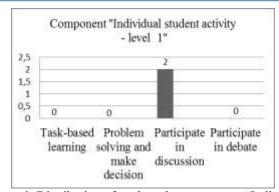
Six other students have a level of activity 3, all of whom have taken part in Task-based training, but with three of them problem solving and decision making was not provided, two students have not taken part in the discussion, and one student have not taken part in the debate – Figure 2. The remaining 4 students are distributed as follows – 2 of them the level of activity is 2, 1 of them has taken part in the debate and discussion, the other – in the discussion and Task-based learning. For the other 2 students, the level of activity is a minimum, i.e. I – in both cases based on activity only during the discussion – Figure 3, Figure 4.



**Figure 2:** Distribution of students by component "Individual student activity level 3"



**Figure 3:** Distribution of students by component "Individual student activity level 2"



**Figure 4:** Distribution of students by component "Individual student activity level 1"

The analysis of component "An individual student's activity level during the course training "Ecological education" (active and collaborative learning)" shows that 22 students have varying degrees of activity –15 of them have a maximum level of activityi.e. 4, and for the other 2 students, the level of activity is a minimum, i.e. 1.

Using the example of the applied methodology by the lecturer, students are assigned to prepare a model of the relationship "goals - learning resources - learning strategies" in the lesson "Life in the Plains and Lowlands". Following the algorithm of the methodology, students first of all have to be confident in formulating goals. This implies that they should be able to analyze basic normative documents regulating the science education in primary school, includingLaw on Pre-school and School Education, State Educational Standard for General Education, School programme "Human and Nature", 4th grade. The formulation of lesson's goals "Life in the Plains and Lowlands" requires the application of the categorical apparatus of philosophy, logic, psychology and pedagogy. On this basis, students should be able to predict, plan and foresee possible ways to realize the stated objectives.

In regard to learning recourses, students have to make a comparative analysis of the current learning content included in the lesson "Life in the Plains and Lowlands" and the additional literary sources provided by the lecturer. The implementation of this analysis requires an adequate structuring of the "animal diversity" knowledge as a theoretical-cognitive text. The text should contain the basic concepts — *insects, amphibians, reptiles, birds, mammals* and also the leading ideas and regularities for knowledge acquisition.

The learning strategies proposed by the students have to respond to the philosophy of constructivism – the child in 4<sup>th</sup> grade shall construct knowledge, discovering the world around him. The choice of interactive methods should be aimed at the affirmation of the non-traditional thinking and breaking the stereotypes in knowledge acquisition in order to overcome the theoretical, descriptive presentation of facts, notions, processes, phenomena. Consistent with the development of scientific literacy, learning strategies should also provide effective feedback in the meaning of the "goals – expected results" relations.

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To determine students' confidence regarding the second component: Self-assessment of student's confidence to prepare a model "goals – learning recourses – learning strategies" at lesson level, a Self-assessment questionnaire for student's confidence level was elaborated and implemented. The Questionnaireincludes8 items that students should answer, covering different aspects of confidence in a four-step scale from excellent to insufficientlevel of confidence. The students were asked to rate their confidence using the following categories:

#### 1. "Excellent" level of confidence:

"I am fully confident in the modeling, including in each of its elements – analysis and formulation of goals, preparation of learning resources and learning strategies.

- 2. "Very good" level of confidence:
- 2.1. "I am confident in the modeling in its entirety, but I am not certain enough about the formulation of goals"
- 2.2. "I am confident in the modeling in its entirety, but I am not certain enough about the preparation of learning resources".
- 2.3. "I am confident in the modeling in its entirety, but I am not certain enough about the preparation of learning strategies.
- 3. "Good" level of confidence:
- 3.1. "I am confident in the modeling in its entirety, but I am not certain enough about the formulation of goals and preparation of learning resources".
- 3.2. "I am confident in the modeling in its entirety, but I am not certain enough about the formulation of goals and preparation of learning strategies"
- 3.3. "I am confident in the modeling in its entirety, but I am not certain enough about the preparation of learning resources and learning strategies".
- 4. "Insufficient" level of confidence:
- "I am not confident in the modeling in its entirety, in particular in formulation of goals, preparation of learning resources and learning strategies".

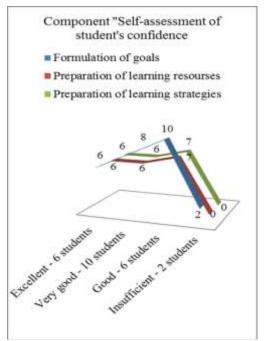


Figure 5: Distribution of students by component "Self-assessment of student's confidence"

Figure 5 shows the distribution of the students under the component "Self-assessment ofstudent's confidence based on their model". Of the total number of participants in the study, 6 students have "Excellent" level of confidence. They are fully confident in the modeling, including in each of its elements – analysis and formulation of goals, preparation of learning resources and learning strategies. The students, who have "Very good" level of confidence are 10. These students feel confident in the modeling in its entirety, but 2 of them are not enough sure in formulation of goals, 4 of them are not certain enough about the preparation of learning resources, 4 other students are not certain enough about the preparation of learning strategies.

The remaining students are distributed as follows – for 6 of them the *level of confidence is "Good"*. These students feel confident in the modeling in its entirety, but 1 student not certain enough about the formulation of goals and preparation of learning resources, 1 student not certain enough about the formulation of goals and preparation of learning strategies, and 4 other students not certain enough about the preparation of learning resources and learning strategies.

Finally, according to the results, 3 students feel "Insufficient" confident. They are not confident in the modeling in its entirety, including in preparation of learning resources and learning strategies. Only 2 of them feel confident in formulation of goals, but this is not enough for teaching science in primary school at lesson level and the development of scientific literacy.

The analysis of component "Self-assessment of student's confidence" shows that 22 students feel confidento transform scientific ecological knowledge "animal diversity" into school knowledge in varying degree. These students feel confident in formulation of goals, preparation of learning recourses (learning content) and preparing of learning strategies – in terms of applying interactive methods of justifying their choice of knowledge acquisition, in particular for understanding the notions of *insects*, *amphibians*, *reptiles*, *birds*, *mammals*, for evaluate the benefits of acquiring this knowledge, as well as its application in real life situations and the development of scientific literacy.

Simultaneously, the formation of these professional competencies of students as future primary teachers is necessary and especially valuable because it is aimed at overcoming the existing disadvantages in practice. The deficiencies in the learning resources (learning content) and the missing learning strategies do not imply the fulfillment of the normatively set objectives of science education in primary school and the development of scientific literacy of children in particular.

## 5. Conclusion

The expectations of science education to stimulate child's development by supporting and encouraging his efforts to think in a complex way, to discover, formulate and study solutions to problems in the surrounding environment are

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proverbial. Redefining the priorities in primary schooling today implies the creation of an effective learning environment — logical and consistent in terms of expectations and realities. Undisputed here is the role of the professionally competent future teacher, but above all, this means that he should have a reliable educational product to ensure access to high-quality opportunities and services. Future efforts of all those on the side of primary school can be directed precisely in this direction — the care and sharing of the teacher's necessity of understanding and more pragmatism in partnering with him.

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