Tartalom

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Hungarian pupils' performance on a biology test and their IQ-s

Measurement

Hungary, Baranya county
Number of schools: 69
Number of pupils: 427
Number of classes: 23
Pupils' age: 12-13 years

Mean of school marks/achievement: 67.7%
Mean of our test achievement: 18.9%
Number of tasks: 16
Number of items: 75

Classification of tasks requiring different cognitive skills

N: naming: when in the test there is a drawing, and the pupil must write the name of it or the name of a part of it

L: listing: when the pupil must remember and write a list learned

S: selection: this is a decision making situation when the pupil must choose one good solution from a list

C: classification: this again requires a decision, but more complicated than the previous one

D: description/definition: the pupil must construct a definition of a biological concept

Structural analysis

The goal of the examination was to determine what kinds of cognitive skills are easier and what are more difficult for the pupils. Because of this, a pass mark was set for each item type. The next table shows the kind of the item, the maximal number of points that a pupil could reach in the item in question, and the pass mark.

Table 1.

Type of thinking skill	*Maximal number of points*	*Number of points for pass mark*
N – naming	51	9
S – selection	5	1
C – classification	7	1
D – definition	3	1
L – listing	9	1
Total	*75*	*13*

Pupils' marks in the 23 classes were grouped according to these types of tasks, which was the basis of the binary input for the Galois graphs. (*Takács*, 2000; *Szigeti*, 2000) Output was used for the creation of the 23 graphs, which demonstrate the distribution of tasks and structures for each class.

Here is an example to show the procedure for class 23. The code BP23 in the next chart stands for class 23. in the biology test, whereas 120112 stands for the associates conducting the test. In the first column, we can see the code of each pupil. The letter code N is used for Naming tasks and items, S for Selection, C for Classification, D for Description, and L for Listing. For each pupil, the total score for each task type was calculated, shown in the squares at the intersection of columns and rows. *(see Table 2.)*

The table also shows the pupils' school grades and a score for IQ.

Table 2. BP23 120112

IDENT	*N*	*S*	*C*	*D*	*L*	*Mark*	*IQ*
101	17	1	4	0	2	4	35,00
102	11	0	0	0	1	2	25,00
103	16	0	4	0	2	3	38,00
104	13	0	2	0	1	3	32,00
105	15	2	0	0	2	3	34,00
106	9	1	1	0	1	4	28,00
107	16	0	4	0	2	2	30,00
108	9	0	0	0	1	3	25,00
109	17	0	4	0	2	5	29,00
110	9	0	2	0	1	3	32,00
111	9	1	3	0	1	3	28,00
112	9	0	0	0	0	2	24,00
113	13	1	4	0	1	4	36,00
114	16	2	4	0	2	2	41,00
116	11	1	2	0	2	4	26,00
117	17	0	4	0	2	5	40,00
118	10	1	2	0	1	3	30,00
119	4	0	0	0	0	2	25,00
120	7	0	1	0	2	2	32,00
121	17	1	3	0	1	5	41,00
122	11	2	3	1	2	4	30,00

On the basis of Table 2., we considered the pass marks for five task types – which was used for charting Binary *Table 3*, the input for the Galois graph.

Table 3.

BP23in
21
5
11101
10001
10101
10101
11001
11101
10101
10001
10101
10101
11101
10000
11101
11101
11101
10101
11101
00000
00101
11101
11111

Applying the software for searching for the so-called closed subset pairs, a listing was conducted. Eight such pairs were found, shown in *Table 4.*

Table 4.

BP23out

1> [1 6 11 13 14 15 17 20 21 22 23]:{ 1 2 3 5 }
2> [1 5 6 11 13 14 15 17 20 21]:{ 1 2 5 }
3> [1 3 4 6 7 9 10 11 13 14 15 16 17 20 21]:{ 1 3 5 }
4> [1 3 4 6 7 9 10 11 13 14 15 16 17 19 20 21]:{ 3 5 }
5> [1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 17 20 21]:{ 1 5 }
6> [1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 17 19 20 21]:{ 5 }
7> [1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 20 21]:{ 1 }
8> [21]:{ 1 2 3 4 5 }

For example, the meaning of the eighth pair is this: The pupils' group with code 21 is the largest group of pupils in which all members solved items 1, 2, 3, 4 and 5 — and the task type group 1, 2, 3, 4 and 5 is the largest task group in which all items were solved by pupil {21}. *(see Figure 1)*

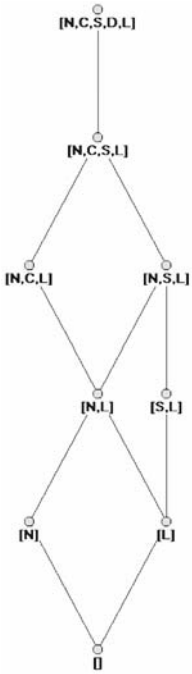

Figure 1. Type of thinking skill structure of class 23.

What does a graph point means? In these graphs each such point indicates, on the one hand, the largest group in which each pupil solved all the elements of a task type. On the other hand, it means the largest task type group solved by the pupils' group indicated. To simplify the chart, not all pupils appear with their code numbers – such notation is given only for the highest scores.

This figure illustrates that pupils who solved only one task type did so either in the Listing or in the Naming category. Classification appears one level higher, Selection yet

one more level up, with only one pupil, with code {122} being able to solve all five categories. This fifth type proved the most difficult task, Description (Definition). When looking at *Table 3*., we can see that the number of pupils grouped at one point ranges from one to twenty-one, but these are not marked.

Conclusions

The first conclusion is that for each task type, a difficulty index can be established. The easier a task type, the more pupils solve it. Also, more difficult types are based on easier ones. We usually find most pupils on the first level, with their numbers decreasing at the higher levels. Also, if, for example, N appears on the first level, N and C appear together on the second – meaning that knowledge of the former is required for the latter.

The analysis shows the following data:

I. Listing
17, 1st level
5, 2nd level
1, 3rd level
23 in total

II. Naming
14, 1st level
4, 2nd level
3, 3rd level
2, not available
23 in total

III. Classification
5, 1st level
9, 2nd level
5, 3rd level
2, 4th level
2, not available
23 in total

IV. Selection
5, 1st level
5, 2nd level
8, 3rd level
1, 4th level
4, not available
23 in total

V. Description
2, 1st. level
2, 2nd level
1, 4th level
7, 5th level
11, not available
23 in total

Listing appears seventeen times on the first level, Naming fourteen times, whereas the most difficult type, Description, only two times. This task type is completely missing from eleven classes: there are eleven classes where not even one pupil was able to solve a D type item.

Based on empirical data we can postulate an order for the various cognitive types – that is, those that are more and those that are less likely to be solved by the pupils. Another important finding is that Description (Definition) proved most difficult. Géczi (2001) also pointed out that biological knowledge is determined by verbal skills, rather than by school teaching or everyday experience. The two independent studies verify the results.

As for task types in the Listing and Naming categories, they are solved with a much higher frequency than the rest, lending further support to V. Takács's findings (2002) related to solving physics tasks. It was claimed there that pupils perform better on tasks that can be memorized possibly because teachers go through them rigorously. Furthermore, knowledge of these tasks is ranked higher when grades are given – which is why there is a large gap between test results and grade averages, ranging between 30 and 60% for physics and 19 and 67 % for biology. In biology, it is listing and naming that are easy to memorize and recall, without any significant cognitive effort.

Achievements – IQ-s

When we consider each pupil's IQ value (IQ category) and unify the results of data of the 23 classes by the different categories we get the following table. *(Table 5.)*

IQ categories:
W – WEAK
B – BELOW THE MEAN
M – MEAN
G – GOOD
VG – VERY GOOD
R – REMARKABLE
E – EXCEPTIONAL

Table 5. Unified table of thinking skills and IQ-s

	N	*S*	*C*	*D*	*L*	*MEAN*
W	66	46	33	20	80	49
B	62	52	66	0	86	53
M	78	69	74	26	83	66
G	77	45	59	18	91	58
VG	78	50	50	21	93	58
R	60	73	66	20	100	64
E	100	57	71	21	100	70
MEAN	74	56	60	18	90	

(For details about the procedure, see V. Takács's paper, *page 41*.) On the basis of the table we can draw these diagrams: Achievement -(A%) as a function of IQ, and Achievement (A%) as a function of task category.)

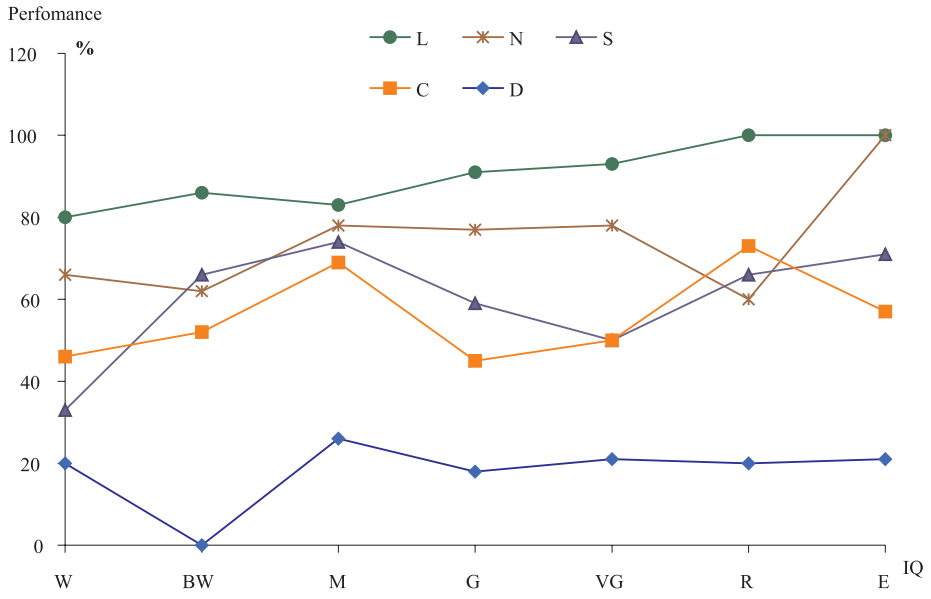

Figure 2. Achievement -(A%) as a function of IQ

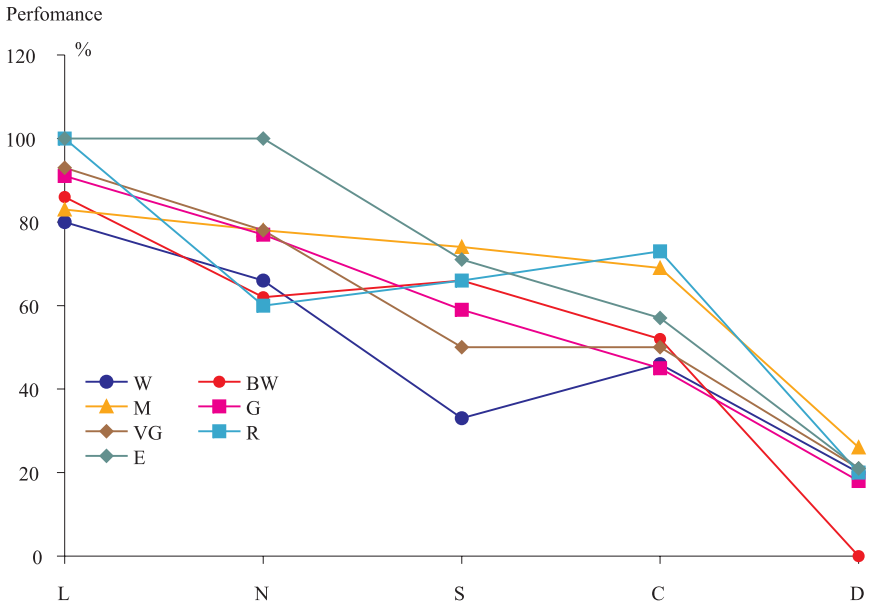

Figure 3. Achievement (A%) as a function of task category.

The distribution of the processed sample is shown in *Fig. 4.*

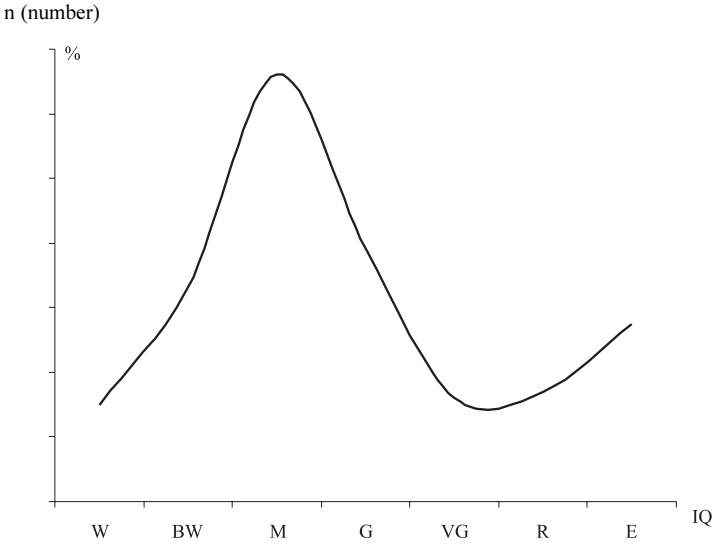

Figure 4. Distribution of the processed sample

Conclusions

The S (SELECTION) can be interpreted as a logical operation: among the elements of a set which all have the same properties one has to search for one element which has at least one property differing from the others.

The C (CLASSIFICATION) is interpretable as a logical operation: a certain set of elements have identical properties, but at least one property a subset of the set differs from the others.

These two categories are very similar but not identical. Therefore, it is understandable why are so near their curves.

Both *Fig. 2.* and *3.* prove that the D (Description/Definition) are independent of biological knowledge but the verbal skill.

The curves of L (LISTING) and close to It the N (NAMING) lies so high, which proves that a pupils' main task – for the teachers – to memorize and this type of knowledge is over evaluated. It can be the explanation for the difference between the marks given by the teacher and our test (67% versus 19%).

New result: the most difficult – D – and the easiest – L – types of tasks are independent of the IQ.

References

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