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Assessment of Science in Special Education Schools: Teachers' Perceptions and Practice

Abstract

A shift from traditional methods of teaching science to modern and better suited to pupils can be noticed in Slovenian primary schools. They should also be followed by assessment both in regular primary schools and special education schools. The purpose of this study was to find out the perceptions of special education teachers about their own practice of science assessments and their actual practices. A questionnaire and authentic written tests were used for the research. Comparative analysis revealed considerable inconsistency between perceptions and practices. The greatest differences were found in the cognitive levels of knowledge and process skills. The research results raise teachers' awareness and thus enable changing of their practices.

Keywords: *assessment, process skills, cognitive levels, science education, special education.*

Introduction

Until 1991, science was taught in Slovenia using a traditional approach, with a distinct emphasis on knowing facts. However, science teaching in primary schools started to change considerably with the TEMPUS: Initial Science Development international project. Fact-based knowledge was joined by process skills. The constructivist conception of learning and teaching, active forms and methods of work, and the development of process skills and abilities (Hus, 2012) started to

be enforced. The changes were also demonstrated by international comparative studies.

There are many definitions of science knowledge or scientific literacy. Even significant and comprehensive international comparative studies, such as TIMSS and PISA, have no uniform definition. The most basic is the division into knowledge of facts and process knowledge, whereby the knowledge of facts refers to scientific concepts and process knowledge refers to various process skills. The concepts are formed on the basis of individual facts and are upgraded to principles (Goldston & Downey, 2013, p. 40). Bloom's taxonomy (1956) is most frequently used to determine cognitive levels. It specifies six different levels: knowledge, comprehension, application, analysis, synthesis, and evaluation. Although revised taxonomies exist as well (Anderson & Krathwohl 2001), Bloom's taxonomy was used in this research since it is best known to Slovenian teachers. Goldston and Downey (2013) divided Bloom's categories into lower cognitive levels (knowledge, comprehension, and application) and higher cognitive levels (analysis, synthesis, and evaluation). Similarly, there is no uniform definition of process skills. Based on Harlen (1992) and Goldston and Downey (2013), a list comprising 13 process skills was formed for this research: observing, collecting, recording and interpreting data, comparing, sorting, classifying, ordering, measuring, investigating, predicting, experimenting, hypothesising, inferring, and communicating. The list includes many different process skills, since their diversity needs to be presented to teachers to enhance their awareness of process skills.

Teachers, however, can also see modern forms of learning and teaching as a problem that a Slovenian teacher described as follows: *"If I encouraged pupils to develop process skills rather than accumulate facts I encountered problems when I wanted to assess the pupils' knowledge. The pupils did enjoy various activities, but all of a sudden I asked myself what my pupils actually knew at all. Previously I was used to pupils learning primarily facts and I knew how to assess them.*" (adapted according to Skribe-Dimec, 2007, p. 67). The described case is a good illustration of the need for a paradigm shift (Gipss, 1994), which is characterised by giving the assessment a considerably broader and more significant role. Recently, high importance has been attached to formative assessment (Harlen &James, 1997, Hall & Burke, 2003, Bell, 2007). The significance of formative assessment is well illustrated by the following thought: "*Formative assessment is a central feature of the learning environment of the 21st century. Learners need substantial, regular and meaningful feedback; teachers need it in order to understand who is learning and how to orchestrate the learning process.*" (Dumont, Istance, Benavides, 2010, p. 17). The efficiency of formative assessment was verified by Black and William (2005, 2009), who clearly proved that it enhanced learning.

The European Commission's report on science education shows that the curricula of only about half of 31 European countries include assessment and evaluation guidelines, which can provide assistance to teachers – and even those are mainly at the level of general recommendations (Eurydice, 2011). In Slovenia, the assessment of science is mainly left to teachers, their personal experiences obtained during schooling, and largely to their subjective theories on the understanding of scientific literacy.

Many researchers are engaged in teaching and assessing science in regular primary schools, but very little attention is paid to science classes in special education primary schools. The USA was clearly aware of the need for science education of all pupils as early as at the end of the 1980s when the Science for all Americans project was developed (Rutherford, Ahlgren, 1990). In Slovenia, 6.45% of the primary school population are defined as children with special needs, approximately 2% of whom attend specialized institutions – primary schools with lower educational standards (Opara, et. al, 2010). Pursuant to the Placement of Children with Special Needs Act (2011), an educational programme with lower education standards, adapted with respect to the type and degree of disability, is adopted for children who cannot achieve the education standard according to the primary school education programme. Special education primary schools with lower educational standards are attended by pupils with minor impairments in mental development. Compared to their peers, these children have different cognitive skills, and therefore both teaching and assessing need to be adjusted to them.

Research Problem

The purpose of the research was to ascertain the science assessment method in special education schools, to determine if perceptions of teachers differ from their actual practice, as well as whether and how assessment is adapted to children with science-learning difficulties. Attention was focused on: a) cognitive levels of knowledge; and b) process skills.

Research Focus

This research identified teachers' methods of assessing science and the ways of adapting assessment to pupils with learning difficulties in science. The research was focused on the conformity between written tests and the teachers' opinions. In view of the purpose of research, the following research questions were asked: (1) What is teachers' attitude to teaching science; (2) Which assessment methods are used by teachers in science classes and how often, and which assessment methods

they consider to be the most important; (3) Which cognitive levels of knowledge and which process skills are most frequently included by teachers in written tests; (4) Are teachers' opinions concerning the cognitive levels of knowledge considered in written science tests consistent with their actual practices; and (5) Are teachers' opinions concerning the process skills included in written test tasks consistent with their actual practices?

Methodology of Research

A questionnaire was produced for this research to identify teachers' perceptions concerning science assessment and the ways of adjusting assessments to pupils with special needs. Authentic written tests were also collected to determine the actual teachers' practice in special education schools. Bloom's taxonomy was used to define the cognitive levels of knowledge, and a special list of process skills was developed.

A non-probability sampling method was selected for this research, which included 10 special education teachers, hereinafter referred to as teachers, who teach science in two Slovenian special education primary schools in classes with lower education standards. The initial sample of teachers was larger, but many schools and teachers refused to participate, as they did not wish to present their written tests. Both schools are located in small towns (between 12,000 and 35,000 inhabitants). All the teachers had completed a higher (university) degree of education, and had 11 years of service on average. In the 2011/2012 academic year they taught classes to the first to ninth grades (between 6 and 15 years of age).

Two instruments were used in the research: a questionnaire and authentic written tests. The first part of the questionnaire collected basic teacher data, and comprised six questions. Five of them were multiple choice questions with a measurement scale from 1 to 4 (in one question it was necessary to explain the choice), and one was an open question. It was decided to use a 4-point scale in order to avoid the selection of the middle reply. The question about the cognitive levels of knowledge offered six options ("knowledge," "comprehension," "application," "analysis," "synthesis," and "evaluation"). The question about knowledge assessment methods offered seven options ("written assessment," "oral assessment," "performance assessment," "written work," "observing children's actions," "group work", and "other"). The teachers indicated how often they used any of these methods, the reason for the most frequently used method, and which method is consid-

ered the most important. The question about the frequency of including process skills in written tests offered 13 options ("observing," "collecting, recording, and interpreting data," "comparing," "sorting," "classifying," "ordering," "measuring," "investigating," "predicting," "experimenting," "hypothesising," "inferring," and "communicating"). The question about adapting assessment was of an open type. Forty authentic written tests composed by the responding teachers (each teacher submitted four tests) were analysed. The research took place in two Slovenian special education primary schools in March and April 2012.

Data Analysis

The questionnaires showed the teachers' opinions on how much they took cognitive levels of knowledge into consideration and on their use of process skills, while the written tests reflected their actual consideration. Two researchers analysed the written tests. Each researcher determined their cognitive level and type of process skills for each task. If their definitions differed, they jointly determined the best possible option. The frequency of cognitive levels of knowledge and process skills in all four tests was defined for each teacher using a 4-point measurement scale. If a cognitive level or process skill appeared in only one of four tests, the frequency was marked by number 1, and by 4 if it appeared in all four tests. All the collected data were statistically processed by OriginPro 8 software. One-sample t-test (one-tailed) was used to determine the statistical significance of differences between the teachers' opinions and their actual practice. Number 0 in Figures 2 and 3 represents perfect consistency between a teacher's opinion and their actual practice. If, however, a teacher selected 3 (often), and 4 (always) in written tests, the difference was of one frequency level which, in line with our classification, corresponds to 25%. In both figures, this corresponds to the value over the marginal value 0, and vice versa if a teacher selected 3 (often), and the tests were graded 2 (rarely), the difference was of minus one frequency level or – 25% (under the marginal value 0 in the figures). The average deviation is denoted by a solid square. Box size represents standard error and whiskers represent standard deviation. Median is denoted by a vertical line.

Results of Research

Table 1 shows basic teacher data. In the case of some teachers several options are indicated as the most frequently used assessment method since they selected the same frequency for different methods.

Table 1. Basic teacher data with respect to grade, number of years of teaching, attitude toward teaching science (+ = likes, ++ = likes very much), and methods of assessment (w = written, o = oral, p = performance assessment, g = group work)

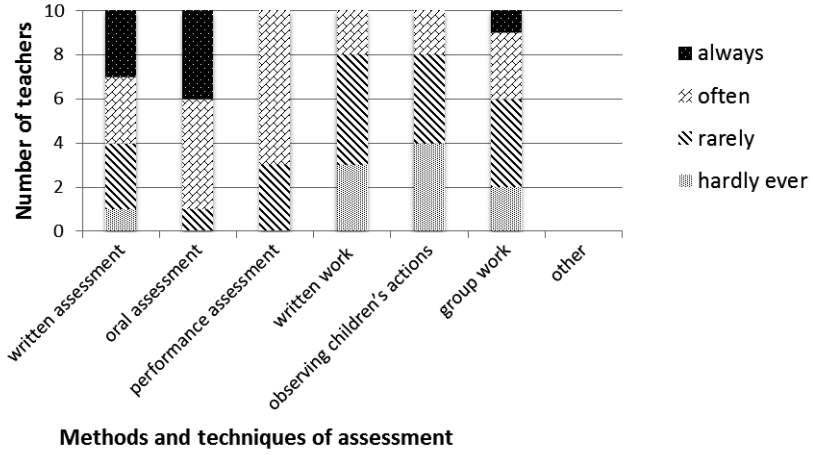
Teacher	Grade taught	Years of teaching	Attitude toward teaching science	Most frequent methods of assessment	Assessment method of maximum importance for the teacher
1	6th, 7th	1–3	+	w, o	w
2	8th	1–3	++	w, o, p	w
3	3rd, 5th	11–20	+	o	o
4	8th	4–10	+	w, o, p	w
5	1st	>31	++	o	w
6	8th, 9th	4–10	+	o	p
7	7th, 8th	4–10	+	g, p	p
8	5th, 6th	11–20	+	o	o
9	7th	1–3	+	w	w
10	8th	1–3	+	w, o	w

Half of the interviewed teachers teach in combined classes with pupils of different ages. Younger teachers with 11 years of teaching experience on average prevail; only one teacher has more than 31 years of teaching experience. All the teachers "like" to teach science, two of them even "like (it) very much." The most frequently used methods of assessing science are "written" and "oral assessment"; only three teachers stated "performance assessment" as the most frequent method. The teachers with the least teaching experience most often use "written assessment" and also attach the highest importance to this method of assessment. With increasing experience, "oral assessment" proved to be the most frequent method of assessment. Teacher No. 5 and teacher No. 6 most frequently assess science by "oral assessment," but teacher No. 5 attaches the highest importance to "written assessment," and teacher No. 6 to "performance assessment." All other teachers attach the highest importance to the method of assessment which they most frequently use. It is interesting that teacher No. 5 attaches the highest importance to "written assessment" although he teaches 1st grade, where the pupils cannot write yet. Teacher No. 6 and teacher No. 7, who teach higher grades, stated "performance assessment" as the most important method of assessment.

Figure 1 shows which methods of assessment are used by the interviewed teachers in science and their frequency of use.

Figure 1 shows that the teachers most frequently use "oral assessment." "Written assessment" is always or often used by six teachers, "performance assessment" is

Figure 1. The frequency of the methods of assessment in science education

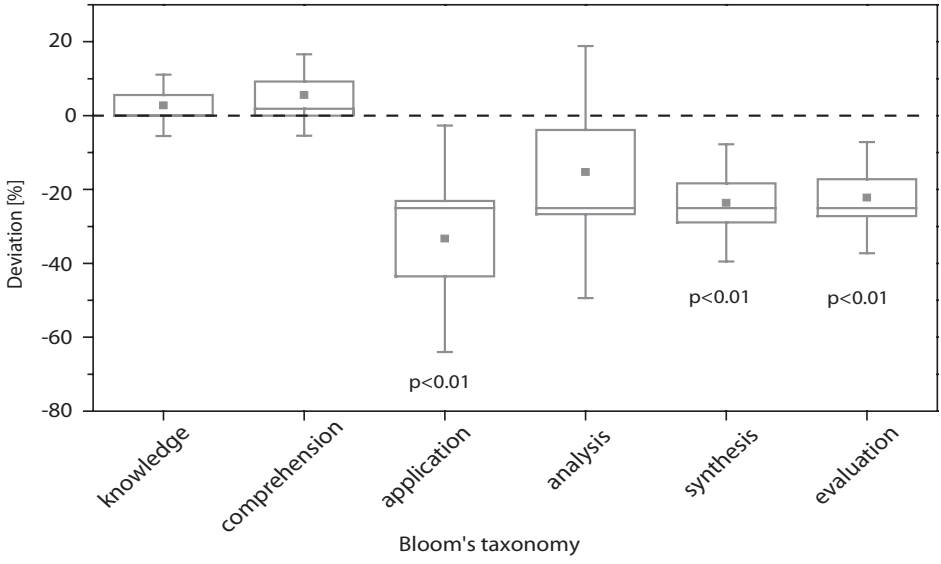


often used by seven teachers and "group work" is always or often used by four teachers. The teachers least frequently assess knowledge by "written work" and "observing children's actions." None of the teachers added any other method or technique of assessment. For "written assessment" the teachers most frequently wrote that such an assessment method was the most objective one. For "oral assessment" the teachers stated that pupils most easily explain the subject, that according to the Rules on the Assessment of Knowledge and Promotion of Pupils in the Elementary School (2008) it was necessary to collect more grades from oral than written assessment, and that it enables a comprehensive insight into the child's knowledge and understanding.

Figure 2 shows differences between the opinions of the teachers and their actual assessment of the cognitive levels of knowledge in written tests of science. It was found that all the written tests included tasks requiring a lower cognitive level. Tasks requiring a higher cognitive level appeared very rarely.

Figure 2 shows that "knowledge" and "comprehension" assessing tasks correspond to the teachers' responses quite well. In the case of tasks assessing the "analysis" there is an almost 20% difference between the teachers' opinions and the actual appearance in the written tests. The greatest variations can be noticed in tasks which assess "application," "synthesis," and "evaluation." In these tasks there is an average difference of 25% between the teachers' opinions and actual appearance. So, the difference amounted to one degree. In assessing the "application" tasks there is a 35% difference which equals one and a half degrees. The t-test

Figure 2. Comparison of the teachers' opinions and their written tests of science with respect to the cognitive level of knowledge

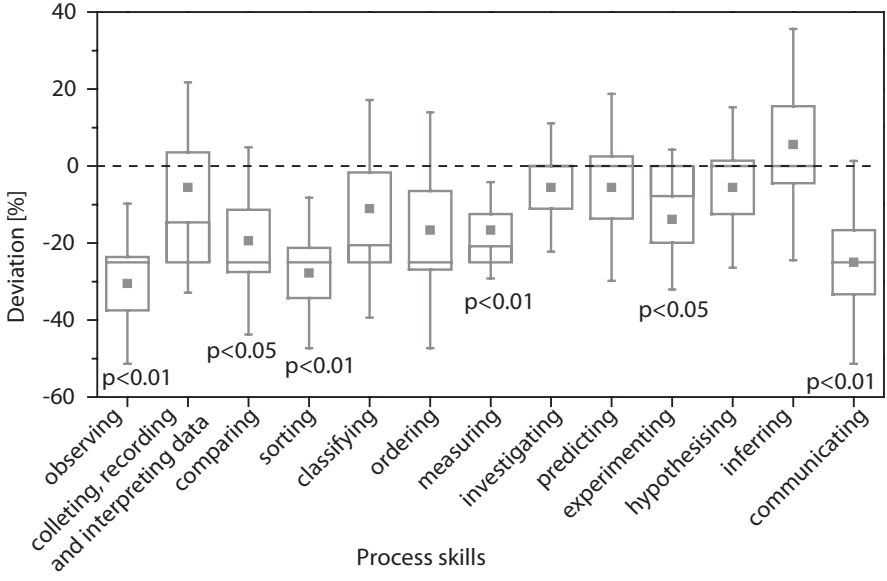


showed the statistic significance of differences in tasks which assess "application" (t = – 3.26599, df = 8, p = 0.00571), "synthesis" (t = – 4.46442, df = 8, p = 0.00105), and "evaluation" (t = – 4.4376, df = 8, p = 0.00109). Standard deviation is high in "application" and "analysis." Particularly in the case of tasks requiring "application" and all higher cognitive levels the teachers' opinions differ considerably from the actual use.

In the questionnaire, the teachers answered which process skills they include in written tests of science. Their opinions were compared to their actual practices as shown in Figure 3. It was established that the process skills very rarely appear in the written tests. Most frequent are tasks requiring "collecting, recording, and interpreting data," "classifying," and "inferring." No "observing," "investigating," and "experimenting" was found in any written test.

Figure 3 shows that with respect to "collecting, recording, and interpreting data", "investigating," "predicting," "hypothesising," and "inferring" the teachers' opinions and their actual use of process skills correspond considerably. Only for tasks which assess "inferring" did the teachers believe that they were less frequent in written assessments than it proved to be the case. Maximum deviations were found in "observing," "sorting," and "communicating," since the teachers' opinion compared

Figure 3. Comparison of the teachers' opinions and their written tests of science with respect to process skills



to the written tests differed by 30% on average or more than one degree. So, the teachers were convinced that they used these process skills in written tests more frequently than was actually established. Similar is true for "comparing," "classifying," "ordering," "measuring," and "experimenting." In this case, the difference between the teachers' opinions and written tests proved to be around 15%. Using a t-test, statistically significant differences between the teachers' opinions and their actual use of process skills were found in the case of "observing" ($t = -4.4$, $df = 8$, $p = 0.00114$), "comparing" ($t = -2.4010$, $df = 8$, $p = 0.02156$), "sorting" ($t = -4.2640$, $df = 8$, $p = 0.00137$), "measuring" ($t = -4.000$ $df = 8$, $p = 0.00197$), "experimenting" ($t = -2.2942$, $df = 8$, $p = 0.02547$), and "communicating" ($t = -3.0000$, $df = 9$, $p = 0.00748$). Standard deviations are rather high, so there are considerable differences among the teachers. In most cases, the teachers' opinions on the use of process skills do not correspond to their actual practices, since they use process skills in their written assessments a lot less frequently than they stated in the questionnaire.

Discussion

Based on the questionnaire results, it was established that the teachers have a positive attitude toward science education. This finding was a pleasant surprise since it is known that teaching science is demanding, particularly with children with special needs. The most frequently used assessment method in science education is "oral assessment," and the teachers attach the highest importance to "written assessment," which is not surprising since such a form of assessment is the most objective, equal for all pupils, and least time-consuming for them. It was surprising, however, to find that assessment is still very traditional. Written tests most frequently include tasks requiring a lower cognitive level, while tasks requiring a higher cognitive level appear very rarely. Perhaps, the teachers are of the opinion that children with special needs cannot achieve a higher cognitive level because of their lower intellectual abilities. The teachers' opinion was that they more frequently included tasks assessing "application," "synthesis," and "evaluation" in their written tests than the analysis actually showed. Although the teachers had 13 process skills available in the questionnaire, they chose only a few. Tasks assessing process skills also appeared very rarely in written tests. Most frequent were tasks requiring "collecting, recording, and interpreting data," "classifying," and "inferring." The teachers thought that they more frequently included tasks assessing "observing," "comparing," "sorting," "measuring," "experimenting," and "communicating" in their written tests than was actually shown in the analysis. The majority of the interviewed teachers expressed concern regarding the questionnaire and written tests as they apologized in advance both for their answers in the questionnaire and for the written tests attached. Everybody wanted immediate feedback about their work. This fact indicates a possibility of changing teacher practices with this kind of work.

Conclusions

The aim was to find out whether teachers take into consideration various cognitive levels of knowledge and to what extent they include process skills in written tests they use for science assessment. Special education teachers teaching in special education primary school took part in the research. All of them had a positive attitude toward science education. They stated "oral assessment" as the most frequent assessment method while attaching the highest importance to "written assessment." Their "written assessment" most frequently consisted of

tasks with a lower cognitive level, and there are very few tasks assessing process skills. The teachers' opinions about their consideration of the higher cognitive level and some process skills differ considerably from their actual practices. A positive consequence of this research is that the teachers have become aware of their practices in science assessment.

References

Anderson, L.W., & Krathwohl, D.R. (Eds.). (2001) *A Taxonomy For Learning, Teaching and Assessing: A Revision Of Bloom's Taxonomy Of Educational Objectives: Complete Edition*. New York: Longman.

Bell, B. (2007). Classroom Assessment Of Science Learning. In: Abell, S., & Lederman, N. (ed.). *Handbook of Research on Science Education.* Mahwah, NJ: Lawrence Erlbaum Associates, Inc., 537–559.

Black, P., & Wiliam, D. (2005). Developing a Theory of Formative Assessment. In: Gardner, J. (ed.). *Assessment and Learning*. London: Sage, 81–100.

Black, P., & Wiliam, D. (2009). Developing the Theory of Formative Assessment. *Educational Assessment, Evaluation and Accountability*, 21 (1), 5–31.

Bloom, B.S. (1956). *Taxonomy of Educational Objectives. Handbook I: The Cognitive Domain*. New York: David McKay.

Dumont, H., Istance, D., & Benavides, F. (2010). *The Nature of Learning, Using Research to Inspire Practice*. OECD: Centre for Educational Research and Innovation.

Eurydice. (2011). *Science Education in Europe: National Policies, Practices and Research*. Brussels: Education, Audiovisual and Culture Executive Agency.

Gipps, V.C. (1994). *Beyond Testing. Towards a Theory of Educational Assessment*. London: The Falmer Press.

Hall, K., & Burke W.M. (2003). *Making Formative Assessment Work*. Maidenhead: Open University Press.

Harlen, W. (1992). *The Teaching of Science*. London: David Fulton Publishers.

Harlen, W., & James, M. (1997). Assessment and learning. *Assessment in Education*, 4 (3), 365–379.

Hus, V. (2012). Constructivist Elements in the Textbook Sets of Environmental Studies Subject. *The New Educational Review*, 29 (3), 239–249.

Opara, B., Barle Lakota, A., Globačnik, B., Kobal Grum, D., Košir, S., Macedoni Lukšič, M., Zorc, D., Bregar Golobič, K., Molan, N., Vovk Ornik, N., & Klavžar, K. (2010). *Analiza vzgoje in izobraževanja otrok s posebnimi potrebami v Sloveniji*

[Analysis of education of children with special needs in Slovenia]. Ljubljana: Pedagoški inštitut.

Pravilniku o preverjanju in ocenjevanju znanja ter napredovanju učencev v osnovni šoli [Rules on the Assessment of Knowledge and Promotion of Pupils in Elementary School]. (2008). Uradni list Republike Slovenije, 73/2008.

Rutherford, F.J., & Ahlgren, A. (1990). *Science for All Americans*. New York: Oxford University Press.

Skribe Dimec, D. (2007). *S preverjanjem znanja do naravoslovne pismenosti* [From assessment to science literacy]. Ljubljana: DZS.

Zakon o usmerjanju otrok s posebnimi potrebami [Placement of Children with Special Needs Act]. (2011). Uradni list Republike Slovenije, 58/2011.