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# Analysis of the Implementation of Practical Work in the Area of Early Science Education of Primary School Pupils in the Republic of Slovenia

## Abstract

The article presents the results of a comprehensive study (N = 497) among Slovene primary school teachers with the aim of examining practical work in Primary Science courses (age 9-11). The study examined the attitude towards practical work and obstacles. The aim was also to find out whether the level of socio-economic development impacts on attitudes and obstacles. The main obstacles to the implementation of practical work at class level are: lack of material support, oversized classes, poor spatial conditions and a need for assistants. Surprising results followed an analysis of differences in the development of the environment: primary school teachers from less developed regions show a more positive attitude towards practical work compared to those from more developed regions. In addition, obstacles are perceived similarly regardless of the socio-economic situation.

**Keywords:** *Primary Science, didactics, material conditions, practical work, primary school general teacher, impact of regional development*

## Introduction

*The Primary Science* course is taught for two consecutive school years (age 10-11). The *Primary Science* course partly upgrades the *Learning about the Environment* course from the first educational cycle (age 5-9). The *Primary science* course continues with the *Technical Sciences and Technology* course in grades 6, 7 and 8 (age 12-15), *Natural Science* in grades 6 and 7, *Housekeeping* in grades 5 and 6, and

*Biology*, *Chemistry* and *Physics* (in grades 8 and 9). As in most European countries (Dow, 2006), the *Primary Science* course aims towards developing and upgrading basic knowledge, skills and attitudes in the area of the natural and technical sciences. These classes allow pupils to use their knowledge and skills in the natural and technical sciences for understanding, explaining and solving various situations and questions in the area of the natural and technical sciences. Genuine modernization of the teaching of *Primary Science* at the class level in Slovenia began in the 1990s, with the "Early Teaching of the Natural Sciences" Tempus-Phare project.

The syllabus encourages research-based learning in pupils and practical work. The importance of practical work in research-based learning has been highlighted by numerous international authors (e.g., Duschl et al., 2007; Bennett, 2003; Peters et al., S., 2002; Monk and Osborne, 2000; Murphy and Beggs, 2005; Taber, 2007; Duschl, et al., 2007; Osborne and Dillon, 2010), who all point out that practical work facilitates pupil development in various areas: socialization and acquisition of scientific language as well as the use of scientific methods and aids. Studies (Bennett, 2003; Pell and Jarvis, 2001) in the area of the pupil's attitude towards the *Primary Science* course (Gibson, 2009) have shown a strong connection between a positive attitude and satisfaction with the natural sciences and technology as a whole and practical work. So far, we have not had cases where pupils could choose between different learning resources depending on their learning style (Hill, Smith, 2005), including the material for practical work.

Teaching materials comprise the following three areas: (1) textbooks, workbooks, (2) teacher's books and other resources and (3) material in the sense of the following two main concepts: matter and objects (Chatoney, 2006). The teacher's book should also serve as a collection of ideas for research activities (Appleton, 2002). Many international researchers (e.g., Taber, 2009; Preparing Teachers: Building Evidence for Sound Policy, 2010; Kelly et al., 2000; Palmer, 2006) emphasize that the available teaching material should support research-based teaching and learning strategies only in those teachers who are generally highly qualified for the course and vice-versa (Bandura, 2000; Bell, 1999; Key, 1998; Swafford et. al., 1999; Murphy & Neil, 2007; Hipkins & Barker, 2005). Additional studies (Appleton, 2003; Hunt & Appleton, 2003; Kruger and Summers, 2000) stress the need for professional training following changes to syllabi and introduction of new manuals, textbooks and aids. Some publishers (US in particular) provide complete sets that include materials recommended by the teacher's book. A set of materials such as *Science and Technology for Children* (National Science Resources Centre, 2002; Kimble, 2006) also provides many teaching methodology ideas for teachers and other knowledge resources. Many studies (e.g., Appleton, 2002; Appleton and Asoko, 1996; L.D. Newton et al.; 2002; Peacock and Gates, 2000) mention teacher autonomy in choosing materials for teaching *Primary Science* in lower grades. Equally important is the preparation of future teachers for the research-based approach (Abell, et al., 2010; Fošnarič et al., 2007; Bencze, 2010), where the importance of practical work and a research-oriented study environment is emphasized (Mance, 2008; Osborne and Dilon, 2010; Taber, 2007). It is particularly important to pay attention to those students, future teachers, who have insufficient or even negative experience from their school days in lower grades (Jarvis and Pell, 2004). It is hard to judge and compare the amount of practical work in lower grades in *Primary Science* in Slovenia compared to other international curricula. We need to keep in mind (Hayes and Deyhle, 2001) that the social environment has a relatively strong influence on science and technology education in terms of teaching, learning and available resources.

## Research Aim

The aim of the empirical part was to analyze the attitude and assess the perception of obstacles among 4$^{th}$ and 5$^{th}$ grade (age 9-11) teachers towards the practical work method in primary science classes after the latest large-scale renewal of curricula. We were also interested in the existence of differences relative to the economic and social development of the environment. For economic and social development of the environment we used objective indicators of development risk of two cohesion regions (*Eastern Slovenia, Western Slovenia*) (The Classification of Territorial Units for Statistics, NUTS 2[1], 2007). The development risk index in Eastern Slovenia is higher (127.00) than in Western Slovenia (73.00)[2].

The survey represents clues for the design of an effective model of teacher training.

1 In accordance with the modification of the NUTS Regulation (2008), the territory of Slovenia is divided into two cohesion regions, Eastern Slovenia and Western Slovenia, and 12 statistical regions.

Development risk index comprises the following: gross domestic product per resident, gross added value per employee, gross income tax basis per resident and the number of work places per number of active population, population aging index, registered unemployment level and employment level, average number of years of education, development of communal infrastructure, area share and inhabitation indicator.

2 Operative program for strengthening regional development potential for 2007-2013; 2006

## Methods

The survey comprised 497 general primary school teachers from two differently socio-economically developed (cohesion) regions. The number of teachers in both groups is an appropriate proportion of the total population. The average age of teachers was 41. On average, they had 19 years of work experience. More than a half of the teachers had university degrees (56.3%), others (43.5%) professional college degrees. Study programs for general primary school teachers were upgraded from the professional college level to university level in 1989. The data was obtained with a survey that was sent to the heads of regional units of the Slovenian National Education Institute. They, in turn, asked the teachers to fill out the questionnaires during the 2nd VIO (age 9-12) professional meeting of teachers. The questionnaire comprised closed-type questions with scaled and verbal answers.

*Validity* – A pretest survey was carried out at the primary school where the author of the presented paper teaches. The next test survey took place on a sample of 46 teachers from the Savinjska region. The questionnaire did not have to undergo much change or modification after pretest measurement and subsequent remarks.

*Reliability* – Reliability of the questionnaire was ensured with detailed instructions and questions that were unambiguous and sufficiently specific.

*Objectivity* – objectivity at the implementation stage was ensured with unified, unambiguous instructions that the teachers followed individually, while filling out the questionnaire. Objectivity at the surveying stage was ensured by using scaled answers that exclude the possibility that subjective judgment would change information.

We processed the data at the level of descriptive statistics with respect to the following items: frequency distribution of variables (f, f%), arithmetic mean ($\bar{x}$), standard deviation (s), coefficient of variation (VC%), SKEWNESS and KURTOSIS coefficient (FC) and inferential statistics, Mann-Whitney test for verifying differences in teachers' attitudes with respect to statistical regions; variance analysis for independent samples for verifying differences in the general attitude between statistical regions and in the overall result of measuring obstacles and a t-test for independent samples for verifying differences between the two cohesion regions in the general attitude and the overall result of measuring obstacles; $\mathcal{X}2$-test for analyzing frequencies of non-numerical variables.

## Research Results

The questionnaire comprised seven attitudes to practical work (five positive and two negative):

S1: Experimental work is in the process of research, an important component in achieving the objectives. S2: The teacher should encourage students to plan experiments. S3: The teacher alone (without the inclusion of students) chooses facilities for experimental work. S4: In the experimental part it is necessary to use a research method. Students at this stage of development have to be given detailed instructions. S5: A laboratory assistant should be included at the stage of preparation and implementation in the experiment. S6: In the experiment, experiments carried out by students themselves with appropriate instructions should prevail, teacher demonstration experiments should be implemented to a lesser extent. S7: With demonstration experiments we often obtain the same results in the knowledge of students as at students' own experimental work.

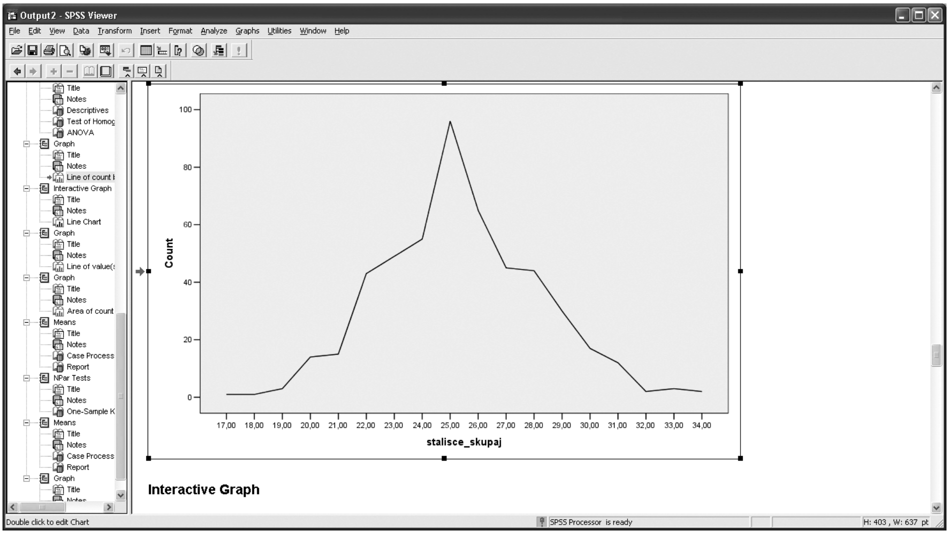
The following are the results of the general attitude analysis (Table 1). The total number of points was 35. General attitude results vary between the lowest (min = 17.00) and the highest value (max = 34.00) with the arithmetic mean ($\bar{x}$ = 25.426) and standard deviation (s = 2.912). The coefficient of variation shows C% = 11.46%; we can thus conclude that teachers had a relatively homogenous general attitude towards practical work. If we examine the distribution coefficient, we can categorize distribution as relatively symmetrical (SKEW = 0.190) and normal (KURT = 0.016). The sample thus shows a relatively homogenous general attitude; however, neither an explicitly positive nor explicitly negative general attitude emerged towards practical work.

**Table 1.** Estimation of the parameters of basic descriptive statistics of the result of measuring the general attitude of a group of teachers overall

| Total available points | Actual score | | Mean $\bar{x}$ | Standard deviation s | Variation coefficient (CV%) | Asymmetry coefficient (AC) | Flatness coefficient (FC) |
|---|---|---|---|---|---|---|---|
| | Min | Max | | | | | |
| 35 | 17.00 | 34.00 | 25.426 | 2.912 | 11.46 | 0.190 | 0.016 |

Next, we verified the existence of differences in the general attitude relative to the economic and social development of the school's region (cohesion region) (Table 2). The assumption of homogeneity of variances is not justified (F = 8.948, P = 0.003) so we refer to the approximation of the t-test (t = 2.766, P = 0.097). On this basis we can say that among teachers a statistically significant difference rela-

**Graph 1.** Frequency distribution of the general attitude of a group of teachers in total




tive to the cohesion regions does not exist and that there is a tendency for teachers in the less economically developed Eastern cohesion region to be more supportive to practical work than for teachers from more developed part of the country.

We assume that perhaps in the less developed parts higher social standing of teachers, less pressure from parents, the greater maneuverability of pupils and thus a greater sense of security are in the background. Many other factors (Paulík, 2012) contribute to the higher level of satisfaction and, consequently, greater willingness to practical work. To get the empirical verification for hypothetically outlined reasons for differences between the two groups further research is needed.

**Table 2.** T-test of differences result in the general attitude of a group of teachers in total with respect to the cohesion region

| Cohesion region | n | Mean $\bar{x}$ | Standard deviation s | Test of homogeneity of variances | | Test of differences between Means | |
|---|---|---|---|---|---|---|---|
| | | | | F | P | t | P |
| Western (more developed) | 160 | 25.012 | 2.480 | 8.948 | 0.003 | 2.766 | 0.097 |
| Eastern (less developed) | 337 | 25.459 | 2.942 | | | | |

The study has further shown that the general primary school teachers in the *Primary Science* course perceive various serious obstacles related to material support for practical work. As can be seen in Table 4, almost a half (45.3%) answered that they were very much hampered by the given obstacles. Slightly fewer (32.6%) were partly or somewhat impeded. Only 11.4% of the answers described the level of obstacles severity as *little* and almost the same proportion (10.7%) as *not at all*. The obstacle that stood out was lack of material ($\bar{x}$ = 3.3038), where as many as 49.7% of the teachers responded that they were *very* and 36.6% that they were *partly/somewhat* impeded by it. Only 8% of the teachers chose the answer *little*. Lack of material was not an obstacle for 5.6% of the teachers. The obstacle following lack of material with almost equal intensity was the lack of aids and equipment ($\bar{x}$ = 3.2956) and maintenance for material and teaching aids (collecting, sorting, cleaning, refurbishing etc. ($\bar{x}$ = 3.2916)). Following are three obstacles that are almost equally represented in terms of intensity: poor spatial conditions in the classroom ($\bar{x}$ = 2.9618), oversized groups of pupils or classes ($\bar{x}$ = 2.9536) and poor spatial conditions for storing material and aids ($\bar{x}$ = 2.9235).

**Table 3.** Number (f) and percentage (f%) of teachers in terms of statements about the intensity of obstacles to the implementation of experimental work in *Primary Science* classes, ranked according to average score of agreement levels (Not at all – 1, Little – 2, Somewhat – 3, Very much – 4)

| R | OBSTACLE | | NOT AT ALL | LITTLE | SOME-WHAT | VERY MUCH | Average grade of obstacle severity |
|---|---|---|---|---|---|---|---|
| 1 | lack of material | f | 28 | 40 | 182 | 247 | 3.303 |
| | | f (%) | 5.6% | 8.0% | 36.6% | 49.7% | |
| 2 | lack of accessories and equipment | f | 39 | 62 | 127 | 269 | 3.295 |
| | | f (%) | 7.8% | 12.5% | 25.6% | 54.1% | |
| 3 | maintenance for accessories and material (collecting, sorting, refurbishing, cleaning, etc.) | f | 9 | 57 | 221 | 210 | 3.291 |
| | | f (%) | 1.8% | 11.5% | 44.5% | 42.3% | |
| 4 | poor spatial conditions in the classroom | f | 74 | 63 | 168 | 192 | 2.961 |
| | | f (%) | 14.9% | 12.7% | 33.8% | 38.6% | |
| 5 | oversized groups of pupils | f | 98 | 50 | 116 | 233 | 2.953 |
| | | f (%) | 19.7% | 10.1% | 23.3% | 46.% | |
| 6 | poor spatial conditions for storage | f | 72 | 67 | 159 | 199 | 2.923 |
| | | f (%) | 14.5% | 13.5% | 32.0% | 40.0% | |
| **Total** | | | **320** | **339** | **973** | **1350** | **3.118** |

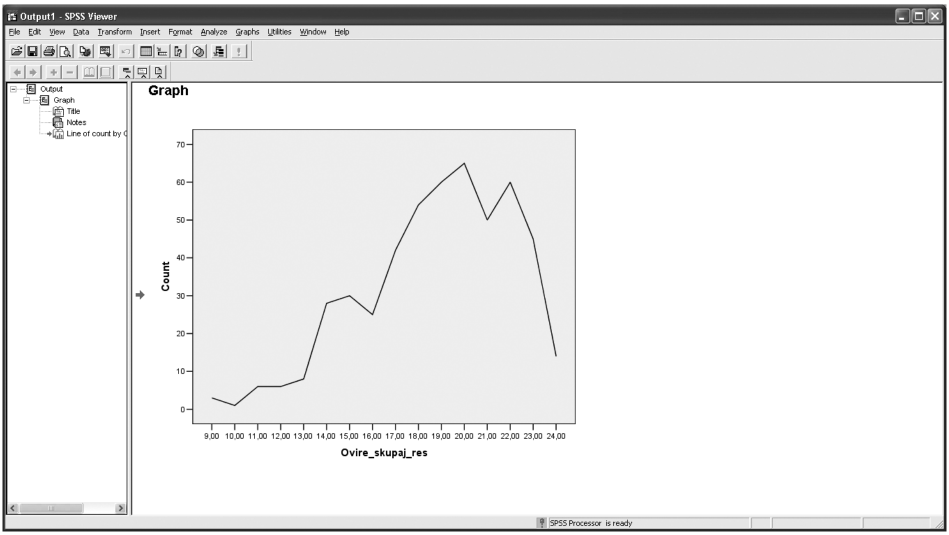
We also analyzed the overall result of measuring obstacles. As can be seen in Table 4, the total number of points was 24. The overall results of obstacle measurement of a group of teachers in total vary between the lowest (min = 7.00) and the highest value (max = 24.00), with the arithmetic mean ($\bar{x}$ = 18.8893) and standard deviation (s = 3.12473). According to the coefficient of variation it occupies 16.54% of arithmetic mean we may say that the teachers' assessment of obstacles was more heterogeneous than their attitudes.

In terms of the distribution coefficient, we can categorize the distribution as somewhat asymmetrical to the left (SKEW =-0.580) and relatively normal (KURT =-0.115). It is evident that the sample comprises more respondents who perceive serious obstacles to the implementation of experimental work (Graph 2).

**Table 4.** Estimation of the parameters of basic descriptive statistics of the overall result of obstacle measurement

| | Total available points | Possible | | $\bar{x}$ | s | Variation coefficient | SKEWNES | KURTOSIS |
|---|---|---|---|---|---|---|---|---|
| | | Min | Max | | | | | |
| Obstacles – overall | 24 | 7.00 | 24.00 | 18.889 | 3.124 | 16.54 | -0.580 | -0.115 |

**Graph 2.** Frequency distribution of the overall result of measuring obstacles of a group of teachers in total



We conclude the report by analyzing the differences in the overall result of the measurement obstacles to practical work in relation to the economic and social development of the environment. As shown in Table 5, the assumption of homogeneity of variances is justified (F = 2.331, P = 2.331). The difference in the overall result of the measurement of obstacles is not statistically significant (t = 0.335, P = 0.563) relative to the economic and social development of the environment.

**Table 5.** Results of t-test of differences between teachers in the overall result of the measurement of obstacles, according to the cohesion region

| | Cohesion Region | n | Mean $\bar{x}$ | Standard deviation s | Test of homogeneity of variances | | Test of differences between arithmetic means | |
|---|---|---|---|---|---|---|---|---|
| | | | | | F | P | t | P |
| Obstacles – overall | Western (more developed) | 160 | 18.6688 | 3.21694 | 2.331 | 2.331 | 0.335 | 0.563 |
| | Eastern (less developed) | 337 | 18.7941 | 3.07930 | | | | |

## Discussion and conclusion

In terms of material support, our survey was focused on the "material", which includes teaching aids, material and equipment for practical work in the *Primary Science* course. Providing material and aids for practical work is a complex area that should include teachers, school management, counseling and other responsible state and local institutions. Slovenia has no norms or standards for the teaching methodology equipment required for research-based learning and teaching in schools. In a difficult economic situation, material support for teaching is becoming a growing problem, often connected with regional development. Our study has shown that general primary school teachers perceive severe shortages of material support, in particular lack of materials, aids and other equipment, which could be one reason for the limited use of research activities in class (Mork, 2005).

Teachers experience obstacles similarly regardless of the development level of their region, which is surprising. We expected that the teachers who teach in economically less developed areas of the country, experienced obstacles more intensely. The survey also revealed that the teachers have neither a positive nor a negative general attitude towards practical work, which is certainly not encouraging. Furthermore, the research findings surprisingly show that the teachers' attitudes to practical work are more encouraging in less economically developed areas. We expected the other way round. We are not aware of any studies in Slovenia about a correlation between the socio-economic development of the region and teachers' attitudes to practical work. However, we can cite many international studies (e.g., Posnanski, 2010; Meichtry and Smith, 2007; Piwowarski, 2010; Milner, et al., 2012;), which claim that the efficiency of teaching is based on the belief about one's own qualifications, based on the following factors: (1) professional, course-related knowledge, (2) teaching methodology knowledge, (3) professional training, (4) teamwork, etc. Aaltonen and Sormunen (2003) list the aspects of teacher efficiency that comprise the following four knowledge areas: (1) teaching plan, (2) pedagogical methods, (3) pupils (4) resources, including material.

We can conclude that material support for *Primary Science* is indeed important, particularly from the point of view of choosing appropriate methods; however, it is not decisive for achieving the objectives (Wilson and Harris, 2003), which consequently prevents teachers from blaming objective criteria such as teaching materials as the only reason and excuse for poor results. The experience of most European countries (Dow, 2006) shows that teachers have to undergo training in all of the following three areas when changing course descriptions (in Slovenia with the introduction of nine-year primary school five years ago): (A) Subject Matter Knowledge (SMK), (B) Pedagogical Content Knowledge (PCK), and (C) Attitude (Parkinson, 2001; Davis et al., 2002; Píšová, 2005).

The results of our study (obstacles, attitudes) provide the basis for developing effective models of professional training of classroom teachers, on the one hand, and the establishment of a scientific center as material support to carry out experimental work in science teaching. The study also raises dilemmas about the impact of the environment on teachers' attitudes and perception of obstacles, which would be interesting to examine with an international study also in the countries where there are differences in economic development between regions and to ask ourselves how to reduce them.

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