Annales Academiae Paedagogicae Cracoviensis
Folia 16 Studia Mathematica III (2003)

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The efficiency of mathematics teaching and integrated instruction at the primary level

Abstract. The mathematical education in primary school is the foundation and the beginning of further learning of mathematics. A research work on the efficiency of mathematical education in early classes of primary school was done using suitable tests. The results confirm low mathematical knowledge of pupils. It concerns especially solving problems demanding from children logical thinking as well as practical knowledge. Good results were accomplished in problems which concerned learned algorithms.

We can draw the conclusion that one ought to integrate subjects both around Polish language lessons and mathematics, too. Then the efficiency in mathematical education will increase.

1. Introduction

Various authors ([1], [3], [5], [6]) indicate that the idea of integrated instruction is at present being reintroduced at the level of primary education. The contemporary understanding of the idea of integration at the level of elementary education has its roots in history and in particular in the concept of "holistic education', according to which the whole precedes its parts in the process of cognition. The concept of "combined teaching", developed in the era of "new education", constitutes a variant of the holistic approach. In his paper, Mioduszewski ([7]) questions the role of the holistic approach in the process of cognition. He claims that the mechanism of cognition consists in the perception of elements as separate entities. This assumption can be illustrated by the following example: the concepts of the integral and series are not learnt simultaneously, but once they have been learnt, integration may occur afterwards.

The concept of "integration" can be defined as "the unification, merger or harmonization of various elements involved in the process of the formation of entities" ([3], [4], [5]). Integrated teaching means 1) organizing educational processes in the way which triggers the occurrence of conditions enabling a multidimensional activity of the child aimed at completing a particular task, and

2) focusing various types of content around one topic area. Integrated teaching consists of so called centres of multidimensional activity. These are taught, depending on the topic, within one week, which is common practice, or sometimes within 2 or 3 days only. Several levels of integration have been distinguished, for instance: the child and common mathematical problems. Undoubtedly this kind of approach makes mathematics more learner centered.

The contents of mathematics are in fact subject to fairly complicated correlation. Complete correlation is possible in class one, as the range of numbers is limited and many concepts can be demonstrated by means of concrete examples and in reference to the immediate environment. As the range of numbers expands, typically mathematical problems have to be introduced and the extent to which correlation can be introduced is limited. This is for instance the case in class three.

Research findings ([2], [5], [8]) show that mathematics instruction at the primary level constitutes the foundation for future mathematics courses. Its aim is to encourage students to work systematically and enable them to acquire basic factual information as well as skills necessary at more advanced levels. Research findings, observation and pedagogical experience indicate that at the later stages of both elementary and secondary education students encounter a variety of problems which stem from inappropriate instruction at the primary level. The scarcity of research into this area has motivated the author of the paper to examine the efficiency of mathematics instruction in primary classes in which integrated courses are run.

2. Methodology and procedure

The research was carried out on the third year students of six elementary schools, in which integrated courses are taught. The primary aim was to establish the level of the students' ability in mathematics at the end of the third year of integrated instruction. In particular, the following concepts and associated abilities were analyzed:

- Arithmetical operations;
- Fractions;
- Practical tasks;
- Calculation;
- Formulating and solving problems based on arithmetical operations;
- Formulating and solving problems based on equations;
- Solving problems involving multiplication and division;
- Solving problems involving subtraction and division;

- Solving problems involving the combination of subtraction and division;
- Formulating and solving mathematical problems;
- Solving problems beyond the primary level curriculum.

The research was carried out in Zielona Góra in May 2002 on the group of 240 third year primary school students. The students were given a test including 30 tasks out of which 28 were in line with the school curriculum, whereas two required the application of knowledge and abilities going beyond the curriculum. For each task students were awarded 1 or 0 points depending on their performance. The test was administered on one day and lasted 90 minutes split into two 45-minute parts divided by a 45-minute break.

3. Data analysis

As particular tasks were grouped thematically, test results shall be presented accordingly.

Group 1: arithmetical operations.
The following tasks were used:
1. $12 + 29$, 2. $25 - 5 \cdot 3$, 3. $(3 \cdot 7 + 9) - 10$, 4. $(42 : 7 + 36 : 9) \cdot 2 - 3$.
Correct responses totalled at 70.3%, with the highest score for task 1: 89% and the lowest for task 4. The results indicate that the students find sequencing arithmetical operations difficult.

Group 2: fractions The following tasks were used:
5. $\frac{1}{3} + \frac{2}{3}$ 6. $10 - \frac{1}{2}$ 7. $\frac{2}{5} + \frac{1}{5}$ 8. $10\frac{1}{2} - \frac{1}{2}$.
The average score totalled at 75.9% which means that the students are capable of carrying out arithmetical operations on fractions.

Group 3: practical tasks.
The following tasks were used:
9. Write the following number in digits: three thousand five hundred and eight.
10. Write out the following number in words: 17306
11. How many minutes pass between 9.45 and 11.00?
12. Draw a rectangle $ABCD$, where $a = 5$ cm and $b = 3$ cm. Calculate the perimeter of the rectangle. Which sides of the rectangle are parallel and which perpendicular?
13. A sportsman can run the distance of 4 kilometers in 20 minutes. What distance can he run in 1 minute?
14 If you have 8 one-hundred-zloty notes, how many zlotys do you have?
15. Think of the biggest and the smallest number that can be expressed using the following digits: 0, 1, 3, 6, 7, 8, 9.

Correct responses totaled at 53.7% with the lowest score — 16.6% for task 13. Most students divided the bigger number by the smaller one — 20 : 4 instead of converting 4 kilometres into meters and dividing the distance by time.

Group 4: calculation. The following tasks were used:
16. $245 + 123$, 17. $481 - 197$, 18. $318 \cdot 3$, 19. $125 : 6$.
Correct responses totalled at 54.7% with the lowest score — 18.6% for task 19 involving division.

Group 5: formulating and solving arithmetical problems based on the following equations: 20. $x + 64 + 6 = 80$, 21. $65 - x = 12$.
The average score totalled at 46.9% with no major difference between both tasks.

Group 6: multiplication and division.
The following tasks were used:
22. One number divided by another gives 3. One of these numbers is 12. What is the other number?
23. Subtract the quotient of the following numbers: 24 and 4 from the product of these numbers.

Group 7: problems with context for two magnitudes to be compared by their difference or ratio.
24. Chris has got 33 comic books and Kate has 6 books fewer than Chris. How many books do Chris and Kate have?
25. A small notebook costs 6 zlotys, while a big one three times more. How much are both notebooks.
26. There are 54 kilograms of honey in 6 containers. How much honey is there in 6 containers?
27. There were 52 roses in a flower shop. Bunches of roses consisting of the identical number of flowers were made and only 4 roses were left. How many bunches were made? Give as many solutions as you can.
The combination of subtraction and division introduced in class two and reinforced in class three seems to be difficult for learners. This observation seems to be confirmed by the test results. Only 31.5% of students managed to do the tasks correctly with only 9.8% of students responding correctly to task 27.

Group 8: formulating and solving problems.
The following tasks were used:
Formulate and solve a mathematical problem about your class.
Only 42.7% of students managed to the tasks well.

Group 9: two additional tasks:
29. There are 60 sheep, both white and black, on the sheep-run. How many white sheep and black sheep are there if the number of the white sheep is four times bigger than the number of the black ones.

30. Solve the following equation: $(x - 488 : 8) - 6 = 933$.
The average score for the additional tasks totaled at 6.5%.

The analysis of the data indicates that the following seem particularly problematic for primary level students: 1/division, 2/equations — probably because students did not apply graphs, 3/combination of division and subtraction and 4/solving mathematical problems. It could be argued that low scores are due to poorly organized and inappropriate instruction.

Conclusion

The results of the research are presented in the table below:

	OBLIGATORY TASKS								AVERAGE SCORE	OPTIONAL TASKS
TASK GROUPS	1	2	3	4	5	6	7	8		9
CORRECT RESPONSES [%]	70,3	75,9	53,7	54,7	46,9	31,5	29,8	42,7	50,6	6,5

Table 1. Test results for particular task groups

The results of the research show that the efficiency of mathematics instruction in primary level classes, in which the integrated approach is followed, is estimated for 50.6%, which corresponds to the "satisfactory" mark. Only tasks 1-4 generated scores above 50%. Optional tasks generated rather poor responses.
Poor results scored by third grede primary school students mean that they are not satisfactorily prepared for further instruction in mathematics. The students did not seem to have major problems with tasks requiring the application of simple rules of arithmetic. At the same time task involving logical thinking, decision-making or practical application of the acquired knowledge and abilities occurred to be rather difficult.
The following conclusions could be drawn on the basis of the research:

- While teaching integrated courses more attention and time, perhaps even one hour a day, should be devoted to mathematics instruction, so that students would have more time for revision and practice;
- More attention should be paid to sequencing arithmetical operations;
- Theory should, whenever it is possible, be illustrated with examples of practical application;
- Graphs should be used while teaching equations;
- Students should be taught how to analyze mathematical problems, plan particular operations, use different techniques while solving problems, as well as solve non-typical problems involving the use of too much, too little or even contradictory data.

References

[1] J. Baranowski, *Krytyka ciągle aktualna*, Matematyka 4 (1987), 225-229.

[2] K. Czarnecki, P. Kowalik, *Sprawdzenie wiedzy pojęciowej uczniów klas początkowych*, Katowice 1993.

[3] K. Duraj-Nowakowa, Integrowanie edukacji wczesnoszkolnej, Krakćw 1998.

[4] *Encyklopedia Popularna*, Warszawa 1993, 232.

[5] J. Hanisz, *Wesoła szkoła — kształcenie zintegrowane w klasach 1-3*, Warszawa 2001.

[6] M. Jakowicka, *Teoretyczne i praktyczne aspekty integracji kształcenia w klasach początkowych*, Życie Szkoły 10 (1995).

[7] J. Mioduszewski, *O nauczaniu zintegrowanym*, Matematyka 1 (2000), 29-30.

[8] M. Żytko, Efektywność edukacji początkowej, Edukacja i Dialog, 95 (1998).

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