SELF-REGULATION OF LEARNING IN THE NATURAL SCIENCE OF FUTURE TEACHERS

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Processed within the project VEGA 1/0443/18 Analysis of self-regulatory learning styles of students in the field of Preschool and Elementary Pedagogy.

Abstract: In this article, we present the results and interpretations of our research, the aim of which was to create a certain picture of how the preparation is set, but also the motivation of students in the programs of Preschool and Elementary Pedagogy for science subjects. We focused on the area of self-regulation of learning and motivation for science education for future teachers. We start from the methodological approach rooted in the theory of self-determination. We consider the most important finding to be the positive motivation of students for science. Within science subjects we see an opportunity to use the student's portfolio as a means of his trajectory of development and self-regulation of learning.

Keywords: future teachers, motivation, natural sciences, self-regulation of learning.

1 Introduction

Learning about nature has been an essential part of education for many years. The aim of science education at all types and levels of schools is to develop science literacy. We identify with Roberts (2007) and Svobodová (2013) who include in science literacy the knowledge and skills that an individual needs to understand the natural influences on his life, to be able to explain the basic natural phenomena in his environment, to know terms, laws and methods of natural sciences, to be able to work with graphs, tables, diagrams, maps and finally to be able to form his own judgment about the credibility of knowledge. It is a lifelong process, not just learning at school. In this context, Janoušková, Novák and Maršák (2008, p. 129) state that "the issue of science education is currently given unusually high attention in the field of pedagogical research and practical educational policy in the states of the European Union." However, the teaching of science subjects in primary schools has been going through a stage of some search for identity for some time (Škoda, 2005). An important moment is the active and scholastic character of teaching, which allows students to gain a deeper understanding of the laws of natural processes. To create competencies in students that develop the ability, based on the observation of natural phenomena, objects and experimental activities, can evaluate and create theories (Píšová et al., 2011). Science education is currently an integral part of a comprehensive teaching process. This education begins in children before entering primary school. They get acquainted with their immediate environment, surroundings, nature, they observe, create ideas. They form a relationship with people and the environment which they live in. Children's attention is focused on exploring current ideas about objects, phenomena and situations. Part of the development of science literacy is the development of specific skills that give the child tools to orient himself in new cognitive situations, help him systematize experience and create meaningful knowledge about the functioning of the world (Uhrinová, 2019).

In the field of Preschool and Elementary Pedagogy, it is primarily a matter of preparing students for the profession of pre-primary and primary education teachers. Study programs in the field of Preschool and Elementary Pedagogy in Slovakia are implemented at the pedagogical faculties of seven Slovak universities in Bratislava, Trnava, Nitra, Komárno, Ružomberok, Banská Bystrica and Prešov. Within the department, bachelor's study programs are mostly implemented for the preparation of kindergarten teachers and educators of children's school clubs, which are followed by the master's study programs Teaching for Primary Education. (Rochovská, 2012).

The university training of future teachers of kindergartens and primary degree of elementary schools with a focus on science education contains three components: vocational; pedagogical-psychological and didactic. Graduates are expected to have a thorough understanding of professional issues, the ability to make knowledge available to target groups, organize, monitor and evaluate educational activities. Although faculties strive to incorporate current scientific knowledge and current teaching approaches into the training of future teachers, to follow constant developments in science, pedagogy, psychology and to reflect on changes in the education system, the teaching profession requires constant supplementation and expansion of knowledge and skills. The professional personality of a teacher is the result of his own efforts to become a teacher, but at the same time it is formed already during undergraduate training, in which the future teacher begins to form his intuitive concept of teaching and also motivation for the teaching profession. It is therefore necessary to pay more attention to the area of motivation. At present, the role of the university teacher is fundamentally changing, which should mainly support the self-regulation of learning, but also stimulate students to acquire the meanings of technical terms and understand the context in science education.

Scientists, as well as practitioners, are currently wondering how a particular way of thinking creates space for a specific form of freedom and independence based on student-teacher relationships. The personal responsibility and self-sufficiency of the individual (student and teacher) is emphasized. On the other hand, the newly conceived freedoms oblige the subject (student and teacher) to inform about the various possibilities in order to make the best possible investment in one's own future and the future of society on the basis of active social integration. Social-constructive exchanges and interactions among students, joint problem solving and partnership - positive teacher interventions support the student's self-regulation of learning. This supports a quality learning process and the learning of others (better quality of communication between teachers and students and between them, gaining lasting and valid knowledge for society, as well as intellectual independence), etc. The process of self-regulatory learning is not based on "memory training", but on developing the ability to distinguish and think, more precisely the ability to ask questions and solve learning problems. Self-regulatory learning is based on taking an active attitude of the student, which is maintained by a didactically thought-out, deliberate strategy of the teacher. This strategy evokes the process of socio-constitution of knowledge and the emergence of the student's competencies regarding the goals, topic, content / curriculum, based on the application of transformative and supportive components.

In order for the goals of self-regulatory learning to be achieved, it is necessary for students to have a learning strategy at their disposal and the teacher to have a strategy for his teaching in order to meet his goals. Conditions for the construction, development and application of a didactic strategy that supports the self-regulation of learning, an emerging conglomerate of competencies and the acquired complex of knowledge of students in the field of Preschool and Elementary Pedagogy in Science Education represents:

- Consciously reflect the importance of the problems that will be presented to students, but especially reflect on the possible solutions in the internal dialogue of students.
- Situate the learning context, something that may be innovative on the one hand, but may not be on the other.
- Consider the creativity of the teacher as a constitutive element of maintaining a focus on the conscious development of students.
- Construct an appropriate learning environment based on adequate didactic situations, sequences, but in advance and in time it is necessary to visualize together with students learning scenarios in their design.

Postmodern thinking knows different forms of life, different aspects of reality. There is no longer only one and only absolute truth, which is predetermined, and therefore it is important that

the individual develops his knowledge on the basis of independent action in collaboration with other subjects in a particular society. Postmodern understanding of reality also considers feelings and intuition as important characteristics of the individual, with which the individual acquires real knowledge / knowledge about the real world (Gojkov, 2006). Emphasis is placed on the autonomy of the individual and on his critical thinking in order to know and be able to survive in everyday life. Brain is not only able to know, but it is objectified (it is the object of discourses) in science and philosophy, it becomes the highest instance in solving all problems of social and individual life of an individual in a socio-cultural context.

The paradigm of self-regulation of learning is to achieve such a status when the individual knows and is able to control himself, takes responsibility for his own development, becomes a self-regulatory individual. In the current discourse, self-regulation of learning represents the interaction of personal, behavioral and environmental triandic processes, it is mainly development through social representations, and it is understood as the disposition, quality (autonomy, competence and collaboration) of an individual's personality, being relatively independent, free to think, decide , to act and operate in the everyday socio-cultural environment (Bandura, 1977; Paterson, 1996; Ryan a Deci, 2017).

Humankind divided the actions and influence of the individual according to the activities carried out by him and their results, as well as generalizations in individual areas into various systems that form one whole - culture. By its nature, the field of science belongs primarily to the socio-cultural system of science and it uses means of communication for its existence and development, because people communicate about science and its achieved results and use various means. Scientists who constantly know the physical (environment surrounding us - nature, people, things, objects, etc.) and physical reality (phenomena, processes, etc.) provide newer, more elaborate theories and explain them. They express these theories in their own created scientific language (terminology) as well as in their own formal thought system. Science can be defined as an organized systematic (group and / or individual) initiative that integrates knowledge about the world and converts this knowledge into verifiable laws and principles, which can again lead to the emergence of new theories. Getting to know the physical and natural environment is part of one of the educational areas that create the school curriculum for kindergartens and primary schools. This educational area is called Human and Nature. The basic purpose of education in this area is to present the knowledge and interpretations of knowledge of the science so that learners understand science and they are able to apply them in their daily lives and further study (Jančaříková, 2019).

From the point of view of the educational goals of science education: to understand scientific and environmental texts; present scientific or environmental problems and be able to solve them; acquire vocabulary at a professional level; be able to independently discuss scientific or environmental topics; to develop thought procedures and ways of acting that apply scientific thinking in the natural sciences, it is necessary to develop students' pre-school and elementary pedagogy (future teachers) self-awareness, self-knowledge, conscience, self-criticism and will as a prerequisite for supporting self-regulation of learning and teaching of others students.

Strategies and methods to support self-regulation of learning in science education of children in kindergartens and primary school pupils Jančaříková (2019) states the following:

- Research teaching (method of learning by discovery).
- Problem-based teaching (problem-solving method).
- Project teaching (project method - project solution).
- Experiential teaching (experiential learning method).
- Cooperative and collaborative teaching (participation in the learning process).

2 Methodology

Based on information available in professional literature and websites of pedagogical faculties, as well as analysis of information sheets of science-oriented subjects, we briefly compared the degree of representation of science subjects in the content of education study programs Preschool and Elementary Pedagogy at three universities, where they primary focus on preparation of students for profession of teachers of pre-primary and primary education at PdF UK in Bratislava, PdF UMB in Banská Bystrica and PdF KU in Ružomberok. The reason for the research set follows from the project VEGA 1/0443/18 Analysis of self-regulatory learning styles of students in the field of Preschool and Elementary Pedagogy. Within the representation and scope of science lessons in bachelor's and master's degree education, there are significant differences in the training of future teachers of kindergartens and primary schools in the field of science education..

The bachelor's program at the Faculty of Education in Bratislava also includes the compulsory elective subject Natural Science Experiments (2C) and the compulsory elective subjects Natural Practice (2C) and Environmental Education (2S) are represented at the master's level. At the Faculty of Education in Banská Bystrica, the subjects are characterized by the fact that they are mostly integrated with technical education. It is not bad, because these objects have many features in common. Within the bachelor's degree, the compulsory elective subject Science Teaching Activities (2S) is represented. Within the master's study, it is a compulsory elective subject Elective Seminar for Didactics of Science and Technology subjects (2S), as well as an elective subject Science, Technology and Social Sciences (excursion). At the Faculty of Education in Ružomberok, a compulsory elective course is the Natural Science Interest Activity (1P + 1S). The master's study includes a compulsory optional subject of Natural Science Practicum (1S).

The results of the analysis of information sheets of science subjects in the field of study Preschool and elementary pedagogy at individual pedagogical faculties indicate that the specific goals of science-oriented subjects are based on the partial goals of the field of study. These goals set the requirements for the knowledge and skills of the student, which should be acquired after completing the subjects. In the information sheets of the mentioned science subjects, in the bachelor's study program, similarly to the master's study program, stated goals focused mainly on the acquisition of professional subject skills (such as theoretical preparation for teaching activities with a scientific focus mainly in the field of living nature). Also, the goals were focused on the acquisition of psychodidactic skills (eg didactically correctly analyze the curriculum). To a lesser extent, the objectives are aimed at developing the ability to plan and organize a specific teaching project with science content. To a very small extent, the goals are aimed at supporting the self-regulation of learning and the development of students' self-reflexive and diagnostic abilities. Exceptionally, there are goals for the acquisition of pedagogical and psychodidactic skills, as well as the ability to evaluate learners in the development of science literacy in pre-primary and primary education.

From the above it can be observed as stated (Rochovská, 2012) that the number of science-oriented subjects in the study programs of the Department of Preschool and Elementary Pedagogy at the pedagogical faculties in Bratislava, Banská Bystrica and Ružomberok is different. Somewhere are two subjects, somewhere are more science-oriented subjects. The education of kindergarten and primary school teachers does not have a uniform concept at individual pedagogical faculties, therefore not only the number of science subjects is different, but also their goals, content and means of teaching.

The aim of the research was to create a certain picture of how the preparation is set, but also the motivation of students of the programs of the Department of Preschool Elementary Pedagogy for science subjects. We carried out the research at three pedagogical faculties, namely in Bratislava, Banská Bystrica and

Ružomberok. We used the theory of self-determination by Richard M. Ryan and Edward L. Deci (Ryan and Deci, 2004), which provided important information about the internal and external factors of self-regulation (prediction, planning, monitoring and self-assessment). Based on the results, we developed a proposal for measures. Within the theory of self-determination by Richard M. Ryan and Edward L. Deci (also), a set of questionnaires was developed for various areas of human activity. Questionnaires assess individual differences in the types of motivation and regulation for a certain area - field of activity. We used the SRQ-Academic questionnaire (Ryan and Connell, 1989), which was standardized in 2017 for the Slovak environment (Kuruc, 2017). For our needs, we modified the questionnaire to record the nature of motivation in relation to science education.

We verified the reliability of the questionnaire in three ways. We implemented the first one by calculating the split-half reliability, which reached the value of 0.687. This value represents acceptable reliability. As the second method, we chose to verify the reliability using Cronbach's alpha, which reached a value of 0.845. This value also represents satisfactory reliability. This coefficient is typical for questionnaires in which the items are scaled (all items in the questionnaire have scales of the same value and length). It is used to assess the internal consistency of the questionnaire item scales. As a third method to verify reliability, we used Scott's homogeneity, which reached 0.647. This value is also acceptable. Based on these implemented processes, we were able to state that the research tool chosen by us reliably and accurately allows to evaluate what self-regulatory style prevails among the respondents.

The research set was compiled on the basis of deliberate selection. Our target group were students of programs in the Department of Preschool and Elementary Pedagogy. The selection criterion was the representation of all three pedagogical faculties, both at the bachelor's and master's level. Respondents at individual faculties were contacted at random. Regarding individual faculties, we perceive the selection as random. 1149 students were involved in the research, of which 467 students from Ružomberok, 444 in Bratislava and 238 in Banská Bystrica. There was a high return of questionnaires at the Faculty of Education in Bratislava and Ružomberok. In the case of the faculty in Ružomberok it is 98% and in the case of the faculty in Bratislava it is 77% return. We consider these two samples to be representative in relation to these faculties. The lowest proportion was the return from the faculty in Banská Bystrica. From the point of view of the overall scope of the sample, we can consider it as representative. Some caution is needed in the external form of study, where there is a significantly low representation of students in relation to the real distribution.

3 Interpretation of research results

We verified whether the collected data have a normal distribution by means of the Kolmogor-Smirnov and Shapiro-Wilk normality test. Based on the results of $D = 0.066$ at $p = 0.006$ and $W = 0.992$ at $p = 0.001$, it can be seen that both tests confirmed that the data do not come from the normal distribution, so we used nonparametric tests to further analyze the differences and relationships.

The descriptive statistics in Table 1 are calculated from the final RAI (Relative Autonomous Index) score. According to this index, the overall orientation of the respondent's motivation and regulation in relation to the specified domain is determined. The subscale scores in some SRQ questionnaires, regardless of their number, can be combined into RAI according to individual subject areas and pedagogical faculties. The Skew and Kurtosis values in each group confirm the results of the normality test. The overall sample was rather kurtosis and sloping to the left. Lower values predominate throughout the file, and most of the RAI values in the file are closer to the average. This is confirmed by the fact that the data do not come from a normal distribution, and therefore we used non-parametric tests to further verify the differences and relationships between the variables.

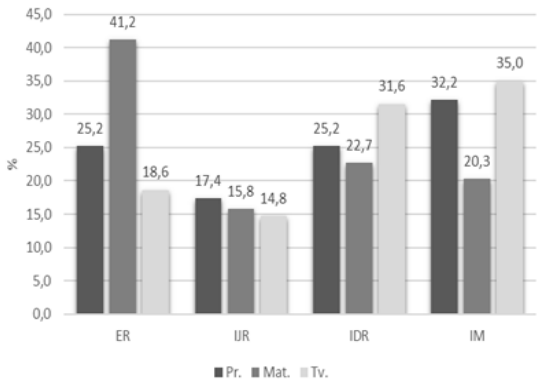
Table 1 Descriptive sample statistics.

	Natural science RK	Natural science BA	Natural science BB
Valid cases	221	167	100
Mean	0,459	-0,150	0,23
Std. Er.	0,168	0,161	0,227
Var.	6,267	4,345	5,164
Std. Dev.	2,503	2,084	2,272
Skew	0,130	0,187	0,225
Kurtosis	0,132	0,563	0,255

The determining value of the final score was the RAI value as defined by Ryan and Connell (1989). This index represents a measure of autonomous motivation / regulation - as a person regulates his learning or is motivated to do it by himself. The final score in the form of RAI for respondents ranges from +2 to -2. Our results show that internally oriented motivation and identified motivation predominate in science subjects when respondents are aware of the meaning and personal value of the subject.

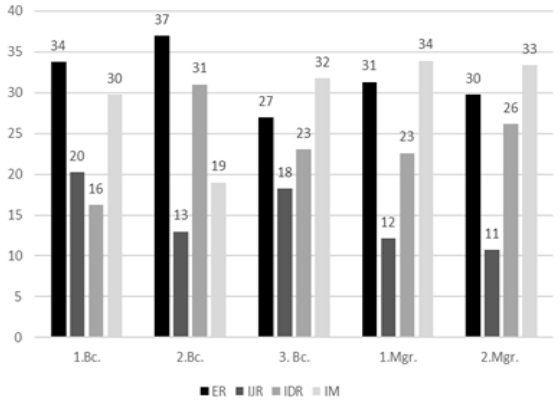
The first research question was: What styles of self-regulation of learning are prevalent among students in individual subjects (with a focus on mathematics, science and technology)? In comparison with mathematical and technical subjects, students showed a reasonable interest in science-oriented subjects (Graph 1). Students saw direct practical use. While in mathematics the external (motivation to learn on the basis of reward and punishment) and introjection (the motivation to learn is motivated on the basis of trying to avoid feelings of guilt and shame or conditional self-esteem) prevailed, in the case of technical education significantly prevailed identified style of regulation (the respondent sees a personal sense of the subject for himself) and internal motivation (the activity is associated with experiencing the joy of the activity). The science area is somewhere between these two areas of education. There is also a significant difference in how these subjects are represented in the study program in terms of scope.

Graph 1 Frequency of occurrence of self-regulatory style according the subject.



Another research question was: What are the differences in internal motivation between undergraduate and graduate students? In the case of natural sciences, internal motivation was statistically most significantly represented. This is followed by relatively equal occurrence of identified and external regulation. The least introjection style of regulation was present (Graph 2).

Graph 2 Frequency of occurrence of regulatory styles by degree of study – natural science.



On the graph above we can see that the value of the average RAI score in the 3rd year rose the sharpest. Remarkable is the more significant decrease in the average RAI score in the last year of master's studies. Testing the differences between the individual years showed that there are no significant differences between them. This fact may be caused by a relatively balanced occurrence of the identified style of regulation, which is an autonomous type of regulation classified as external motivation.

The third research question was: What are the differences between full-time and part-time students? We did not observe statistically significant differences between the individual forms of the study. Remarkably, in the external form of the study, there was a lower incidence of the external regulatory style and a higher incidence of the identified regulatory style. We assume that this difference may be because external students are of a higher age category than full-time students, there is the impact of a certain life experience. Also, the possible impact of the fact that they decided to study more voluntarily (without social pressure, which we perceive at full-time students as more significant due to social expectations). There is also a consideration associated with the financing of self-study for students of external forms of study, as well as greater responsibility for the success of studies.

In the fourth research question, we found out what the differences between the individual faculties are. In the case of subjects focused on science education, the most varied differences in the occurrence of individual regulatory styles between the faculties became apparent. In the case of the faculty in Ružomberok, internal motivation is significantly the most frequently represented (37%). In the case of the faculty in Bratislava, it is external regulation (34%) and in the group from the faculty in Banská Bystrica it was internal motivation (33%). Further testing confirmed that the differences in RAI scores among faculties are significant. More detailed testing showed that the difference in average RAI between the faculty in Ružomberok and Bratislava is significant. The difference between the faculty in Ružomberok and the sample from Banská Bystrica is insignificant. Finally, the difference between the faculty in Bratislava and the sample from Banská Bystrica is significant. Based on these findings, we can state that while at the faculty in Ružomberok and in the sample from Banská Bystrica, autonomy supporting the setting of motivation predominates, the control style of motivation predominates at the faculty in Bratislava. Despite these specifics provided by the analysis of the frequency of occurrence of regulatory styles, further testing between faculties of the average RAI score values showed us that there are no significant differences among the faculties in the field of science education. For better structuring, we relied on the method of SWOT analysis when framing observations and suggestions for research results. We use it as a tool to summarize suggestions, observations and other considerations related to the results of our research.

Table 2 SWOT analysis of results and recommendations of research findings.

STRENGHTS (characteristics that can help to achieve the goal)	WEAKNESSES (characteristics that make it difficult to achieve the goal)
Natural science	Natural science
Significantly higher representation of internal sources of motivation in the regulation of science learning.	Significant representation of external regulation of learning at the beginning of the study and associated more negative (more cautious) attitudes towards science subjects.
Autonomy is dominated by autonomy supporting the setting of the style of motivation to learn during their studies.	Low efficiency of the method of self-regulation of science learning at the beginning of the study.
OPPORTUNITIES (external conditions that may help to achieve the goal)	THREATS (external conditions that may make it difficult to achieve the goal)
Natural science	Natural science
Systemic guidance of students to create their own portfolio as a means of their trajectory of their own learning and development.	Not very positive attitude towards science subjects at the beginning of the study.
Analysis of the influences leading to the regrouping of regulatory styles in the third year of study.	The control style of motivation ranges from 60 to 40% of students throughout the study. In all years, the occurrence of external style prevails over introjection.
Also, an analysis of the causes of such a low incidence of identified regulatory style in all three years of study.	Internal motivation is maintained from the third year to the final year in the range from 33 to 37% and its increase in the third year no longer increases its occurrence.
Support for research-oriented education using elements of social constructivism. Less theory more practice (experiments). Use the interconnection of subjects in the style of Anglo-Saxon "sciences" and not the differentiated model that is typical for our education system (divided of subjects already at the primary level of education into natural science and geography).	The identified regulatory learning style tends to decrease with the higher year of study, still around 15%. It is a regulatory style in which the student has internally values of importance to learn a given subject.

4 Results and discussion

Based on the research investigation, we came to these answers in relation to the research questions:

- The most important research finding was found between the bachelor's and master's degrees. While at the beginning of the study the external style of regulation and controlling motivation prevails among the students, from the third year of the bachelor's and the last two years of the master's degree, the internal motivation to learn science subjects significantly prevails.
- Regarding science education, style of motivation supporting autonomy has been shown to prevail.
- In the field of science education, we found significant differences between the faculty in Bratislava and other faculties. The external style of regulation was statistically significantly more frequent than at other faculties. The identified regulatory style and internal motivation were significantly less frequent at the Faculty of Bratislava than at other faculties. No significant differences were found between the faculties in Banská Bystrica and Ružomberok.

As we can see in Table 2 from the point of view of scientific disciplines to the strengths in the third year of bachelor's study and in the last two years of master's degree we include a higher incidence of internal motivation as well as autonomous learning style, which we understand as requirement of regulation of self-behaviour in meaning of achieving requested science literacy. From the above we propose the creation of autonomy supporting environment in the first two years of the bachelor's degree and its further support in other years of study, as well as developing external motivation (identified regulation, which is a natural part of our environment and active student interaction with his environment) in both degrees at all monitored faculties. As a weakness in science education, at all monitored faculties, we consider a not very positive attitude towards science subjects at the beginning of the study. In order to achieve the goals of self-regulatory learning in science disciplines, it seems important to us that the teacher has a suitable strategy for teaching in order to

meet his goals, and students in turn have their own appropriate learning strategy. Within science, we see an opportunity to use the student's portfolio as a means of his trajectory of development and learning (as a basic idea to bring non-autonomous young people into a status of relative autonomy, which creates space for mutual cooperation in a learning group of students - an opportunity for learning collaboration). In terms of self-regulation of learning and learning on occasion, we also include the role of a teacher as a researcher (a teacher promoting an autonomous style of learning based on an examination of didactic reality, its subjects and components carrying out the reconstruction of professional experience, who seeks to know and recognize what he / she considers important, decisive and essential). The threats also include a not very positive attitude towards science subjects at the beginning of studies at all monitored faculties with a predominance of the external style of learning regulation, especially for full-time undergraduate students at the Faculty of Education, Charles University in Bratislava and the control style of motivation. By taking advantage of the opportunities arising from research on self-regulation of learning, we propose to minimize threats in science education.

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Primary Paper Section: A

Secondary Paper Section: AM