Non-standard vs. standard problems: a possible coexistence.

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The use of non-standard problems in school is limited by several factors:
1. teacher difficulty in discussing content which is not scholarly or clearly recognisable as such
2. lack of uniform strategies for solving different problem types and consequent difficulty in assessment and evaluation
3. more time needed for solving
4. pupils may unpredictable strategies

For all these reasons, teachers often use standard problems or exercises in applying what they have taught. In interviews, some teachers say they use non-standard problems when pupils are fired, perhaps as a change from routine.

Experiments were carried out in order to test whether using non-standard problems would improve pupil performance. The project lasted for one school year and involved 99 ten year olds from Class 5 of different primary schools that were all geographically and socially similar.

The pupils were divided into two samples: a control sample of 51 children and an experimental sample of 48 children. Both groups took the same test, consisting of 8 standard problems, between October and December 2001. The exit test also consisted of the same 8 standard problems and was taken between April and May 2002. Children took both tests working singly, 13 non-standard problems were given to solve in group work to the experimental sample. The problems were taken from those used in different years of the Transmath Maths Rally (1998). The first author agreed the assessment of the standard problems results with the class teachers involved in the project.

The average marks obtained by the experimental and control sample in the entry and exit tests are shown in the table. The experimental sample showed statistically significant performance improvement. The control sample showed improvement too, probably due to the pupils’ gain in maturity over the school year.

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### Standard problems

1. **The greengrocer**
   A greengrocer has bought 71 kg of bulk lettuce. He has to sell every 25 kg. How much will he sell?

2. **The field**
   25 dm² of the apple tree drawn in the diagram. The following measurements are known:
   - LG = 10 dm
   - DC = 2 dm
   - CD = 6 dm
   Calculate the perimeter and the area of the field

3. **Chocolates**
   Sylvia bought 9 chocolates and spent 5.05€. Paul bought 15 chocolates. How much did each spend?

4. **Coloured marbles**
   Determine the probability of coloured marbles so that the probabilities of pulling out a green marble are respectively
   - I. 9
   - II. 7
   Which container gives you the best chance (the highest probability) of pulling out a green marble? And which sometimes gives you the best chance of pulling out a marble that is not green?

5. **The sports club**
   Some children belong to a sports club. 16 of the children play basketball, 13 of them play football and 11 of them play both basketball and football. How many children are members of the club?

6. **Helen and the ribbon**
   Helen cut a ribbon into two pieces. One piece is 2 dm 9 cm longer than the other. She then cuts the shorter piece exactly in half and puts this piece on top of the longer at the point where the ribbon was cut off. How much ribbon is there at the end?

7. **The shepherd’s will**
   An old shepherd divided his sheep among his four sons. The fourth son received 120 sheep, the third one received 115 sheep, the second one received 110 sheep. How many sheep did the first son receive before the test?

8. **The game of marbles**
   Frank took the game to the go 20 marbles to Andrea. Frank took half the number of marbles that Andrea had. The total number of marbles was 96. How many marbles did Frank have at the beginning of the game? How many did Andrea have?

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### Non-standard problems

1. **Cleopatra’s camels**
   Cleopatra owns a number of camels (with two humps) and dromedaries (with one hump). She draw 21 humps and 52 camels. She then draws a line along each of them. How many red does she see? Does this problem have a solution? How many solutions can there be?

2. **Medals for everyone**
   Four children received 1 medal each of 71 medals on sports day. Ali won the most. Robin won twice as many as Peter. How many medals did each child win? Is there only one solution to this problem?

3. **The boards**
   On the first board, the numbers on the left hand side show how many red squares there are on each row, and the numbers on the right show how many red squares there are on each column. Use the numbers in the same way to colour the red squares on the second board. How you coloured the right hand side of red squares in each row and column

4. **Packing eggs**
   Cook packs eggs. He is packing the 1239 eggs he has found during the week. He uses crate, big boxes and small egg boxes. How many crate of eggs are small egg boxes? How many egg boxes should he use?

5. **Logos**
   Find the 7 logos in the 9 squares on the board, following these indications:
   - The first row contains the red squares, the blue circle and the blue triangle.
   - The second row contains two circles and one triangle.
   - The blue square is in the third row, between the yellow square and the blue triangle.
   - In the left hand column, there are three different shapes and three different colours.
   - In the right hand column there is a circle between two triangles.
   - In the centre of the board there is a yellow shape.
   - The problem has a solution! How many solutions can there be?

6. **The three spiders**
   Three spiders, (A) Albert, (B) Bill and (C) Charlie live at the nodes of a spider’s web. The distance between nodes (A) always one “threadmeasurer”. (Distances on the spider’s web are measured following the shortest route from node to node) Charlie lives 0 threadmeasurer away from Bill and 8 threadmeasurer away from Albert. How many threadmeasurer is it from Bill to Albert?

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### Meta-cognitive aspects

Group work, as seen by pupils

Group work is good and it is useful to work with other pupils. I would suggest we carry out the problems (control).

With problems I work better in a group with my friends, because they help me when I don’t know what to do. I used a friend’s version when I was solving problems in my notebook (slightly). I like maths and geometry but I don’t like the teacher … and I like groups a bit, because your friends teach you things that the teacher can’t manage to explain in children’s words (Shamla)

I feel I’m better at maths when I’m working in a group (Marlina)

Working with your friends is great because they give you things you don’t understand (Shamla)

I really enjoy doing group work (Marta)

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### Questions for discussion

- How do you think the problems presented in this activity could be used in a classroom setting?
- What strategies could be employed to encourage students to engage with non-standard problems?
- How might the results of this study influence teaching practices in mathematics education?