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AGE AND THE CHANGES OF TRANSFER IN PUPILS' INTELLIGENCE

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Abstract. *The researches inspired by Ferguson's hypothesis on educability of abilities that intelligence, as the general mental ability can be practised through the system of mental operations, specific and concrete components which are essentially conditioned and connected and, due to transfer, generalized. The results of this experiment, carried out with children from the third to the eighth grade of the elementary schools, showed the following:*

- 1. Practising algorithmization of cognitive functions and logical perceptive games has significant and durable transfer effect on the growth of pupils' intelligence.*
- 2. The amount of transfer of this practise on the age of pupils the type of tests and the stage of growth of intelligence: a) Spearman's basic principles of cognition (relation education and correlate education) can be significantly developed; furthermore, more efficiently developed with pupils in the fourth, seventh and the eighth grades than with pupils in the third, fifth and the sixth grades; and ultimately more efficiently developed with pupils of lower intelligence. b) the ability of conceiving, understanding and defining notions can also be significantly and durable developed of these stages of growth, than, more efficiently developed with pupils in the seventh and eighth grades than with pupils of other stages; and ultimately, in the majority of the examined grades, with pupils of lower intelligence.*
- 3. This type of programme shows transfer activity even after its completion. This was evident only in the tests based on Spearman's laws of education.*

To measure intelligence we have applied the following tests: 1) Raven's progressive matrices, 2) Word defining, 3) Verbal analogies, 4) Word pairs. The subjects were pupils from the third to the eighth grade of three elementary schools from Jagodina. 542 of them were examined. Therefore, the results of this experiment show that the level, speed, direction and quality of the growth of intelligence depends on the interaction among the factors of heredity, environment, experience and training. We believe that the period that was included in the experiment is still the period in which the significant interaction among these factors is realized in the growth of intelligence.

1. INITIAL ASSUMPTIONS

The educability of intelligence includes the conditions which would improve the developmental intellectual potentials of a child and provide optimal functioning.

According to Ferguson's (1954) standpoint, the basic variables of transfer are certain skills which are the product of specially planned activities (experimental programmes). The skills created in that manner exhibit the transfer power when adapting to new situations.

In Yugoslav psychology, an impressive number of studies in the field of educability of abilities has been done by R. Kvašček. In one of his researches, Kvašček determined that the intelligence of an individual or a group can be significantly and durably developed under the influence of the examinees practising creative solution of problems. Kvašček thought that the subjects under the influence of this practise developed intelligence on two levels: on the level of intelligence that measures the results of mental faculties and on the level of changing and developing psychological mechanisms of the functioning of mental abilities.

The important notional basis for this research of intelligence of today is the informational-process approach. Lately, according to Stankov, there have been attempts where people were trained to understand a text better, (to) acquire vocabulary, (to) think inductively and deductively, (to) memorize words (Belmont, Butterfield, and Ferethi 1982; Glaser and Pellegrino 1982; Sternberg, Ketron, Powel 1982). These researches differ from Kvašček's approach. The difference is first of all, in the more specific choice of exercises, the procedure of training, the planning strategy and contents of training. These skills are supposed to have greater transfer value on the intelligence tests.

Our research into the area of educability of perceptive and intellectual abilities which included the pupils of the sixth grade of an elementary school showed that these abilities could develop in two ways:

- a) directly-by practising visual perception of pupils.
- b) indirectly-by pupils practising the algorithms of perception and the methods of solving mathematical tasks.

The effects of this practise were more durable.

In this course of this research, a few questions stood out as prominent, like the following: (1) do the effects of the experimental programme depend of the pupil's age, (2) does the amount of transfer depend on the level of the growth of intelligence, (3) do the experimental programmes significantly influence the success of the which register the so-called fluid and crystallized intelligence.

2. PROBLEM AND HYPOTHESES

The basic problem of this part of the research was to examine whether there were any changes in the growth of intelligence with pupils from the third to the eighth grade of the elementary school under the influence of their practising algorithmization of cognitive functions and logical-perceptive games. Within the frame of the general problem we also tried to find the answers to the following questions: are the transfer changes more durable and does the amount of the transfer depend on the age, the type of tests, and the level of the growth pupil's intelligence.

The hypotheses were the following:

1. We expected that the pupils practise in the algorithmization of cognitive functions would have significant effects on the growth of intelligence with pupils from the third to the eighth grades.
2. We expected that the experimental programmes would have durable effects on all the examined ages.
3. We expected this type of programme have effects on the growth of intelligence with those pupils who have lower intelligence.

3. METHODS, VARIABLES AND THE SAMPLE

The research was carried out by the method of experiment with parallel groups. The experiment included three ages: an earlier age (the third grade), a middle age (the fifth grade) and the older age (the seventh grade). The pupils were being watched for two school years. The experiment had nine groups: three control groups and six experimental groups. Each of these groups contained 18 classes or 542 pupils. The examined persons were pupils of elementary school from Jagodina.

Before the beginning of the experiment all the groups had been examined with the prepared group of intelligence tests. Then the first experimental group got the experimental programme, whereas the other two didn't have the special programme. After the twenty hour long experiment had been taken there was the first final examining of the following school year. The second experimental group got the same experimental programme whereas the other two remained without the programme. Afterwards, the second final examination of all the groups was taken by the same intelligence tests.

Taking into consideration the great amount of various definitions of intelligence we chose for this research the definition of the professor Stevanović (B. Stevanović). He has defined intelligence as the ability of comprehending various relations between data and discovering new data. Besides, in this experiment we have expanded this definition by including the ability of comprehending, understanding and defining notions.

The experimental programme had two totalities:

- a) the algorithmization of the cognitive functions,
- b) the logical perceptive games.

The main aim of the programme was to make pupils develop mechanisms of cognitive functions, especially of perception and thinking. We can enumerate the following mechanisms as the most important the mechanisms of identification, classification, elimination, perceptive discrimination, the discovery of relations, the operations of analysis, synthesis, comparison, estimation, generalization, transformation and so on.

The imagined aims included into algorithmization of the cognitive functions were achieved by realization of the following exercises.

- the practise of the speed and accuracy of finding a given element,
- algorithms for the precise copying of the samples (models),
- algorithms for revealing the relations between the elements in the perceptive field,
- algorithms for revealing the figures that have the same shape, the same shape and size, the same shape and position, the same position and size and finally, the same position, shape and size.
- algorithms for visual memorization of the objects in space and graphical realizations.

The following concrete games were realized in the area of logical perceptive games: (1) clasification of elements (2) coinciding of forms (3) assembling of squares (4) new forms (5) fil in the gap.

The experimental programme was realized by combination of algorithmical leading and learning by discovery. The experimental programme was new for most pupils and the pupils had positive opinion on it. The results of polls that were conducted after each exercise proved that. In this research intelligence was measured by the following tests:

1. *Raven's progressive matrices*. This is non-verbal intelligence test. The data of factor-analysis indicate the great presence of G-factor (Spearman's type) in it.
2. *Word defining*. This is a standard scale test of Bine – Simon's type that requires defining of the word meaning. A list of 50 words from New Belgrades Revision of Binet – Simon's scale was taken in this research. The subjects would get a 50 words long list and answer by writing down. Their answers right behind the assigned words. It was a group test. Each answer evaluated by one point.
3. *Verbal analogies*. This is the standard test of verbal intelligence that requires noticing relations between words and suggested words; on the basis of relation that exists between that two words. The test was to be completed for a definite time and each corect answer was evaluated with one point.
4. *Word pairs*. In this test the subjects should chose among 5 possible words (standards) the one that relates the given word pairs in the greatest degree. It was assigned as the test of speed and every corect answer was evaluated with one point.
5. The data were arranged and processed by the applience of co-variance analysis and by testing the significance of the differences between changes.

4. THE RESULTS OF THE RESEARCH

We have examined the effects of experimental programme by comparing the deferences between the results of experimental groups with the results control groups. We have established the following on the basis of that statistical analysis.

4.1. There is a significant transfer of pupils exercises in algorithms cognitive finctions and logical-perceptive games to the success in intelligence tests.

In the first phase of the experiment (the third, the fifth and the seventh grade) in the used tests of intelligence we specified statistically significant differences between groups. The differences in the average improvements are illustrated on table 1.

The analysis covariance and the testing of the significance between differences as well as the given table show that the progress of the first experimental group is remarcably bigger than the progress of the control group and the second experimental group (the group which didn't have programme in this phase). This was proved at all three ages in all the intelligence test. More over, there were some differences between the control and the second experimental group which indicates the natural differences between classes and schools in the progress of the development of intelligence.

In the second phase of experiment (the fourth, the sixth and the eighth grades) the second experimental group was given the experimental programme while the control and

the first experimental groups were without programmes, significantly better improvement of the second experimental group was proved. This was proved for all three ages and in all used tests. These differences between average improvements are represented by table 2. Due to the analysis of covariance and the testing of the importance of the differences, it can be seen that in this phase of the experiment, the improvement the second experimental group is significantly better the improvement of the other two groups.

Table 1. Differences in the Groups Progress and Their Importance at the Intelligence Tests (the third, the fifth and the seventh grade)

	$D_{E_1} - D_K$	p	$D_{E_1} - D_{E_2}$	p	$D_{E_2} - D_K$	p
	(Dm)		(Dm)		(Dm)	
<i>The third grade</i>						
Raven's progressive matrices	3.584	.01	4.154	.01	*0.569	-
Verbal analogies	2.656	.01	3.178	.01	*0.521	-
Word pairs	3.006	.01	2.694	.01	*0.391	-
Word defining	8.477	.01	15.666	.01	*0.412	-
<i>The fifth grade</i>						
Raven's progressive matrices	5.492	.01	3.602	.05	*1.890	-
Verbal analogies	2.581	.01	3.831	.01	1.251	-
Word pairs	3.749	.01	2.573	.01	*1.167	-
Word defining	11.601	.01	7.375	.01	*4.225	.05
<i>The seventh grade</i>						
Raven's progressive matrices	9.445	.01	5.339	.01	*4.105	.01
Verbal analogies	2.538	.01	1.936	.01	*0.602	-
Word pairs	2.441	.01	1.661	.01	*0.779	-
Word defining	18.335	.01	7.062	.01	*8.511	.01

*in advantage E_2 group

Table 2. Differences in the Groups Progress and Their Importance at the Intelligence Tests (the fourth, the sixth and the eighth grade)

	$D_{E_2} - D_K$	p	$D_{E_2} - D_{E_1}$	p	$D_{E_1} - D_K$	p
	(Dm)		(Dm)		(Dm)	
<i>The fourth grade</i>						
Raven's progressive matrices	9.211	.01	4.978	.01	*4.233	.01
Verbal analogies	4.539	.01	4.411	.01	*0.127	-
Word pairs	4.320	.01	3.661	.01	*0.658	-
Word defining	7.543	.01	9.386	.01	1.844	-
<i>The sixth grade</i>						
Raven's progressive matrices	4.570	.01	3.064	.01	*1.506	-
Verbal analogies	5.464	.01	3.226	.01	*2.238	.01
Word pairs	4.108	.01	5.050	.01	0.942	-
Word defining	8.254	.01	12.481	.01	4.224	-
<i>The eighth grade</i>						
Raven's progressive matrices	6.357	.01	3.976	.01	*2.381	.05
Verbal analogies	4.003	.01	4.719	.01	0.715	-
Word pairs	2.439	.01	3.334	.01	0.894	-
Word defining	6.261	.01	11.498	.01	5.237	.01

*in advantage E_1 group

4.2. The effects of the experimental programme were of more durable character. In all tests and ages, it was proved that even after one year, the improvement of the first experimental group was significantly better than the improvement of the control group. This is illustrated by table 3.

Table 3. Differences in the Progress of the First experimental and Control group and Their Importance on the Intelligence Tests

<i>The Intelligence Tests</i>	The First period (III-IV)		The Second period (V-VI)		The Third period (VII- VIII)	
	$D_{E_1} - D_K$	p	$D_{E_1} - D_{E_1}$	p	$D_{E_1} - D_K$	p
Raven's progressive matrices	7.817	.01	6.998	.01	11.825	.01
Verbal analogies	2.783	.01	4.819	.01	1.823	.01
Word pairs	3.664	.01	2.798	.01	1.547	.05
Word defining	10.321	.01	7.376	.01	13.097	.01

Explanation: Now, the question, is how explain these results. Within the experimental programme, members of experimental groups developed certain logical-psychological mechanisms (operations) of cognitive functions, primarily perception and thinking through the process of algorithmization and method of discovery. By combining these two approaches, members of experimental groups primarily developed mechanisms of identification of the elements, classification of the elements, perceiving differences and similarities among the elements, transformation of the elements abstraction of significant and insignificant, than certain sensory and motor mechanisms, mechanisms of analysing, forming and generalizing. Beside this, by using this type of the experimental programme, members of the experimental groups developed a certain attitude, conviction that this way of solving the problem is effective and successful. This way of traing influenced the development of certain interior motives such as curiosity, achievement, competence, compenting with one self.

According to this, these are possible variables which led to the transfer of the area of the subject's, intelligence. This is in accordance with the theory of the heneralization of transfer (procedures, general principles, attitudes and experiences are transferred) and the cognitive theory of transfer (setain structures of experience and psychological mechanisms and operations are major transfer variables).

4.3. Comparing the changes in the tests of intelligence caused by the influence of the experimental programme showed that the quantity of transfer depends on not only growth but also the type of test.

- a) pupils of the eighth grade showed the best readiness to develop abilities of comprehension, understanding and defining the terms.
- b) pupils of the seventh and the fourth grades showed equal readiness to develop mehanisms of education of relations and correlates as psychological bases of Spearman's G-factor.
- c) pupils of fourth and sixth grade showed some what better readiness to develop abilities of abstaraction and concluding according to the analogy.

4.4. Especially interesting is the fact that improvement of the first experimental group even in the year after the end of the programme (the group which had the experimental programme in the previous year) is significantly better than improvement of control group. These differences are shown by the table 2 (column DE₁-DK). The analysis of covariance and the testing of the importance between changes show that the amount of this effect depends on growth and type of the test of intelligence.

In the test of intelligence which basically contain educative principles of cognition, effects of the experimental programme were more important, more durable and prolonged (lengthened). This shows that the experimental programme: a) significantly stimulated the progress of education of relations and correlates, and b) achieved important positive change in the development of intelligence not only in tempo of improvement but also in the direction of progress of all abilities.

In the case of tests which register abilities of verbal communications, comprehension and defining of the terms, programme has achieved important, more durable but not prolonged (lengthened) transfer effects.

The results of this research prove that G-factor of Spearman's type is possible to bring up. The programme also left important effects on tests, which for Cattell (R. Cattell) are better measure of the so called fluid intelligence as well as on tests which are better measure of the so called crystallized intelligence. This proves that the distinguishing of the two separate intelligences on the basis of different tests (primarily according to the content) is not really based on solid basis.

4.5. The analysis showed that the quantity of transfer depends on the level of development of the subject intelligence.

Globally considered this programme is more useful and leads to the greater transfer of the subjects with poorer intelligence.

This is illustrated by the table 4 where it can be seen that all correlates are between results of the initial study and the improvement during the programme with a negative presage while the majority of them is statistically significant. However, the detail analysis shows that this depends on growth and type of tests. Therefore, pupils of the third, fourth, fifth and sixth grades show tendency that the programme is more useful for pupils with poorer intelligence, while for pupils of the seventh and the eighth grades the programme is significantly more useful for the pupils with poorer intelligence.

Table 4. Korelation Between the Previous Testing and the Progress Made During the Experiment

<i>The Intelligence tests</i>	<i>The 3rd grade.</i>	<i>The 4th grade.</i>	<i>The 5th grade</i>	<i>The 6th grade</i>	<i>The 7th grade</i>	<i>The 8th grade</i>
Raven's progressive matrices	*-0.25	-0.19	*-0.71	*-0.27	*-0.52	*-0.76
Verbal analogies	-0.03	-0.10	-0.11	-0.11	*-0.41	*-0.41
Word pairs	-0.21	-0.30	-0.24	0.03	*-0.48	*-0.50
Word defining	-0.20	*-0.40	*-0.33	-0.16	*-0.28	*-0.33

*Importance level .01 or 0.05

Accordingly previous results prove that the level speed, direction and quality of the

development of intelligence depends on the interaction of the factors of heredity, environment, experience and training. We believe that the sooner this interaction is realized and the longer it lasts, the better the effects and greater the quality of the development of intelligence.

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UZRAST I TRANSFERNE PROMENE U INTELIGENCIJI UČENIKA

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Ovo istraživanje je iz domena vaspitljivosti i inteligencije. U istraživanju je proveravana transferna vrednost posebno pripremljenog eksperimentalnog programa (algoritimizacija saznavnih funkcija i logičko-perceptivne igre) na oblast inteligencije. Za merenje inteligencije korišćeni su sledeći testovi: 1) Ravenove progresivne matrice, 2) Definisane reči, 3) Verbalne analogije, 4) Parovi reči. Subjektivno su bili učenici od trećeg do osmog razreda osnovnih škola iz Jagodine. Ispitano je 542 učenika.

Rezultati eksperimenta su:

1. *Vežbanje u algoritimizaciji saznavnih funkcija i logičko-perceptivnim igrama ostavlja značajne i trajnije transferne efekte na razvoj inteligencije učenika.*
2. *Iznos transfera ovog vežbanja zavisi od uzrasta učenika, vrste testova i nivoa razvijenosti inteligencije: a) Osnovni Spirmanovi principi saznavanja (edukcija relacija i edukcija korelata) mogu se razvijati značajno i trajnije, zatim, kod učenika četvrtog, sedmog i osmog razreda efikasnije nego kod učenika trećeg, petog i šestog, i na kraju efikasnije kod učenika slabije inteligencije.*
3. *Ovakva vrsta programa pokazuje transferno delovanje i po njegovom završetku. Ovo se pokazalo samo u testovima u čijoj osnovi su Spirmanovi zakoni edukcije.*

Prema tome, rezultati eksperimenta pokazuju da nivo, brzina, pravac i kvalitet razvoja inteligencije zavise od interakcije faktora nasleđa, sredine, iskustva i obuke. Verujemo da period koji smo obuhvatili ovim eksperimentom je još uvek vreme kada se ostvaruje značajna interakcija ovih faktora u razvoju inteligencije učenika.