EXAMINATION OF TEACHER STUDENTS' INDUCTIVE THINKING ABILITY

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Abstract: Available literature on researching inductive thinking ability is really rich. Our study presents three types of approaches: it is (1) a constructive element of intelligence, (2) the decisive method of human learning, (3) a key competence playing an important role in understanding. The main objectives of our research were to (1) determine the development level of the inductive, and within that the abstract and analogue thinking of the teacher students starting their studies in higher education, (2) find the background variables by means of which significant differences can be found between the various student groups, (3) respond to the question whether any conclusions regarding the performance expected in the inductive test can be drawn based on the time spent on solving the tasks. The students' analogue reasoning and rule induction are more developed than their diagrammatic thinking. One of the preconditions of a good result achieved in the inductive test is the full utilization of the available time frame. Introducing the ide of specific performance we found that the students having achieved the best results were studying at teacher specialization in full time training, lived in cities and had parents with a degree. The students could be properly grouped according to the time used for problem solution: (1) negligent and superficial, (2) reflective but not persistent enough; (2) persistent and diligent. Knowing the type of training and specialization of the students helps defining/understanding the clusters.

Keywords: inductive, analogue and diagrammatic reasoning, teacher training, specific learning performance, task solution time

1 Background

The students' intellectual capacities to meet university requirements is one of the most significant risk preliminaries identified by the relevant literature (O'Neill et al., 2011; Stewart et. al., 2015; Sarra et al., 2018). The justification of focusing at the vulnerability of university studies (Sosu- Pheunpha, 2019) is directly connected to the policies of the world's governments the objective of which is to achieve equity and social justice in the access to higher education (UNESCO, 2015). However, the impact of this vulnerability is not deterministic; it is in close connection with psychological factors like self-efficiency and self-control that are important indicators of university persistence (Richardson et al., 2012; Respondek et al., 2017). The papers focusing at the learning results reveal the fact that an integrated learning of the education content leads to better conceptual understanding, improves cooperation skills, the students' capacities to solve problems and critical and inductive thinking at all levels of school education (Roberts, 2009; Cervetti et al., 2012; Darwish, 2014; Zahatňanská – Nagy, 2020). The results of several studies have declared close connection between abstract reasoning and educational results (Bennedsen - Caspersen, 2006; Armoni, Gal-Ezer, 2007; Roberts, 2009). Abstract reasoning is inevitable to comprehend and interpret scientific concepts (Darwish, 2014).

Inductive reasoning and thinking can be explained from three various points of view.

The first idea reckons the ability of inductive implication and reasoning among the elements of intelligence (Wilhelm, 2005). Intelligence can be defined as using intentional mental operations to solve new problems. These mental operations include implications, the creation and classification of the concept, generation and testing of the hypothesis, identification of the relations, understanding the consequences, problem solution and the extrapolation and transformation of information (Dumontheil, 2014). Thus intelligence is closely connected to inductive reasoning and thinking (Ferrer et al., 2009). It is thought that intelligence is a basic constituent of cognitive development (Goswami, 1992) and provides as the base for gaining various capabilities in various fields in childhood and adolescence, as well (Blair, 2006; Ferrer et al., 2009). Childhood intelligence is an apt indicator to forecast cognitive school performance (Gottfredson, 1997; Primi et al., 2010). So intelligence is a predictor of learning effectiveness, especially in new and complex situations.

The second view comprehends inductive reasoning, and within that abstract thinking, as an important method of human cognizance. By means of this we become able to extract the essence from complicated and abstract issues and to realize the interconnections. This is particularly essential in understanding knowledge in natural sciences. Abstract reasoning and thinking plays an important role in drawing conclusions, forming opinions, recognizing rules and regularities, i.e. in logical thinking as well as in concept creation (Inhelder, Piaget, 1958; Schwank, Schwank, 2015; Brendefur, Rich, 2018; Devi, 2019). Researchers have proved that the pupils quitting the nursery school in lack of the basic competencies in mathematics would face serious difficulties at primary and secondary schools, as well (Duncan et al., 2007; Jordan et al. 2009; Morgan, Farkas, Wu, 2009). It is, however, important to emphasize the fact that the development of inductive reasoning and thinking is influenced by several other biological, psychological, social and cultural factors, too (Amsel, Moshman, 2015).

According to the third approach, inductive reasoning is a key competence (Kramer, 2007) in achieving learning successes and results and in comprehension, which is mainly stressed by the teachers of mathematics, computer sciences and natural sciences (Iqbal, Shayer, 2000; Kuhn et al. 1977; Adey, Shayer, 1994; Szőköl – Nagy, 2015). Puberty appears as the critical phase of the reorganization of regulatory systems (Steinberg, 2005). Blakemore (2012) has shown that puberty is a period of permanent neurological development that may last longer than that suggested by Inhalder and Piaget's (1958) and Piaget's theory (Piaget, 1972). This was also proved by the examination of pupils' skills to solve simple algebraic equations. The gained results showed that younger students were less precise and were slower when solving the equations with letters and symbols than they were when using numbers. Küchemann (1981) reported that most of the students under 15 do not know algebraic letters (symbols) as unknowns or universal numbers, which can be expected of operative thinkers. This difference disappeared with older pupils (aged 16-17), which refers to the fact that they reached an abstract level of argumentation (Markovits et al., 2015). Similar conclusions were drawn based on the analyzation of their strategies, which indicates that the younger pupils had mostly used strategies like the embedment of numbers while older students had generally followed more abstract and rule-based strategies. Kusmaryono et al. (2018) reported that none of the pupils aged 14-15 had reached the quality stadium of inductive reasoning. Darwish (2014) presented similar results and also stated that only 42 percent of the first-grade teacher students at natural scientific specializations were capable of formal cognition, which shows that university students are late in cognitive development (Cohen, Smith-Gold, 1978) or in reaching the expected level of abstract thinking. These outcomes, too, point to the fact that the development of algebraic cognition is a process taking long time to evolve (Susac et al., 2014).

During the latest 25-30 years, many researches examined the inductive reasoning of teacher students (Astin, 1997; Bowman, 2010; Darwish, 2014). These on one hand prove that dealing with natural sciences needs a high level of inductive and abstract reasoning, which may ease the proper teaching of abstract theories (Darwish, 2014); on the other hand, they emphasize the importance of teachers' vocational development (Brendefur et al., 2016; Brestenská et al., 2019), and highlight the most effective elements of vocational development (Koellner et al. 2011; Desimone, 2011; Sztajn et al., 2011). Yoon et al. (2007) write that most of the researches related to the vocational development of mathematics disproved an improvement in the pupils' performance as the characteristics and competencies necessary to change the teachers' practice were lacking.

However, latest researches have found contrary results. Nagdi et al. (2018) identified cooperation, flexibility, the knowledge of pupils' needs and openness to equality and inclusion as the key elements of the personal characteristics of STEM (science, technology, engineering and mathematics) teachers. The notions conform to the literature on teacher identity (Akkerman, Meijer, 2011; Franzak, 2002; Schutz et al., 2018) where the nature of teacher identity is considered a dialogue concept in which personal and professional experiences interact with the so-called STEM-skill. Searching the problem from the students' aspect, one will find that the pupils' STEM knowledge, skills and abilities can be supported by the informal learning environment (Denson et al., 2015), which can have a positive impact on pupils' interest in STEM (Denson et al., 2015; Mohr-Schroeder et al. 2014) and may increase the probability of the continuation of a STEM career during higher education studies (Kitchen et al. 2018; Kong et al., 2014).

2 Aim of research

The main objective of the empiric research was to (1) determine the development of the inductive, and within that the abstract and analogue thinking of teacher students starting their studies in higher education, (2) find the background variables by means of which significant differences can be detected between the various groups of students and (3) respond to the question whether any conclusions regarding the performance expected in the inductive test can be drawn based on the time spent on solving the exercises.

3 Materials and methods in research

We face a question here: how could it be possible to measure reliably the students' inductive, and within that abstract reasoning without the specific subject knowledge and competences (e.g. in mathematics or physics). There are several methods available, like some intelligence tests (e.g. Raven), tests measuring abstract reasoning or measuring tools focusing at the given competence component.

During our research we applied the measurement tools elaborated by Psychometric Success WikiJob Ltd. (UK, London) that lays great stress on labour market expectancies (Newton, Bristoll, s.a.). These tests were built on single- and multiple-factor intelligence theories (Mackintosh, 1998).

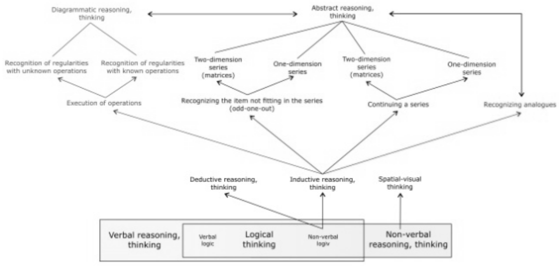
Spearman, for example, was of the opinion that there is one or several common factors existing in terms of the solution of each intellectual task that is a pledge of success (Mackintosh, 1998). He divided the g-factor of intelligence into two parts: (1) inductive logical (eductive) and (2) reproductive skills related to storing and recalling information. The Raven-test, for example, connects to the previous one, while vocabulary test belongs to the latter (Kane, Brand, 2003).

Eductive competences refer to logical operations based on conclusion by means of which, through the recognition and comprehension of interconnections and the consideration of the contextual content, new knowledge is created from the perceived information. To understand the whole of the problem, holistic approach is needed while its solution demands the ability to recognize the relations and interdependences between the parts. Understanding the problem is more than comprehensive pattern recognition (Gestalt); it is also necessary to highlight the essence and neglect unimportant elements. In most cases, these are not possible to be verbalized, therefore, the measuring tools mainly consist of geometrical figures (squares, polygons, circles etc.). The perception of these geometrical forms, the recognition of their typical characteristics and the comprehension of the relations between them is dependent on the existing knowledge on one hand and certain cultural effects on the other (Kane, Brand, 2003). The previous one is in harmony with the inductive operations (Klauer, Phye, 2008). As for the latter, one of the main advantages of the test must be stressed: it is, to a certain extent, culture-independent.

Paul Newton and Helen Bristoll (s.a.) elaborated an inductive reasoning test building on the Raven eductive skills measurement test but paying more attention to career aspects in nature sciences. To examine cognition based on inductive reasoning and thinking, they developed the skills structure presented in Figure 1.

The problem for the solver lies in the difficulty to realize the logical relations hiding behind the patterns in the tasks. The problems root in the difficulty to recognize the changes or the iteration of the following characteristics: (1) form, (2) size), (3) colour and (4) pattern. The tasks consist of visual patterns and geometrical figures, and the series (one-or two-dimension matrices) must be continued, or the elements not fitting be found, relying on the recognition of the logical interrelations behind them.

Figure 1: The task system examining inductive reasoning and thinking



In our research, we used an inductive and abstract reasoning online test made of 30 items where the certain types of exercises contained 6 items:

- Continuation of one-dimension series
- Recognition of the ('odd-one-out') elements not fitting in the one-dimension series
- Recognizing an analogue
- Recognizing regularity – unknown operation (examination of diagrammatic reasoning)
- Recognizing regularity – known operation (examination of diagrammatic reasoning)

One- (series) and two-dimension matrices demand the capability to recognize various interconnections that in many cases are not evident at the first instance. The recognition of connections between geometric figures can be isolated from the identification of single figures. This latter one must be clear-cut for each person in the experiment. According to Spearman (1927), the perception of the geometrical forms immediately elicits knowledge created about the connections, and this is true vica versa, as well. All this means that perception, observation and abstract thinking make one whole during cognition. When solving the problem, each characteristic of the geometrical figures must be observed simultaneously, their interconnections must be understood and perception must be precise to the smallest details. No good solution can be born without recognizing the "whole", however, identifying the "parts" is of decisive importance, as well (Georgiev, 2008).

In terms of identifying analogues, already Sternberg pointed to the fact that the difficulty of the problems lies in the recognition of regularities originating in the change of the characteristics of the certain objects (A, B, C, D) for which the relation(s) (R) in terms of A and B must be recognized and then applied in terms C and D to identify D (Sternberg, 1977):

A – R – B :: C – R – D

He found that the experimentee may follow two strategies in selecting object D: (1) (s)he considers the potential D candidates one by one, and examining each of their characteristics chooses the object fitting in the recognized relation the most (sequential search), or (2) examines the characteristics one by one in terms of each potential object D and then selects the one in the case of which all the characteristics are the most suitable according to the recognized relation (alternative search).

The analogue mappings applied during the research are consistent while the structure mapping processes playing a role in the analogue are selective. The latter one refers to both the individual characteristics and relation (Boulton-Lewis, Halford, 1992).

The test examining diagrammatic thinking was focused at accomplishing tasks as well as recognizing and accomplishing them. Flow charts are presented through which the impacts exerted by the so-called operators (rules) on various figures can be detected. The first task of the experimentee is to conclude the functions of the certain operators or operations based on the diagrams (flow charts), and then relying on this knowledge, select the missing output.

The test measures the ability of how logically the subject is able to follow the arranged sign series. Although the test consists of simple flow charts, its solution requires the experimentee to be able to track the changes taking place in the form, colour and size of the objects. This skill is outstandingly important, for example, when analysing certain system processes, in error correction and in system planning (Stieff et al., 2010).

Items similar to the applied test can be seen at: http://www.psychometric-success.com

Several researches examined whether it was possible to draw conclusions in relation to the difficulty and performance from the time used for the solution of identical items. Jacobs and Vanderventer thought that the difficulty level of the items was in connection with the number of the characteristics that had to be compared and remembered (Georgiev, 2008), so those achieving better results were able to keep several thing in mind at the same time; however, it could also mean that they spent more effort on the given item (Jacobs, Vandeventer, 1968). Vodegel et al. refer to the work of Home and Habon who found it was not possible to draw conclusions concerning the difficulty level of the items from the time spent on solution (Vodegel et al., 1994).

4 Materials and methods in research

The research involved 204 first-grade teacher students of J. Selye University. The demographical data of the participants are summarized below:

- Gender: 17.6% (N=36) male, 82.4% (N=168) female,
- Age: M=25.10 years, MOD: 20 years, SD=8.267 years, 76 persons (37.2%) between 19 and 20, while 49 persons (24.0%) between 21 an 22,
- Father's highest education level: primary school 9 persons (4.4%), vocational school 85 persons (41.7%), secondary technical school 72 persons (35.3%), secondary grammar school 18 persons (8.8%), higher education 20 persons (9.8%),
- Mother's highest education level: primary school 17 persons (8.3%), vocational school 47 persons (23.0%), secondary technical school 85 persons (41.7%), secondary grammar school 24 persons (11.8%), higher education 31 persons (18.2%),
- Place of living: city 92 persons (45.1%), other settlement 112 (54.9%),
- Country of secondary school leaving exam: Slovakia 120 persons (58.8%), Hungary 83 persons (40.7%),
- Type of the school of secondary school leaving exam: four-grade secondary grammar school 70 persons (34.3%), eight-grade secondary grammar school 9 persons (4.4%), secondary technical school 113 persons (55.4%) and adult education 12 persons (5.9%),
- Language of teaching at secondary school: Hungarian 182 persons (89.2%), Slovakian 12 persons (5.9%), bilingual 10 persons (4.9%),
- Specialization: teacher training 57 persons (27.9%), nursery school education 127 persons (62.3%), pedagogy and public education 19 persons (9.3%),
- Training: full-time 145 persons (71.1%), correspondence 59 persons (28.9%),
- Place of stay during the studies: live at home 127 persons (62.3%), at dormitory 71 persons (34.8%), in lodgings 6 persons (2.9%),
- Family conditions: live with their families 160 persons (78.4%), with life-partner or spouse 31 persons (15.2%), alone 7 persons (3.4%), with a friend 6 persons (2.9%).

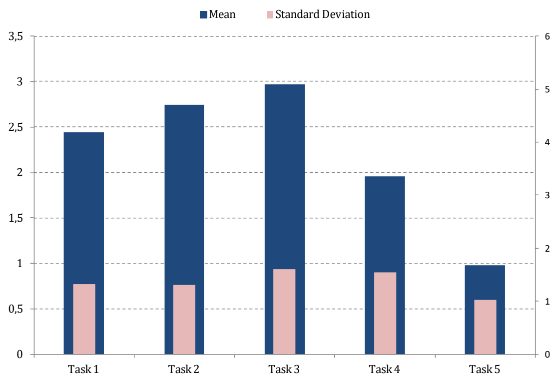
According to the above presented data, most of the students hade their secondary school leaving exams in Hungarian, at secondary technical schools, and the rate of those having applied for the full-time nursery school teacher training is high. A high proportion of the students took their exams in Hungary. As for the parents' education level, the rate of those with secondary vocational education is high.

5 Results

First we compare the results achieved by the students during the solution of the certain tasks. There were 179 students who solved each type of the exercises. As shown in Figure 2, the results remained under the average. The students' diagrammatic reasoning proved to be especially underdeveloped. The best results were reached in the exercises demanding analogue thinking, however, standard deviation is also the biggest here.

According to Kolmogorov and Smirnov, the components of abstract reasoning and thinking are not of normal distribution, however, because of the permissive conditions (Kurtosis/Std. Error of Kurtosis and Skewness/Std. Error of Skewness, i.e. they are under 2.58) (Rumelhart, 1989) we still accept them as that.

Figure 2: Breakdown of averages and standard deviation of abstract reasoning by exercises



During the pilot measurement, the students had 25 minutes to solve the problems, which proved to be insufficient in some cases. The items could be solved only one after the other. The online system registered the time used by the students by items. Analysing the gained data, two statements can be made.

- Figure 3 indicates the average time spent by the students who started to solve the given item. As for task types 4 and 5, it can be seen that the average amount of time spent on the first exercise is very high as compared to that spent on the rest of the items. This means that it was difficult to understand these two types and to explore the interconnections. The high standard deviation value of the tasks proves this fact, as well.
- We created three categories by task types (weak performance: 0-2 points, medium performance: 3-4 points, good performance: 5-6 points). Figure 4 shows that the number of those gaining low numbers of points swelled at Task 4.

Figure 3: Time consumption by items

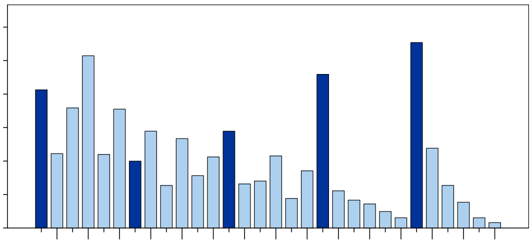
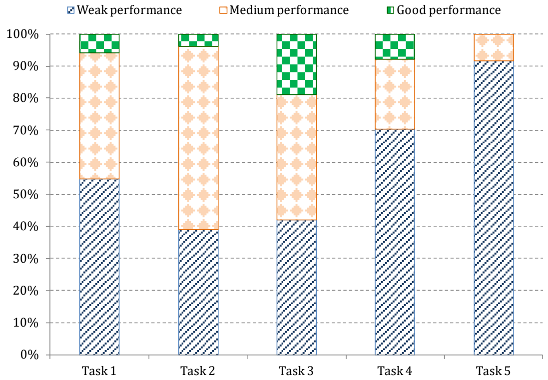
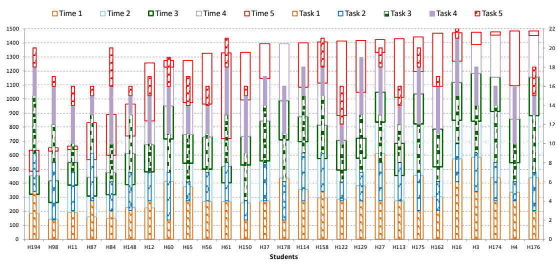


Figure 4: Proportion of student performance categories by task type



Now let us examine the students who achieved higher scores as compared to the whole of the group, i.e. whose abstract and inductive reasoning is more developed. There are 27 students of this type. The points (filled columns) and time usage (empty columns) of these students are presented in Figure 5, by time consumption, in an increasing order, from left to right. In the cases of the first six students it is clearly visible that they achieved higher scores even with relatively low time consumption. These students gained 16-20 points in a time less than 16 minutes (superficial but quick-witted). The next category is again made by six students, they achieved similar results in less than 21 minutes (considered and clever). The rest of the students used almost all of the time available (24-25 minutes) and reached good results (slow and clever).

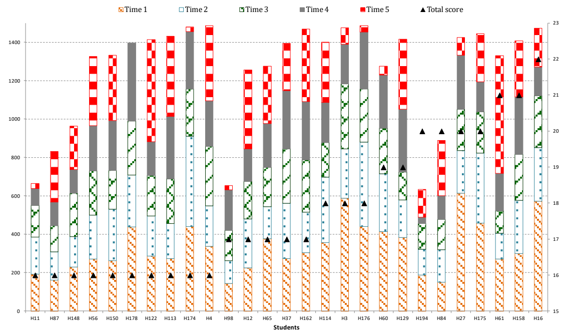
Figure 5: Scores of 27 students achieved in the test and the time consumed



Remark: Time is indicated on the left hand vertical axis and the scores on the right one.

To demonstrate success, we introduced the concept of specific performance. In the inductive test, we can understand specific performance as the time necessary to achieve a unit of score, which was defined as the ratio of consumed time and achieved points by tasks: timex/scorex where timex indicates the time spent on solving task x (6 items) by seconds, while scorex represents the score reached during this time. We put the students reaching the highest scores in this dimension, as well. We considered 300 sec/point as high specific performance, which means that the student achieved a high number of points using little time. The value between 300 sec/point and 450 sec/point was assessed as specific performance of medium level, and the values above were considered low specific performance, i.e. a high amount of time was used to reach one unit of points.

Figure 6: Specific performance of the 27 students



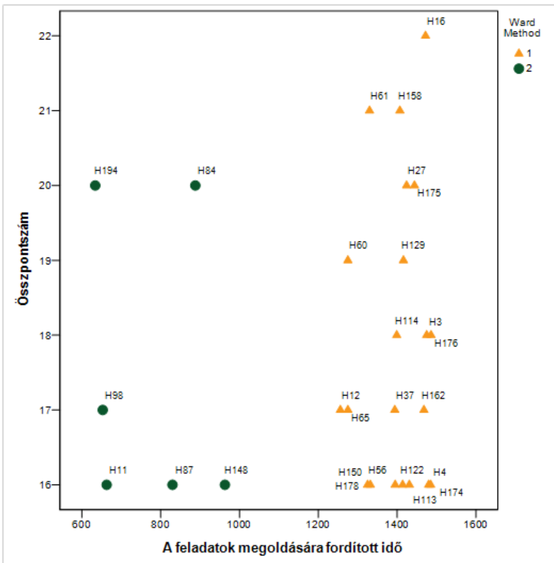
Remarks: Time is indicated on the left hand vertical axis and scores on the right one.

It can be clearly seen in Figure 6 that in almost each cases (except for H60, H174, H178 and H176) it was the last task demanding diagrammatic reasoning that reduced specific performances.

We ranked the students according to the total number of points gained in the five types of tasks (Figure 7). It can be clearly seen that in most cases, the students used the whole of the time frame available, however, each category includes one or two students who achieved results similar to those of the others by using little time. For example, in the group of 16 points, student H11 and H87, H98 in the group of 17 points and students H194 and H84 in the group of 20 points.

We can state that using the whole of the time available does not necessarily bring about a high score, however, it can be seen that almost each of the students having gained more than 20 points utilized the 25 minutes left for them for the test.

Figure 8: Time consumption and final score of the best 27 students, divided in two clusters



We also examined the results of the 27 students performing well in the test by cluster analysis (Figure 8). The first group indicated with triangles includes the sober ones utilizing the whole time frame, while the second group involves the impatient and superficial ones seeking quickness. We analysed the clusters according to the cluster centroids (Table 2). The averages were examined by variance analysis. No significant differences were found in terms of the achieved scores, however, there were significant differences between the certain cluster centroids in terms of time consumption (F=222,902; p<0,05). Time consumption accounts for 89.9% of the standard deviation. We checked the reliability of the hierarchic cluster analysis by the K-mean process but found no major discrepancy between the results.

Table 2: Cluster centroids and standard deviations

Cluster		Number of points gained in the test	Time used for solving the task
1	N	21	21
	M	17.90	1399.19
	SD	1.947	73.352
2	N	6	6
	M	17.50	771.83
	SD	1.975	140.276
Total	N	27	27
	M	17.81	1259.78
	SD	1.922	280.295

Concerning the background variables of the 27 students having achieved good results, the following statements can be made:

- their parents have a degree, it is especially the rate of the mothers that is high as compared to the participants of the research,
- most of them are nursery school teacher students who
- took their secondary school leaving exams in Hungarian speaking schools and
- at a correspondence course.

We examined the background variables of the 7 students who had reached the best results (≥20 points) separately. In their cases, the pattern of the background variables changed to some extent:

- their parents have a degree, the rate of mothers with higher education is especially high as compared to all participants of the research,
- most of them are teacher students,
- they took their secondary school leaving exams in Hungarian-speaking schools and
- in full-time training.
- These students live in cities and
- possess work experiences, most of them in educational fields, despite the fact that five of the seven attend full-time training.

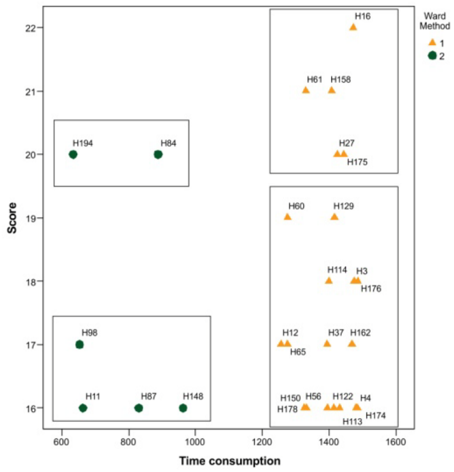
In terms of task solution, two groups can be created (Figure 8): superficial but quick-witted (≤1000 sec) and prudently thorough (>1000 sec).

The pattern of the superficial but quick-witted ones (6 persons) has the following characteristics:

- their parents do not have a degree,
- they live in smaller settlements,
- they studied in Hungarian-speaking secondary grammar schools previously,
- are in full-time training now,
- in teacher training.

In relation to the superficial but quick-witted ones it must be remarked that for students H83 and H194 it is rather the latter attribute that should be used because low time consumption goes hand in hand with high scores (Figure 9).

Figure 9: Time consumption and total score of 27 students distributed into 4 groups



And as for the prudently thorough ones (21 persons):

- parents with a degree make the majority but the rate of the mothers with no secondary final exam and that of the fathers with a secondary final exam is also high,
- they live in cities,
- significantly most of them are involved in the correspondence training
- and the nursery school teacher specialization.

Among the sedate ones, a group of students achieving good results with high time consumption can be observed (upper right corner of Figure 9) as well as another group reaching lower scores, however, cluster analysis did not give a proof of this.

We also checked the relation of time consumption and achieved scores in terms of the whole sample (Figure 10). This relation can be sufficiently described by an exponential function:

*Score = 6.48*exp(0.00055*time consumption)*

The model accounts for 39.9 percent of all of the variances. The ANOVA survey indicates a significant regressive relation (F=100.318; p<0.05).

Finally, we made the cluster analysis of the whole sample. We came to a conclusion similar to that regarding the students with good results, i.e. clusters can be created according to the time used for task solution. In this case, three groups can be created (Figure 11):

- neglectful and superficial ones,
- sober-minded but not persistent enough and
- persistent and diligent ones.

Figure 10: Relation between time consumption and total score of the whole sample

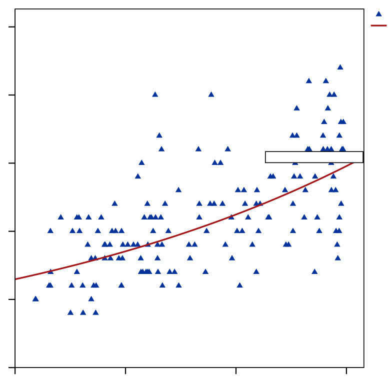


Figure 11: Clusters composed of the whole sample

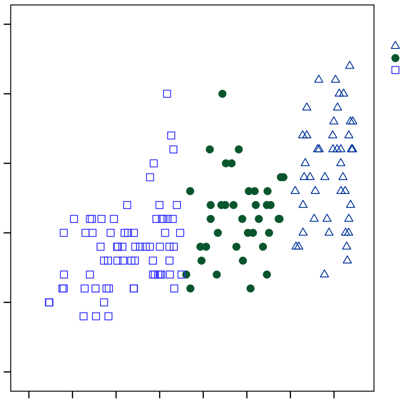


Table 3: Cluster centroids and standard deviation

Cluster		Total score during the test	Time used for task solution
1	N	45	45
	M	1378.36	14.51
	SD	84.658	3.841
2	N	38	38
	M	961.000	11.21
	SD	128.830	3.024
3	N	70	70
	M	455.79	8.93
	SD	166.251	2.994
Total	N	153	153
	M	852.61	11.14
	SD	419.463	4.023

Each of the three groups contain students having reached low as well as high scores, however, the tendency is what is described by the regression analysis.

Reliability here was checked by the K-means procedure and was found sufficient. The data of the cluster centroids are summarized in Table 3.

Figure 12: Belonging to the clusters by the type of training

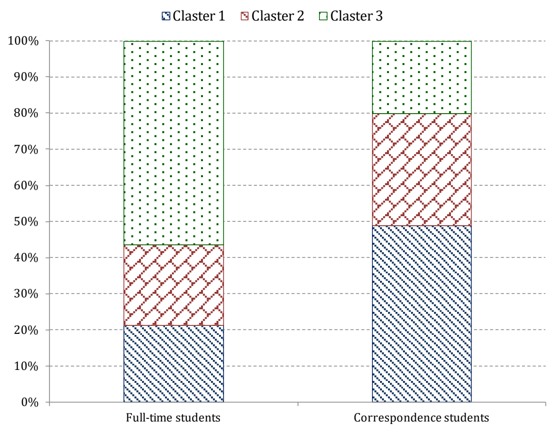


Figure 13: Belonging to clusters by specialization

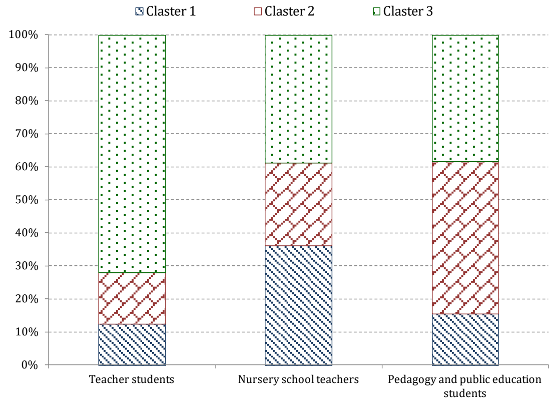


Table 4: Description of clusters

	Cluster 1	Cluster 2	Cluster 3
Time used for task solution	less	medium	more
Achieved result	5 – 20 points	6 – 20 points	7 – 22 points
Type of training	correspond-ence	full-time and correspond-ence	full-time
Specialization	nursery school teachers	pedagogy and public education	teacher students, nursery school teacher students

We examined the composition of the clusters in terms of the background variables for the whole sample (Figure 12-13). The higher rate of full-time students belongs to cluster C3 while that of the correspondence students to C1. Most of the teacher students belong to C3, most students of pedagogy and public education to C2 while nursery school teacher students mainly belong to C1 and C3. We proved it by Chi-square test that there is significant correlation between the type of training and classification into clusters ($F= 18.473$; $p<0.05$) as well as between the specialization and belonging to a cluster ($F= 15.138$; $p<0.05$). Table 4 presents the summary of these by describing the clusters.

6 Conclusions

The objective of our research implemented with the participation of 204 first-grade teacher students was to (1) determine the development level of their inductive, and within that abstract and analogue as well as diagrammatic reasoning and their rule induction; (2) respond to the question whether it is possible to draw conclusions from time consumption regarding the performance expected in the inductive text; (3) identify the background variables by means of which significant differences can be detected between the student groups. We have found the following answers.

(1) The students' analogue reasoning and rule induction are much more developed than their diagrammatic reasoning.
(2) One of the preconditions of achieving a good result in the inductive test is the utilization of the whole time available, however, maximal time utilization does not necessarily bring about outstanding performance. Each of the students having gained high scores used the available time fully. Introducing the notion of specific performance, we found that the students with the best results are involved in full-time teacher training, live in cities and their parents have a degree. Specific performance was mainly deteriorated by the high amount of time used for the diagrammatic exercises.
(3) Students can be well grouped by time consumption: (a) neglectful and superficial, (b) considered but not persistent enough, (c) persistent and diligent. Knowing the type of training and specialization of the student helps us understand the clusters.

The deficiencies in diagrammatic reasoning are less problematic in teacher training; developed rule induction and analogue thinking are, however, of outstanding importance in understanding the learning content.

In the next phase of the research we wish to explore what results will be achieved during their first-year studies by the students who have reached good results in the inductive test. Do good study results follow from developed inductive reasoning and thinking? And likely: are poor test results able to predict learning difficulties?

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