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Didactic strategies in early science teaching

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The purpose of the article is to show the results of empirical research on the prevailing teaching strategies for teaching contents of the subject environmental studies (specifically when dealing with natural content) in the first triennium of the nine-year primary school in the Republic of Slovenia. The information was obtained through a survey of 141 teachers from 60 randomly selected primary schools in the Republic of Slovenia. We found that teachers use different teaching strategies as students gain knowledge through experience, participation in education, they express their opinion, views, solve simple problems and explore. Such notice shall then direct the transmissions to the transaction and transformation, which was an important objective of the reform of the subject.

Keywords: primary education; environmental studies; teachers and learning

Introduction

The subject environmental studies developed through the Elementary School Curricular Reform (1996) in the Republic of Slovenia and has replaced the subject natural and social studies, which was part of the Program življenja in dela osnovne šole (1984).

The purpose of environmental studies, which is taught in the first triennium of the nine-year elementary school system, is to show the complexity, variety and intertwining factors which are present in the human, natural and social environment. It includes elements from different scientific fields – natural, technical and humanistic.

Environmental studies consists of 315 hours in the first triennium; altogether there are 105 hours in a school year; three hours per week and three days of activity (three times for four hours) annually (Curriculum 1998, 5).

The subject matter is divided into 11 units connected in terms of contents and goals, which have been progressively structured from one school year to another. These units are: "who I am", "you and me", "you and us", "my school and me", "we celebrate", "my past", "it was once", "nature and me", "health and me", "I look around" and "what I can do".

Participation of students as well as experience gained by the pupils are taken into consideration (Kron 1994; Blažič et al. 2003). These are characteristics of an open class(room) as environmental studies classes present a continuation in the direction of the child's spontaneous exploration of the world and the discovery of phenomena and processes being co-dependent and intertwined in the natural and social environment.

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The knowledge gained through direct experience in the environment or through the media is expanded and deepened during classes (Curriculum 1998, 5).

This kind of lesson can be realised with the help of different modern didactic strategies that have a common denominator – the open lesson. For this kind of lesson it is typical that we do not cling onto the teaching goals, study contents and methods but rather adjust to the pupils' interests and abilities, and that we create conditions for the participation of the students during lessons, take into account already acquired experiences of the students, etc. (Kron 1994; Blažič et al. 2003). These characteristics of open classes can be seen at research, project and problem lessons, behaviour (work)-orientated lessons, an experience-orientated lesson and a team lesson.

A research lesson is one thought of as a special strategy of scientific comprehension, which brings elements of scientific comprehension into lessons. The main intention of this kind of lesson is not to inform but to qualify the pupils for searching and discovering new things. It stimulates different ways of thinking, experiencing, motivating and also creativity in the students. This kind of lesson is about simulation of scientific research. Pupils are placed in the role of the researcher who studies and seeks answers to complex questions in didactic situations. Most often we use research lessons in choosing the problem. Through research pupils gain new knowledge they obtain on their own. They discover what they did not know before, it gives them pleasure and it works as stimulation for further work. This way of working gives teachers a chance to get to know the pupils better, it develops cooperation among the pupils and contents from different fields are connected. Learning at school offers a lot of research possibilities; they have to be adjusted according to the age of the pupils. It is important that we encourage pupils to observe systematically, collecting and sorting experiences, setting and verifying hypotheses and distinguishing between observable facts and conclusions (Cencič and Cencič 2002). Organising study lessons can be a part of regular classes or may take place within different extracurricular activities.

In project lessons pupils and teachers jointly recognise and deal with some rounded up, usually interdisciplinary learning topics as a project. Besides acquiring new knowledge in these lessons, the emphasis is also on motivation, acquiring practical knowledge and developing social learning (Henry 1999). Project lessons are also present in our school practice. We can include elements of project lessons in our regular lessons, but most often they occur outside regular lessons.

Problem lessons are oriented towards solving different problems, whether they are simple or slightly more complicated. The starting point of this kind of class is a problem situation that is presented in the form of a problem or different questions and tasks. This functions as motivation among pupils and leads them towards achieving didactic goals. High cognitive concentration is present in the pupils, combining prior knowledge and thinking that lead to developing creative thinking, being critical, and divergence. Problem lessons motivate pupils to connect prior knowledge with new knowledge. It is important that we evoke in the consciousness the experiences and the knowledge of a certain problem. Then the pupils seek answers, data, make conclusions and set the hypotheses. The teacher, however, leads the conversation, explains, demonstrates, and the pupils gain new knowledge with mental activity (Cencič and Cencić 2002). Yet in problem lessons it is necessary to consider the pupils' ability, that it does not come to an irrational "running around in circles" (Blažič et al. 2003). Problem lessons, which direct the pupils to seek the core and principles rather than demand of them to learn data and facts, require a different articulation of classes.

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A behaviour (work)-oriented lesson is an upgrade of the work lesson that was limited to the work in school gardens, orchards and school workshops. The extent of this kind of lessons has expanded to creating different models, preparing different collections, exhibitions, organising shows, working in the library, the computer room, etc. The result of this kind of lesson is not only theoretical knowledge but also useful knowledge and a connection between theoretical and practical knowledge. Work-orientated lessons in this day and age serve mainly for a higher-quality recognition of the subject or phenomenon. Pupils work individually, in pairs or in groups, and the teachers guide them. Social relations among pupils and between pupils and teachers become richer (Blažič et al. 2003).

Experience-orientated lessons are based on the important role of experience in classes. The experience symbolises some prior activity and its meaning: not just passive memory but also an important orientation in the present and future, and it stands for a conscious base of learning. Experience learning tries to connect direct experience, observation, recognition and acting in an inseparable whole. Experience-orientated lessons enable pupils to gain their own experience during lessons that help them in understanding the study content or gaining knowledge and that they know and can manage to confront these experiences in classes, with pupils and teachers. When it comes to experience in terms of the lesson strategy, we bear in mind particularly the pupils' prior knowledge, which enables them to pay attention to classes more easily or to learn better on their own.

Team lessons are more or less about close cooperation of two or more teachers. We can talk about two forms of team lessons (Blažič et al. 2003). In coordinated team lessons there is only one teacher who bears the main responsibility and coordinates the work of other teachers. In associated team lessons there is a closer connection and cooperation between teachers. It is all about common planning and conducting the classes and with it the division of responsibility. This kind of lesson can become more flexible, can enable better communication inside the classroom, can provide a more complete viewpoint on the study content, can have an important impact on the co-operational culture, and reflective teaching can be intensified (Polak 2004). In the first year of the nine-year elementary school system, where there is often co-operation between the teacher and the educator, we can talk of associated team lessons. Conducting the team lessons is not only linked to the first year of the nine-year elementary school system but also, in conducting the classes, teachers of related subjects can be joined together with purpose, that the pupils get a more complete and deeper knowledge.

Within the presented strategies, there is much more seeking and discovering, more life-like didactic situations are present; it is not only goals that are important but also the processes that lead the pupils, all geared towards the desired results. The centre of the didactic work is not in the direct presentation of the study content but in re-establishing the conditions for direct contact of pupils with the didactic reality in order to get to know it better on their own (Blažič et al. 2003). If we analyse the syllabus for environmental studies, we learn that the way of work in this subject presupposes precisely this kind of approach.

The key starting point of this research work presents the studying of lessons in environmental studies, especially from the point of view of how frequently individual didactic strategies are used.

We wanted to know which didactic strategies teachers carry out during these lessons and how often they practise them. Furthermore, we were interested to find out

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if there are statistically significant differences among teachers as far as the use of individual didactic strategies is concerned according to the period of time (cycle) when a particular school started with the nine-year school system.

This article focuses on the presentation of the following three topic units: "nature and me", "health and me" and "what I can do". Our assumption was that teachers during environmental studies practise didactic strategies which most frequently and eventually lead to an open lesson.

Methodology of research

Key research method

Descriptive and causal non-experimental methods of pedagogical research were used during research work.

Definition of a sample

In the sample, teachers (male and female) were included who teach in the first triennium of a nine-year elementary school system and have entered the programme either in the first cycle (49 teachers, 34.7%), second cycle (51 teachers, 36.2%) or third cycle (41 teachers, 29.08%).

The research involved 48 (34.04%) teachers who teach in the first class, 43 (30.50%) teachers who teach in the second class of a nine-year school system, 42 (29.79%) teachers who teach in the third class and 8 (5.67%) teachers who teach a combined class.

Teachers participating in the research have the appropriate level of education, the majority (86.53%) of teachers participating in the research have been promoted to a new title and 95 (67.37%) teachers have more than 10 years of seniority.

The process of data collecting and processing

Data were collected through an anonymous questionnaire for teachers. From the list of schools carrying out the nine-year elementary school programme, we randomly chose 20 elementary schools from each cycle (first, second and third), 60 elementary schools in the Republic of Slovenia altogether. Three questionnaires were sent to each school and the headmasters were asked to distribute them among teachers who teach in the first, second and the third class. Altogether 180 questionnaires were distributed and 141 (78.33%) questionnaires came back. The questionnaire for teachers included general data about an individual and a set (six) of four-level descriptive assessment scales where teachers were asked about the use of various didactic strategies connected with individual topic units in environmental studies. The data were statistically processed following the basic descriptive and inferential (Kruskal–Wallis test) statistics where descriptively expressed scales were pondered with values 4 (always), 3 (often), 2 (sometimes) and 1 (never).

The results and interpretation

Didactic strategies used in the unit "nature and me"

The unit "nature and me" is conducted in the first, second and third year of the nine-year elementary school system.

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An analysis of examples of activities defined in the syllabus (Curriculum 1998) reminds us that the focus of the work in this unit is on observing (e.g. pictures and movies of plants and animals, of themselves and of other living beings in different activities, animal cubs, whole and damaged plants and fruits, etc.), searching, discovering, describing (e.g. external parts of their bodies, animals, plants, etc.), imitating (e.g. animals), experimenting (harmless experimenting with plants and animals in farms), collecting (e.g. of data about living beings, their way of life, etc.), sorting (e.g. of collections of leaves, fruits, etc.), comparing (e.g. of vital needs of plants and animals in different environments) and talking (e.g. about plants and animals that they have at home, about air pollution, possible consequences of the changing human environment, etc.).

Special didactic recommendations direct the teacher to consider experience and prior knowledge of the pupils while conducting lessons. While discussing the content, the teacher should derive from the environment close to the pupil (school vicinity), and then all those environments in the broader vicinity, that expand and deepen the knowledge of the pupil, should be included.

An analysis of these recommendations shows that in this unit the following didactic strategies are emphasised: experiential lessons, behaviour (work)-oriented lessons and elements of project, problem, research and team lessons (Table 1).

In the unit "nature and me" the teachers most often conduct experiential lessons, which are followed by the project and work lessons. There are fewer problem and research lessons here, and least of all, team lessons. It turns out that the teachers follow the special didactic recommendations while conducting lessons in this unit.

The differences in conducting the classes within this unit from the didactic strategies' point of view regarding the period of entering the nine-year elementary school system can be observed in Table 2.

The results of the applied non-parametrical test show that there are no statistically significant differences among teachers regarding the period of entering the nine-year elementary school system in conducting different didactic strategies in this unit. Yet the data remind us that active learning in classes based on the experiences of the pupils and concrete life circumstances is extremely important. The pupils thus discover knowledge on their own, they experience the dynamic process of knowledge taking shape, they rehearse mental skills, and the teachers' duty is to make them aware of these processes and to maintain the natural curiosity among the pupils.

A class organised this way is about a great number of logical interactions between the teachers and the pupils and among pupils themselves. A lesson planned and

Table 1. Ordered series of didactic strategies according to average frequency ($\bar{x}$).

Ordered series	Didactic strategies	$\bar{x}$
1	Experience-oriented lesson	3.886
2	Project lesson	3.482
3	Working lesson[a]	3.362
4	Problem lesson	3.355
5	Research lesson	3.126
6	Team lesson	2.369

Note: [a]The term 'working lesson' will be used in the tables for what we refer to as behaviour(work)-oriented lesson.

Table 2. The results of Kruskal–Wallis test for differences among teachers according to the period of entering a nine-year school system as far as the frequency of carrying out individual didactic strategies in the unit "nature and me" is concerned.

Didactic strategies	Cycle	Average ordered series ($\bar{R}$)	χ^2	g	$\alpha = P$
Team lesson	First	70.40	0.158	2	0.924
	Second	69.94			
	Third	73.04			
Project lesson	First	68.05	0.657	2	0.720
	Second	71.26			
	Third	74.20			
Problem lesson	First	74.87	1.00	2	0.607
	Second	70.19			
	Third	67.39			
Research lesson	First	72.93	0.926	2	0.629
	Second	72.85			
	Third	66.39			
Working lesson	First	63.97	2.855	2	0.240
	Second	76.08			
	Third	73.09			
Experience-oriented lesson	First	70.71	4.376	2	0.112
	Second	67.02			
	Third	76.29			

conducted in this manner can also cause changes in the concept of knowledge, where the traditional concept of knowledge, characterised by passivity, being static, vagueness of notions, gives way to the modern way, marked by pupils' activities, the dynamic process of comprehension and the connecting of theory with practice (Votilainen, Mehtaelaeinen, and Niiniluoto 1990).

Didactic strategies in the unit "health and me"

The unit "health and me" is conducted in the first, second and third year of the nine-year elementary school system.

The analysis of the examples of activity defined in the syllabus (Curriculum 1998) demonstrates that the focus of the work in this unit is on conversation (e.g. about health, diseases that the pupils have already had, nutrition), observing (e.g. tiny creatures under the magnifying glass), preparing (e.g. social meetings, snacks), adjusting to certain behavioural patterns (e.g. while eating, taking care of health) and simple experimenting.

Special didactic recommendations for the teacher are that classes should be organised in such a way that the pupils have clear perceptions and ideas about the discussed content (e.g. they observe microbes through magnifying lenses) in order to form an attitude towards a healthy lifestyle and that they can recognise some signs of illness.

The analysis of these recommendations shows that in this unit mainly experiential lessons are highly emphasised, which guide the pupils to deepen their own experiences

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Table 3. Ordered series of didactic strategies according to average frequency ($\bar{x}$).

Ordered series	Didactic strategies	$\bar{x}$
1	Experience-oriented lesson	3.886
2	Project lesson	3.482
3	Working lesson	3.319
4	Problem lesson	3.000
5	Research lesson	2.865
6	Team lesson	2.277

through contact with the teaching reality, and that with the support of the teacher, the pupils and other people form their own opinions about the discussed phenomena. The elements of other didactic strategies are also present, for example, behaviour-orientated lessons, project lessons (Table 3).

In the unit "health and me" the teachers most often conduct experiential lessons, followed by work and project lessons. There are fewer problem and research lessons present, especially team lessons. It can be seen that the teachers follow the special didactic recommendations while conducting lessons in this unit. The differences in conducting the classes within this unit from the didactic strategies point of view with respect to the period of entering the nine-year elementary school system can be seen in Table 4.

Table 4. The results of the Kruskal–Wallis test for differences among teachers according to the period of entering a nine-year school system as far as the frequency of carrying out individual didactic strategies in the unit "health and me" is concerned.

Didactic strategies	Cycle	Average ordered series ($\bar{R}$)	χ^2	g	$\alpha = P$
Team lesson	First	72.01	0.114	2	0.944
	Second	69.53			
	Third	71.62			
Project lesson	First	61.88	4.815	2	0.090
	Second	74.05			
	Third	78.11			
Problem lesson	First	75.69	2.574	2	0.276
	Second	72.13			
	Third	63.99			
Research lesson	First	71.50	0.269	2	0.874
	Second	68.96			
	Third	72.94			
Working lesson	First	71.45	0.012	2	0.994
	Second	70.75			
	Third	70.77			
Experience-oriented lesson	First	70.37	2.680	2	0.262
	Second	67.94			
	Third	75.56			

The results of the applied non-parametrical test show that there are no statistically significant differences among teachers regarding the period of entering the nine-year elementary school system (cycle) in conducting different didactic strategies in the unit "health and me". The established tendency ($P = 0.090$) raises attention in the case of project lessons – it is more frequent in the third cycle than in the second and the first one.

On the bases of the data it is possible to conclude that different didactic strategies are present in the lessons of this unit and with this a variety of approaches, forms and methods of work, which according to Meyer (1996) lead to more variegated and efficient lessons. This way of discussing study contents creates a broader reference frame in the pupils, a sense of connection and progress of the discussed content, variability of knowledge and its different perspectives (Plut Pregelj 2000). Behaviour (work)-orientated lessons are also important in carrying out this unit due to their important connections in relations such as skills–knowledge, experiences–thinking; or in other words it is about close connections between theory and practice.

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Didactic strategies in the unit "what I can do"

The unit "what I can do" is conducted in the first, second and third year of the nine-year elementary school system.

The analysis of the examples of activities defined in the syllabus (Curriculum 1998) shows that the focus of the work in this unit is on observing (e.g. movement of the celestial bodies, falling of leaves, etc.), describing (e.g. weather conditions, drying fruit, etc.) cognition, classification and comparison (e.g. of different substances, etc.), cutting and making products from paper material (e.g. traffic signs, ornaments, etc.), realisation of different visits and viewings (e.g. visit to a library, viewing of how to borrow a book, etc.), preparing different experiments (e.g. air movement) and preparing various products (e.g. a histogram, table, etc.).

Special didactic recommendations guide the teacher to organise and to conduct research and experiments during lessons where pupils can experience more research procedures. While conducting the lessons, the teacher should consider the pupils' prior knowledge, their experience and guide them to preparing the product.

The analysis of these recommendations shows that in this unit the following didactic strategies are emphasised: research, problem, project, team and experiential lessons and behaviour-orientated lessons (Table 5).

In the unit "what I can do" the teachers most frequently conduct experiential lessons, followed by work and project lessons. There are fewer problem and research

Table 5. Ordered series of didactic strategies according to average frequency ($\bar{x}$).

Ordered series	Didactic strategies	$\bar{x}$
1	Experience-oriented lesson	3.872
2	Working lesson	3.425
3	Project lesson	3.361
4	Problem lesson	3.121
5	Research lesson	3.085
6	Team lesson	2.326

lessons, especially team lessons. It can be seen that the teachers follow the special didactic recommendations while conducting lessons in this unit.

The differences in conducting the classes within this unit from the didactic strategies point of view with respect to the period of entering the nine-year elementary school system can be seen in Table 6.

The results of the applied non-parametrical test show that there are no statistically significant differences among teachers regarding the period of entering the nine-year elementary school system (cycle) in conducting different didactic strategies in this unit. If we analyse the didactic recommendations defined in the syllabus for environmental studies, and the frequency of usage of different didactic strategies in this unit, we can establish that the basis of these strategies was both the pupil's and the teacher's activity.

All three types of learning activities have been importantly interwoven and supplemented, namely the motor, the emotional–experiential and the cognitive ones. Teaching and learning organised in this manner is most successful if both the pupil's and the teacher's personalities are engaged and if all of their basic psychophysical capabilities are optimally activated (Blažič et al. 2003).

The data acquired in this research do not allow us to establish and conclude with certainty whether the pupils are adequately aware of the fact that they have learned something or that they could first go from (the) manual through expressing what they have done to thinking about how they did it and to evaluate this. Modesty of awareness of the pupil's activity in the lessons (Hus 2004), despite the teacher's engagement

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Table 6. The results of the Kruskal–Wallis test for the differences among teachers according to the period of entering a nine-year school system as far as the frequency of carrying out individual didactic strategies in the unit "what I can do" is concerned.

Didactic strategies	Cycle	Average ordered series ($\bar{R}$)	χ^2	g	$\alpha = P$
Team lesson	First	71.04	0.051	2	0.975
	Second	70.16			
	Third	72.00			
Project lesson	First	65.78	1.513	2	0.469
	Second	73.73			
	Third	73.85			
Problem lesson	First	74.01	1.438	2	0.487
	Second	72.77			
	Third	65.20			
Research lesson	First	73.08	0.876	2	0.645
	Second	72.72			
	Third	66.38			
Working lesson	First	75.68	2.424	2	0.298
	Second	64.80			
	Third	73.11			
Experience-oriented lesson	First	70.43	2.499	2	0.287
	Second	68.02			
	Third	75.39			

by using different didactic strategies, could prove to be a deficit in conducting lessons which cannot contribute to more quality lessons.

Conclusion

The results of the research work show that during the environmental studies classes teachers carry out various didactic strategies, which are quite common for a lesson (in the area of always and often).

It is only the team lesson that occurs sometimes, which is expected since it is mainly carried out in the first grade of the nine-year elementary school system. The frequency of use of individual didactic strategies is, in most cases, not dependent on the period of time when a school started with the nine-year school system.

It can be concluded that environmental studies has the characteristics of an open lesson since pupils gain knowledge through experience, they take active part in the lesson, they express their opinions, views, solve simple problems and explore. This kind of lesson is directed from transmission to transaction and transformation, and these are lesson characteristics typical of the nine-year elementary school system (Ivanuš Grmek 2004; Hus et al. 2005). This kind of approach in the implementation of lessons could affect the motivation of pupils for the learning process as well as the pupils' knowledge. We should ask ourselves if this is really the case. If we compare the results of the TIMSS 2003 research, we can see that our younger pupils came 21st among 29 countries and school systems in knowledge of natural sciences and that they scored an average of 490 points, which was one point higher than the international average (Martin et al. 2003). So, the result was an average one. Forty-six percent of Slovenia's pupils claim that they like to study science very much, which is below the international average, although we could state that regardless of the relative proportion of the answers, Slovene pupils are still more motivated than not for learning science. The Slovene pupils with a relatively high motivation for learning, however, achieve average results (Kolenc 2005).

Based on the results of our research we can conclude that pupils are taught in a way that could make them gain more thorough knowledge. Is transmission therefore also necessary in classes? If it is clear that in terms of theoretical musing a teacher in the role of a carrier is also important in the modern models of classes (Valenčič Zuljan 2004), then it appears that the perception of the teachers is somewhat different in practice. We should probably focus on the changed role of the teacher in modern models of classes in qualifying the present teachers as well as the future ones (Lesar, Čuk, and Peček 2005).

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