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Students' Scientific Literacy in the third Educational Period

Students nowadays spend a lot of time on the Internet and are exposed to a great deal of information overload, so it is important that they learn to critically evaluate information as early as primary school. A scientifically literate person can judge whether certain information is credible. In this paper, we would like to highlight the importance of developing scientific literacy in primary school science classes. Science curricula in Slovenia contain general and operational learning objectives that introduce students to scientific methods. In the study, we follow the definition of scientific literacy as a knowledge matrix necessary to critically evaluate scientific reports. We aim to gain a more detailed insight into the scientific literacy of primary school students in the third educational period in Slovenia. In recent decades, interest in science has tended to decline, which has a negative impact on aspirations for a scientific career. Getting young people excited about science is an important goal of science education.

This opportunity can be provided by inquiry-based instruction. Blažič et al. (2003) defined inquiry-based instruction as a specific didactic strategy of scientific knowledge that introduces elements of scientific work into the classroom. In inquiry-based instruction, the student is in the role of active researcher. The importance of inquiry-based teaching is also recognized in Slovenia (Markuš and Čagran, 2017; Markuš and Hus, 2018).

Students mainly have problems with achieving scientific competencies in learning scientific concepts and have insufficiently developed skills for planning and conducting research (Glažar and Devetak, 2013). The authors also point out that in the context of science literacy, it is particularly important to develop the ability to understand the impact of science and technological development on our daily lives, and to identify problems. It is also important to apply strategies of active participation in solving problems (Glažar and Devetak, 2013).

Showing interest in science and not only supporting scientific research but also demonstrating the motivation to behave responsibly are important dimensions of the definition of scientific literacy in the PISA survey (PISA, 2008). The goal of science education in school is not only to stimulate interest in the subject, but also to provide career guidance so that students continue on the path to science careers after completing secondary education and remain interested in scientific questions in adulthood (DeBoer, 2000). In primary school education, it is critical to develop positive attitudes toward science among students in the early years. However, this is mainly influenced by teachers' attitudes towards science and technology (Glažar and Devetak, 2013). Based on the research problem and research objective, we asked ourselves the following research questions:

- What ideas do students have about the work of scientists?
- What is the attitude of students towards research work at school?
- What ideas do students have about the importance of science and technology in society?

The research was based on a qualitative and quantitative approach to pedagogical research. We used a descriptive and causal non-experimental research method. In the research, data collection took place through a survey. The survey was completed by 513 students from 10 randomly selected Slovenian schools (170 7th grade students, 145 8th grade students, and 198 9th grade students).

We sent the school a link to the electronic questionnaire and instructions for the teacher who conducted the survey at the school. We gained an insight into students' ideas about scientific

literacy using an adapted version of the questionnaire by Silver and Rushton (2008) and Kang et al. (2021).

We asked the students to answer the question "What do scientists do?". Their responses were coded into three categories. We used the categorization of responses from Kenneth Jones and Hite's (2020) survey, which focused on positive and negative associations about the work of scientists. With a sample of 513 students, we successfully categorized 674 student perceptions. The first category, called internalization of goals, included 87.8% of all ideas about the work of a scientist, wherein the students most often point out that the scientist is doing research. The second category covered the fields of science and technology. This category included 11.7% of all ideas about the work of a scientist. The third category, called working environment and equipment, included 0.4% of all perceptions. The answers of the participating Slovenian students were very superficial. In their answers, the students mostly point out that scientists only do research. We do not perceive any negative connotations from the above associations. From the results of the research, we can also conclude that primary school students in the third educational period still have very poor ideas about the work of scientists, even though all the curricula in Slovenian schools for natural science subjects contain general and operational learning objectives related to research and scientific activity. In the answers, we did not find stereotypical ideas about scientists (e.g., scientists are older men who wear lab coats and work indoors), which is often mentioned in foreign research (Bozzato et al., 2021; Emvalotis and Koutsianou, 2018; Ferguson and Lezotte, 2020; Martins, 2023).

In the second research question, we are interested in the students' attitude towards research work at school. The questionnaire, which determines the student's attitude towards science at school, includes 11 statements that the students evaluated on a seven-point Likert scale. Arithmetic mean values (M) higher than 4 were taken into account as the majority positive opinion, and values lower than 4 as the majority negative opinion. 7th, 8th and 9th grade students expressed a positive attitude towards ten statements ($M = 5.85 - 4.48$) and a negative attitude towards one statement ($M = 3.75$). The majority (74%) of students agreed with the statement that they (very much) like working with their classmates during research work ($M = 5.85$, $SD = 1.54$). However, they like writing lab reports the least ($M = 3.75$, $SD = 1.80$). The obtained results are comparable to the research of Silver and Rushton (2008); the two researchers point out that the students did not want to become scientists and assume that the reason may be that the students do not connect school activities with the actual work of scientists.

In the third research question, we were interested in what ideas students have about the importance of science and technology in society. The questionnaire, which determines the students' attitude towards science and technology in society, includes 12 statements that the students evaluated on a seven-point Likert scale. Arithmetic mean values (M) higher than 4 were taken into account as the majority positive opinion, and values lower than 4 as the majority negative opinion. 7th, 8th and 9th grade students expressed a positive attitude towards ten statements ($M = 5.38 - 4.12$) and a negative attitude towards two statements ($M = 2.88 - 2.75$). They rated the statement that men and women can be good scientists ($M = 5.38$, $SD = 2.00$) and engineers ($M = 5.35$, $SD = 1.92$) the highest. Students expressed the view that science and technology are considered socially beneficial. Despite their awareness that science and technology are important to society, students generally do not want to become scientists ($M = 2.75$, $SD = 1.82$) or engineers ($M = 2.88$, $SD = 1.78$). The results of our research are consistent with the findings of comparable foreign research (Kenneth Jones & Hite, 2020; Lee & Kim, 2018). Moreover, in conducting research among 5th graders in Great Britain using the same

questionnaire, Silver and Rushton (2008) found that the students mostly do not want to become scientists or engineers.

We tested the students' interest in science with eight statements. The students evaluated them on a four-point Likert scale. The majority of students expressed positive views on all the given statements ($M = 2.14 - 3.02$). The most positive attitude was expressed in the statement "Natural science helps us to better understand nature" ($M = 3.02, SD = 0.91$). A total of 80.1% of students agreed with the statement. The least positive attitude was found in the statement "Dealing with science is one of my favourite activities" ($M = 2.14, SD = 0.89$), with which 32% of students (strongly) agreed. In many studies (Kang et al., 2021; PISA, 2008, 2016; Roberts, 2007; Silver and Rushton, 2008; Simon and Osborne, 2010; TIMMS, 2016; Tytler et al., 2008) they investigated the attitude of learners towards natural sciences, where, among other things, they find that the problem is not that natural science is not interesting, but that other school subjects are more interesting than natural science, which has also been confirmed by the results of our research. Foreign research also finds that students who had more information about science careers increased their interest in science and thus their desire for science studies and careers (Bartels and Lederman, 2022; Drymiotou et al., 2021; Kang et al., 2021). The researchers pointed out that for this purpose it would be necessary to systematically include a career aspect in the curricula.

Using the Pearson correlation coefficient we checked the connection between the total number of ideas about the work of a scientist, the students' attitude towards science in school, the attitude towards science and technology in society, their interest in natural sciences, the final grade in biology or natural science, and the classes they are currently attending. We find statistically significant positive correlations between the number of ideas about the work of a scientist, the attitude towards science in school, the attitude towards science and technology in society, interest in science, and the final grade in science or biology. However, there are no statistically significant correlations between the class attended by students and other variables. The results of our research significantly contribute to the understanding of various factors that influence the scientific literacy of primary school students in Slovenia. Science curricula in Slovenia include learning objectives that introduce students to scientific methods, but we should clearly emphasize more strongly that scientists use scientific methods in their work, what scientific activities involve, and what contribution science and technology make to society.