Development of critical thinking in physics education

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Abstract. These days we have unlimited access to an overabundance of information. Some of it is not true or not based on scientific knowledge. Therefore, we should be developing the critical thinking skills of students. We need to teach them how to verify information, recognize scientifically correct information and ask questions or draw conclusions appropriately. This contribution presents an initial mapping of the level of critical thinking in university students and grammar school students. Methods for developing critical thinking were used in physics classes during one year in a selected grammar school. Consequently, we observed the changes in students' critical thinking.

Introduction

Almost unlimited access to information, including a large amount of fake news and conspiracy theories, forces us to draw conclusions, assess the credibility of facts or judge the strength of arguments. Hence the skill of critical thinking is necessary. It is one of the indispensable prerequisites for the proper functioning of a democratic society. It is the critical evaluation of acquired knowledge that helps to avoid succumbing to often emotionally charged untruths or distorted information. Critical thinking is classified as one of the 21st century key skills needed for a university degree, to pursue certain professions and to navigate everyday life situations [1].

The development of critical thinking is given considerable attention in curriculum across the world. Hence activities to advance critical thinking in physics education are included more frequently. They enable students to correctly relate the information they have learned to scientific knowledge and to ask questions. It is the six fundamental questions of "what, when, where, how, who, and why" that are the cornerstone of inquiry in science but also in philosophy, law, journalism, and many other fields. Students should learn to use them in everyday conversations [2].

The aim of our research is to map the level of critical thinking in first year university students, third year high school students and future physics teachers. Another aim is to determine whether incorporating methods that promote the development of critical thinking into physics teaching can help develop critical thinking in students.

Watson-Glaser Critical Thinking Appraisal

There are many methods of testing which differ in the form of the test and the starting points. In the Czech Republic, the Watson-Glaser Critical Thinking Appraisal (W-G CTA) is the most widely used, as it is the only foreign test that has been translated into Czech. The original version of this test was created in the 1960s and the Czech translation in 2000. We used the C form of the test for our testing, which contains 5 subtests focusing on inferences, assumptions, deductions, interpreting information and analysing arguments.

Each subtest contains 16 multiple-choice questions. In the first part the student chooses from 5 possible answers. There are only two answers to choose from in the other parts. One point is awarded for each correct answer.

The test contains emotionally neutral topics as well as topics that may evoke strong emotions. In such cases, the respondent should not be influenced by preconceived ideas but solve the inquiry based on the factual information provided.

Critical thinking of university students and grammar school pupils

In the autumn of 2023, a survey was carried out with the participation of first-year students of the Faculty of Science at Palacký University in Olomouc (N = 164), students of physics teaching in their 4th or 5th year (N = 18) and third-year students of a grammar school (N = 98). Students and pupils were tested using W-G CTA. All respondents scored the lowest in the area of inferences. They scored highest in the domain of assumptions. It appears that scores in some areas correlate with total scores more than others.

During the winter semester, more activities were incorporated into the curriculum to promote critical thinking in a course designed for prospective teachers (N = 10). The goal was to observe if the level of critical thinking would increase. At the end of the semester, students took the critical thinking test again. We also noted their opinion on the importance of critical thinking in education at the beginning and at the end of the semester. It emerged that the use of methods in university education can positively influence the opinions of future teachers.

The next part of the research was conducted throughout the school year (September 2023–June 2024) at a selected grammar school. The tested pupils attend four different classes. In class A, almost every lesson includes at least a short activity promoting the development of critical thinking. In class B, these activities are included in physics classes approximately once every 1–2 weeks. Classes C and D form the control class. The teaching of physics is done in a typical way for the Czech school system. At the end of June, all pupils will be given the critical thinking test again. We want to observe if the pupils in classes A and B have made a more significant shift in critical thinking than the pupils in classes C and D.

Once this phase is complete, the following hypotheses will be tested:

H1: "University students score higher on the W-G CTA than grammar school students".

H2: "Males score higher than females".

H3: "Students in classes A and B have a greater score difference in the pre- and post-test than students in classes C and D."

Conclusion

Developing students' critical thinking skills is important for their further education and everyday life. We focused on promoting critical thinking in physics lessons. The results of the investigation show that both students and pupils have the biggest problem with reasoning. Our hypothesis is that more frequent inclusion of activities aimed at developing critical thinking in physics lessons positively affects the level of critical thinking in students. It has been shown that students of teaching who have taken a course including such activities in the curriculum want to use them in future practice to develop their students' critical thinking.

References

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