

MTA-DE Early Science Learning Research Group

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MTA-DE Early Science Learning Research Group Annual Progress Report – First Year (1 September 2022 – 31 August 2023)

1) Research milestones and their completion

The primary objective of the research group for the four-year programme is to conduct research on the development of integrated scientific knowledge and approach for Grades 1- 4 in elementary schools. This includes the identification and investigation of cognitive, noncognitive and social factors together with their interrelationships necessary for the development of an integrated approach, and the design and impact assessment of a schoolbased programme for the development and evolution of integrated scientific knowledge and thinking.

Research plans for the first year and their implementation:

1. Plan: Research, processing and systemisation of the international literature on early childhood (pre-school and grades 1-4) science education with an integrated approach. Implementation: Using a variety of search engines, 98 relevant publications were selected and processed according to a set of criteria defined by the research group focusing on STEM education and its approaches applied in different dimensions. The aim of the processing is to provide a theoretical basis for developmental teaching and to study teaching and learning methods. The results are going to be summarised in a systematic review which is under preparation.

2. Plan: Study of the conceptual knowledge and integrated approach to science among primary school students in grades 1-4 using word association. The aim is to compare the knowledge of the different grades and to explore the conceptual knowledge of 6-7-year olds (first grade) as a starting point for development. Implementation: A total of 764 students (Grades 1-4) participated in the survey from Eastern Hungary. The oral interviews were conducted and recorded by 38 pre-trained teachers. During the survey, we asked the students to say what comes to their mind about 6 stimulus words belonging to a total of 6 topics (Health, Energy Sources, Sustainability, Aviation, Forest, Science) in a maximum of 1 minute. The connection networks also reflect the source of information related to the given topic. A dramatic change in the knowledge structure can be seen in the 2nd year (Sustainability, Aviation), in the 2nd and 3rd years (Science), and in the 4th year (Energy Source, Health). The obtained connection networks indicate the critical points to which special attention must be paid during teaching, if we want the holistic nature of natural processes to be reflected in the knowledge structure of our students. The content analysis of the student answers (testing of professional correctness, frequency of occurrence of answer categories) is in progress. The word association analysis of the topic of “Forest” is ready for publication.

3. Plan: Age-specific study of strategic elements of problem-solving in science (pilot study). The aim is to develop a method and a measurement tool. Implementation: In May 2023, pilot semi-structured interviews were conducted in a firsthand in a fourth-grade class. The interview structure was found reliable, with content varying from measure to measure.

4. Plan: Study of elementary and complex schemes used by elementary school students in problem-solving, pilot measures

Implementation: Using semi-structured interviews in focus groups, we investigated the schemes that first- and fourth-grade students activate when solving problems that are presented to them and that go beyond their prior knowledge. We wanted to find out whether we could identify typical misconceptions or p-primes, or complex schemes for problem-solving based on these or on previous experience. The pilot study involved students in groups of six from grades 1-4 in a small-

town school. The interviews were audio-recorded. The study confirmed our expectations: when solving problems (1) young school children often recalled their own previous experiences (I have seen it before; when at home... etc.); (2) in many cases, they used known p-primes (the bigger the heavier; ugly is harmful; closer is stronger; the wetter is heavier; obstacles slow down movement; the older moves slower; warm air flows out and cold comes in), and (3) in some cases in situ complex models were also used (e.g. the flow of rivers is similar to that of cars). Based on the above experience, we plan to develop the teacher-administered structured interviews and written tests used for large-sample measurements which would allow us to continue the study with even more students in the future.

5. Plan: Study of the students' motivation, interest, attitude, discreet emotion and academic self-concept regarding science learning. Conduct a pilot study in the first year. Implementation: Data was collected by selecting one third-grade and one fourth-grade class from our list of four partner schools in May-June 2023. Altogether 200 students completed the pilot questionnaire pack. All data were recorded during the summer. At present, we are preparing the psychometric analysis of the questionnaires included in the questionnaire pack and the factor analysis necessary for the validation of certain questionnaires, and interpreting the pilot results.

6. Plan: Studying mathematical skills related to science learning. The aim is to explore the characteristics of mathematical knowledge needed for learning sciences in early childhood and to prepare for the development in third- and fourth-grades. Implementation: This year, we started preparing and implementing the planned intervention in the mathematics lessons in Grades 3 and 4 in the schools participating in the programme. The activities tested the knowledge of mathematical operations and skills that are also functional in the process of learning sciences. The findings will be used when designing the future teaching experiment with Grades 3 and 4. The statistical processing of the data is still in progress. The results will be presented in a journal article.

7. Plan: Measuring the socio-economic background of the students using a questionnaire. Implementation: Compilation and conduction of a questionnaire consisting of seven questions. The questionnaires were completed by the teachers considering the early age of the students. The data are used as background variables in the surveys and studies of the research.

8. Plan: Eye-tracking study of comprehension reading of scientific texts and map reading in a virtual reality environment. Preparation of the investigation. Implementation: Developing examination by using the eye-tracker method. Preparation of the method for measuring with eye-tracking devices. Development of a measurement tool (slide show) for measuring Grades 1-4. Adaptation of international methodology to the age group.

9. Plan: Organising the first sensitization sessions in Grade 1 in elementary schools. Training of teachers, methodological development of lesson plans, experiments, and observation in nature, delivery of sessions. Implementation: All the elements of the plan were successfully delivered. Altogether 12 activity plans were elaborated in the themes of Water, Air, Light and Earth each including 3 activities. The sessions were held in 8 first-grade classes with the participation of 195 students who will be involved in the development programme up to the fourth-grade. A complex interdisciplinary approach to science learning was implemented in the thematic activities.

2) Problems encountered when implementing the research plan and their solutions The problems during the programme period were related to the mobility of the participating schools. By the end of the academic year (2022/23) 4 schools resigned from the programme. This mainly affected the word association analysis by causing a loss of data in the longitudinal study but it may be regarded as a relatively insignificant problem and the sample size is still adequate. At the end of the academic year one more school joined the programme whose students could be added to this initial stage of the research without any problem.

3) Key publications related to the research programme As the research is in its initial phase without any preceding projects, therefore publications are expected in the coming year. Besides the processing of the theoretical background for the research, the word association and mathematical skills related studies are also ready for publication.

4) Dissemination events We

presented the research process and the results at 2 conferences (24 February 2023 and 29 June 2023). The problems raised at these conferences were mainly related to the developmental activities which we have taken into consideration in the continuation of the programme. The research activities were not affected by these problems. Debrecen, 30 September 2023. Ibolya Revákné Dr. Markóczy Group Leader MTA-DE Early Science Research