These of a PhD dissertation

The role of background factors of educational psychology in the efficiency of biology teaching

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I. Introduction, aims

Finding solutions to the long-standing problems of science education in Hungary has by now become a pressing issue. A growing body of research has called special attention to learners' gradually declining learning outcomes, their poor ability to apply their knowledge and the decrease in the popularity of science subjects. The vast quantities of knowledge to be mastered, the number of classes available for the teaching of this knowledge, and the low number of opportunities for practice have all contributed to the situation that prevails today (REVÁKNÉ and MÁTH, 2002; REVÁKNÉ, 2003; CSAPÓ, 2004; and BALOGH L., 2011).

In our study we chose team work for experimental purposes, expecting a beneficial effect on learners' interest in biology and academic performance in the subject. Our decision was supported by the fact that team work has a beneficial effect on learners' academic independence and the development of the plasticity of their thinking. Doing work, solving assignments together with other members of a team promotes team spirit, and improves cooperation and communicative skills. It also favourably influences learners' attitude to school and their academic performance (BUZÁS, 1980; SZABÓ É., 2006; TURMEZEYNÉ, 2011).

Interest in the subject is, however, not sufficient for success. Successful mastering of the increasing amounts of the teaching material can only take place through the application of efficient learning strategies since use of appropriate strategies favourably influences academic performance (SCRUGGS and MASTROPIERI, 1988; DÁVID M., 2006; BALOGH L., 2011). Results of PISA 2000 showed that mechanical learning plays a dominant role among Hungarian learners. At the same time a pressing need emerges urging our learners to be able to study on their own and possess efficient problem-solving skills. More efficient ways of processing information enable a deeper understanding of the teaching

material and achievement of better academic performance (MEZŐ, 2002; B. NÉMETH and HABÓK, 2006).

Results of research by LÁSZLÓ BALOGH' (2011) showed that there is no demonstrable relationship between learning methods and learners' general intellectual abilities. It was, however, concluded that the more intelligent a person is, the more likely they are to avoid mechanical learning. The importance of creativity linked to divergent thinking has been underlined by a large body of research (CROPLEY, 1983; DÁVID I., 2002; MÜNNICH, 2011). We thought that logical thinking and creative problem-solving enable better academic performance in biology learning.

It has been proven by research that learner anxiety is higher in the case of science subjects. Coping with stress also impacts academic performance. During team work children experience fewer failures (SZABÓ É., 2006; NÓTIN, PÁSKUNÉ and KURUCZ, 2015). This led us to believe that using team work could decrease learner stress, indirectly impacting academic performance in biology in a positive way.

Thus, it can be concluded that, with a view to improving efficient school work, it is indispensable to focus on varied methods of processing the teaching material in the given subjects as well as on the role of psychological factors in the teaching-learning process. The main aim of our investigation was to map the main scope of applicability of team work within biology and its effect on academic performance in the subject. We also considered it important to study the interrelationship between the psychological factors influencing academic performance together with their effect on academic performance in biology.

II. Methods applied and the procedure of the study

During our two-year, longitudinal study we assessed the learning habits of secondary school students in years 10 and 11. The beginning of the study was determined by the fact that in the traditional four-class secondary grammar school education arrangement students first start their biology studies in class 10. The study took place in the secondary schools of five towns, and involved 345 students. In the experimental classes, learners regularly processed the teaching material using group work. In terms of learners' cognitive abilities, the groups of 4 or 5 were heterogeneous. There was primarily frontal instruction in the control classes. Classes were learning from the same text books, in accordance with common standards, and the learners had average cognitive abilities. We chose this particular group because they represent the majority of students in secondary education, allowing us to gain widely usable results through their study.

The measuring tools used during the study fall into two categories:

a) Tests and questionnaires used to measure psychological background factors:

- To assess learners' general intellectual abilities, the 36-item version of the Raven Standard Progressive Matrix Test was used. We chose this test because the Raven test, a non-verbal test, is reliable, can be widely used, and also eliminates differences from culturally diverse backgrounds and language use (BALOGH L., 2006).
- To measure learners' creativity, the circles test was used. We assessed learners' creativity based on the test's indicators of originality, flexibility and fluency (ZÉTÉNYI, 1989).
- We measured learners' interest in biology using a shortened, modified version of the DUCKWORTH – ENTWISTLE questionnaire (1974) revised by KÓSÁNÉ, PORKOLÁBNÉ and PÁLNÉ RITOÓK (1987).

- To study learners' school motivation we used a questionnaire developed by KOZÉKI and ENTWISTLE (1986). The 60 statements of the questionnaire are organised into ten scales. Three scales make up the followers' dimension, another three the dimension of those interested and a third three the performers' dimension, complemented by the feeling of pressure (TÓTH L., 1999).
- To assess learners' learning strategies, we applied KOZÉKI–ENTWISTLE's (1986) learning motivational questionnaire. The questionnaire's statements constitute the following three large categories: deep, reproductive, and organised. A complementary category of the questionnaire is the instrumental (motivation) factor, which signals when a learner only studies to be awarded by good grades and external recognition (TÓTH L., 1999).
- To measure learners' test-related anxiety we used a questionnaire developed by SIPOS, SIPOS and SPIELBERGER (1988). The questionnaire's subscale for anxiety measures anxiety linked to consequences of tests while the emotional anxiety subscale studies what vegetative reactions a learner experiences during these tests (TÓTH L., 1999).

b) Tasks related to achievement in the subject

- The assignment sheets used for group work during the lessons made the following types of group work possible: simultaneous solution of the same assignments; rotation type solution of the same assignments; the assignment is identical from a subject matter-logical point of view, but the objects of the study are different; differentiated work; differentiated work complemented by identical assignments.
- We measured learners' performance in biology with end-of-topic assessments. During the study the topics of teaching materials changed of

necessity but the assignment types in the test (concept definitions, tests, table completion, and figure recognition) remained unchanged.

In autumn of 2004, at the beginning of the longitudinal study, all learners completed questionnaires to measure psychological background factors. At the end of the study we retook the surveys so as to be able to monitor the changes that had occurred during the study. Data were evaluated using the SPSS 13.0 Windows software package. (Statistical analysis of the data took place under the professional supervision of Dr. János Máth, university associate professor.)

III. Results of the study

a) During analysis of the results of the study we first examined the interrelationships between the psychological background factors that play a decisive role in learners' academic achievement as well as the relationship between these factors and group work.

Hypothesis 1: We hypothesized that active participation in the processing of the teaching material and successful work carried out together with other group members would have a favourable effect on learners' interest in and attitude towards biology.

During the study we concluded that, irrespective of whether learners belonged to the experimental or control group, they found the knowledge that they acquired in biology lessons interesting and useful at the beginning of the study, but at the end they found the teaching material hard and complicated. All this is in accordance with the fact that, towards the end of the study, understanding of the relationships, analytical, logical thinking and concentration within and among subjects were indispensable.

In order to have a better understanding of the changing over time of learners' interest in biology we performed a two-way variance analysis of the data. We found that, irrespective of which group learners belonged to, "interest in biology" showed a significant decrease ($p<0,01$) while "difficulty of biology" showed a significant increase ($p<0,01$) as time passed. Contrary to our expectations, there was a greater loss of interest in biology among members of the experimental group. We consider that one of the reasons for this was that during group work learners had to work out relationships themselves, which is not simple when it comes to complicated materials even with teacher explanations.

Hypothesis 2: Since we applied group work regularly only in the field of biology teaching, we hypothesized that group work would not significantly change learners' motivation structure towards learning.

At the beginning of the study learners' school motivation in both the experimental and the control group showed a similar picture. The motives of emotional warmth (love for parents), conscientiousness and responsibility proved to be decisive in both groups while the feeling of pressure was pushed to the background. There was no significant difference between the results of the experimental and the control groups, expect for the motives of conscientiousness and responsibility. At the end of the study the mean values of the motives showed a similar picture. The results showed that the form of group work that we used did not significantly influence the way learners' performed their overall school assignments, in other words, it was not capable of significantly changing their motivation structure.

Hypothesis 3: We hypothesized that learners' learning orientation would change in a positive direction during the study.

Traditional analysis of the learning strategies revealed a significant correlation between the elements of the deep and organised strategies. There was

a similar correlation between the elements of the reproductive strategy and instrumental orientation. The results gained during the traditional analysis of the questionnaire encouraged us to identify clusters that are easy to use even during everyday school work. In the case of learners who were studying to get a good school report, instrumental and reproductive orientation were crucial, while those using deep learning strategies attributed an important role to learning with a focus on understanding and was based on good work organisation. In answer to the learning orientation questionnaire based on self-characterisation some learners said that they were "good at all orientations of the given questionnaire". However, their later results revealed that their performance was motivated by their desire to meet their parents' and teachers' expectations rather than outstanding achievement. As a significant change, the number of learners with reproductive strategies decreased while that of learners with deep strategies increased, verifying our hypothesis. As a negative, we can mention that during the study a group of learners who had a "sloppy" attitude to school work appeared.

Hypothesis 4: We hypothesised that belonging to a particular cluster based on learning orientation correlated with results on the intelligence test and creativity.

Results showed that among those who performed better on the intelligence test learning to understand was more frequent while among learners who performed worse on the intelligence test there were more who preferred mechanical learning. Although the results alerted us to some interesting relationship, we did not find the data we gained convincing enough due to the not too strong correlations. We further hypothesised that there was a relationship between creativity and use of learning strategies. We found a significant difference between the clusters observed at the beginning of the study based on creativity indicators. Learners using deep learning strategies surpassed others in all three creativity indicators (originality, flexibility, and fluency). Their results were also borne out by those of the one-way variance analysis.

Hypothesis 5: We hypothesised that there was a relationship between transformation of learning orientation and learners' levels of anxiety.

A traditional analysis of the questionnaire revealed that there was a positive significant relationship ($p<0,01$) between anxiety felt over consequences of progress checks and elements of reproductive learning strategy. In contrast, there was a negative relationship between anxiety and results of deep and organised orientation. In addition to the traditional analysis of data we also used a multi-factor ANOVA model to analyse the relationship between cluster membership and anxiety. The results led us to believe that learners used different ways of dealing with test-related stress. While learners using reproductive learning strategies did not succeed in coping with stressed generated by school expectations, "sloppy" students were successful in reducing levels of anxiety. Most of those students using deep learning strategies reduced the levels of anxiety but were unable to reduce the effect of emotional anxiety as effectively as laid-back ones. It seems that the latter can only be significantly decreased through "letting go" of the desire to meet expectations.

b) The other group of hypotheses examined how using group work and psychological background factors affect learners' academic performance in biology.

Hypothesis 6: We hypothesised that use of group work would increase learners' academic performance in biology in those sections of the material that are predominantly based on grasping causal links, an integrated approach and the practical use of knowledge.

Over the course of the study the test results showed a decreasing tendency in both groups. Using t-test to compare data, we found that in terms of their knowledge of botany and zoology the experimental group's result was

significantly ($p<0,05$) better. Contrary to our expectations, in sections of the teaching material which contained more complicated (inter-) relationships it was traditional teaching that proved more efficient. Analysis of the tests by types of assignments showed that, irrespective of the type of task, learners' results showed a decreasing tendency. Learners' results were also influenced by the type of the teaching material, learners' errors in the subject and routine task-solving.

Hypothesis 7: We hypothesised that interest in the subject would show a close relationship with academic performance in the subject.

We used the ANCOVA-model to analyse the effect of the variables "interest in biology" and "difficulty of biology" on learners' academic performance in the subject. No relationship was found between the variables "group" (experimental/control) but the effect of the variable "interest in biology" was significant ($p<0,01$) in the additive mode. In other words, the more interesting a learner found biology, the better their academic performance was in the subject. Nor did we find an interaction between the variables "group" and "difficulty of biology", but the variable "difficulty of biology" was significant ($p<0,05$) in the additive group. However, this relationship was negative, which meant that the more difficult a learner found the subject, the lower their academic performance was in the subject, irrespective of how they had mastered the material.

Hypothesis 8: It can be assumed that certain elements of the school motivation system regarding learners' overall school work would favourably influence academic performance in the subject.

Analysis of the data did not reveal a significant positive relationship between academic performance and elements of motivation in the control group. In the experimental group, however, several motives (affiliation, conscientiousness, need for orderliness, and responsibility) were significant

($p<0,05$). The differences between the groups were verified by the analysis using the ANCOVA-model. We believe that for the elements of school motivation to correlate with academic performance, it was necessary for the knowledge presented in lessons to somehow engage and involve learners in the process of acquiring knowledge. In the experimental group this was made possible by group work.

Hypothesis 9: We hypothesised that learners' academic performance in the subject would be greatly influenced by changes in the learning strategies.

Analysis of the relationship between learning strategies and academic performance in the subject found no significant relationship in the control group whereas in the experimental group the effects of conscientious, deep as well as organised orientation were significant ($p<0,01$). All this is important because efficient group work is inconceivable without these traits. It was also concluded that learners with reproductive learning strategies performed at a low level while those using deep strategies with a focus on understanding produced outstanding performances in the subject throughout the study period. Becoming "sloppy" when facing easier sections of the teaching material facilitated better results by lowering psychological burdens of expectations set by the school while with more demanding sections of the teaching material it was accompanied by poorer performance. The reason for this is that mastering more difficult parts of the teaching material requires the kind of well-organised, rigorous learning that is hardly compatible with behaviour typical of "sloppy" students.

Hypothesis 10: We hypothesised those learners' academic performance in the subject would show a relationship with their performance on the intelligence test.

Based on the results of the intelligence test we divided the standardised samples into three groups ("Raven3" groups) with roughly the same number of

elements. The control group had more members with higher Raven numbers than the experimental group. Results of the one-way variance analysis showed no relationship between the total score of the tests and "Raven3" in the control group while in the experimental group the relationship was highly significant ($p<0,01$). In the case of learners who performed poorer on the intelligence test the form of group work we used did not come up to expectations while we observed a favourable effect with learners who did better on the Raven test.

Hypothesis 11: We hypothesised those learners' creativity would be related to their academic performance in the subject.

We used variance analysis to analyse the relationship between creativity and academic performance in biology. We found no significant relationship in the case of easier parts of the teaching material. This suggested that with these parts creativity did not provide the learners with an advantage that could have manifested itself in the test results in a measurable way. However, at the end of the investigation, more creative learners' results were significantly better ($p<0,05$) on the more difficult sections of the teaching material. We think that this can be attributed to the fact that a creative approach and flexible thinking played a greater role in task solution.

Hypothesis 12: We hypothesised that anxiety linked to progress checks would have a negative effect on learners' academic performance in biology.

Results showed that there was no significant relationship between emotional anxiety and academic performance in biology, however, anxiety showed a significantly negative ($p<0,01$) relationship with academic performance. We believe that test-related anxiety and academic performance in a subject mutually influence each other. Anxiety over an unsuccessful test's result impairs performance and poorer result, in turns, further enhances learners'

anxiety. The type of group work that we used could not sufficiently influence the amount of test-related anxiety to produce a sizeable effect in academic performance in biology.

c) Results of the joint analysis of the investigated factors

Last, we examined whether the joint examination of the key factors of the previous analyses provides any additional information that separate analyses of these factors do not. We found that, when applied by learners who did better on the intelligence test and accompanied by interest in the subject and good work organisation, the group work we used is likely to enable better performance in biology.

During our study we wished to shed light on some factors that are of key importance in the teaching of biology in secondary schools. We think that the importance of our research lies in the fact that it repeatedly confirmed the favourable effect of rigorous, conscientious learning with an aim to understand material. Despite the fact that our framework did not allow for a comprehensive analysis of the entire secondary school biology material with all its diverse topics, we believe that our results have supported the favourable effect of group work on academic performance in biology and the relevance of its use in biology teaching.

Works Cited

BALOGH LÁSZLÓ (2006): *Pedagógiai pszichológia az iskolai gyakorlatban.* Urbis Könyvkiadó, Budapest.

BALOGH LÁSZLÓ (2011): *A tanulási stratégiák fejlesztésének pszichológiai alapjai.* Didakt Kiadó, Debrecen.

B. NÉMETH MÁRIA és HABÓK ANITA (2006): A 13 és 17 éves tanulók viszonya a tanuláshoz. *Magyar Pedagógia, 106,* 2. 83-105.

BUZÁS LÁSZLÓ (1980): *A csoportmunka.* Tankönyvkiadó, Budapest.

CROPLEY, A. J. (1983): *Tanítás sablonok nélkül. Utak a kreativitáshoz.* Tankönyvkiadó, Budapest.

CSAPÓ BENŐ (2004): *Tudás és iskola.* Műszaki Könyvkiadó, Budapest.

DÁVID IMRE (2002): A tehetségazonosítás eszközeinek összehasonlító vizsgálata az intellektuális szférában. In: Dávid Imre, Bóta Margit és Páskuné Kiss Judit (szerk.): *Tehetségkutatás.* Kossuth Egyetemi Kiadó, Debrecen, 7-108.

DÁVID MÁRIA (2006): A tanulási kompetencia fejlesztése – elméleti háttér. *Alkalmazott Pszichológia, 8,* 1. 51-63.

DUCKWORTH, D. és ENTWISTLE, N. J. (1974): Attitudes to school subjects: a repertory grid technique. *British Journal Educational Psychology,* 1. 76-93.

KÓSÁNÉ ORMAI VERA, PORKOLÁBNÉ BALOGH KATALIN és RITOÓK PÁLNÉ (1987): *Neveléslélektani vizsgálatok.* Tankönyvkiadó, Budapest.

KOZÉKI BÉLA és ENTWISTLE, N. J. (1986): Tanulási motivációk és orientációk vizsgálata magyar és skót iskoláskorúak körében. *Pszichológia,* 2. 271-292.

MEZŐ FERENC (2002): *A tanulás stratégiája.* Pedellus Novitas Kft., Debrecen.

MÜNNICH ÁKOS (szerk.) (2011): *A kreativitás többszempontú vizsgálata.* Didakt Kiadó, Debrecen.

NÓTIN ÁGNES, PÁSKUNÉ KISS JUDIT és KURUCZ GYŐZŐ (2015): A tantárgyi szorongás kérdőív bemutatása. *Alkalmazott Pszichológia, 15,* 4. 109-131.

REVÁKNÉ MARKÓCZI IBOLYA (2003): *A természettudományos problémamegoldás és befolyásoló tényezőinek összefüggései a középiskolában.* PhD értekezés, Debrecen.

REVÁKNÉ MARKÓCZI IBOLYA és MÁTH JÁNOS (2002): A természettudományos problémamegoldó gondolkodás fejlesztése a középiskolában. *Új Pedagógiai Szemle, 52,* 10. 101-109.

SCRUGGS, T. E. és MASTROPIERI, M. A. (1988): Acquisition and transfer of learning strategies by gifted and nongifted students. *The Journal of Special Education,* 22. 153-166.

SIPOS KORNÉL, SIPOS MIHÁLY és SPIELBERGER, C. D. (1988): A Test Anxiety Iventory általános iskolások számára kidolgozott magyar változata. In: Mérei Ferenc és Szakács Ferenc (szerk.): *Pszichodiagnosztikai Vademecum I/2.* Tankönyvkiadó, Budapest, 136-148.

SZABÓ ÉVA (2006): *Szeretettel és szigorral. Az iskolai nevelés problémái a szülők és a tanárok szemszögéből.* Akadémiai Kiadó, Budapest.

TÓTH LÁSZLÓ (1999): *Pszichológiai módszerek a tanulók megismeréséhez.* Kossuth Egyetemi Kiadó, Debrecen.

TURMEZEYNÉ HELLER ERIKA (2011): *A tehetséggondozás lehetőségei a kooperatív tanulásban.* Didakt Kiadó, Debrecen.

ZÉTÉNYI TAMÁS (1989): *A kreativitás-tesztek tesztkönyve I.* Munkalélektani Koordinációs Tanács Módszertani Sorozata, Munkaügyi Kutatóintézet, Budapest.

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1. **Ceglédi, E.**: A tanulási orientációk és változásaik tanulmányozása középiskolás tanulók körében. *Magyar pedagóg. 115* (4), 343-362, 2015. ISSN: 0025-0260.
2. **Ceglédi, E.**, Máth, J.: Az iskolai teljesítményt befolyásoló tényezők vizsgálata. *Alk. pszichol. 13* (4), 23-46, 2013. ISSN: 1419-872X.
3. **Ceglédi, E.**: A csoportmunka alkalmazásának lehetőségei a biológiatanításban. *Biol. tan. (Szeged). 18* (2), 13-20, 2010. ISSN: 1216-6626.
4. **Ceglédi, E.**: A csoportmunka hatása az iskolai teljesítményre. *Iskolakultúra. 19*, 95-106, 2009. ISSN: 1215-5233.
5. **Ceglédi, E.**: A kreativitás és az intelligencia szerepe az iskolai teljesítményben. *Új pedagóg. szle. 59* (11), 42-52, 2009. ISSN: 1215-1807.

Foreign language scientific articles in Hungarian journals (1)

6. **Ceglédi, E.**: Science Education in Hungary. *Hung. educ. res. j. 6* (2), 87-92, 2016. EISSN: 2064-2199. DOI: http://dx.doi.org/10.14413/HERJ.2016.02.07

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