Research of developing critical thinking in inclusive biology education

Nurillya Gabdullina1, Aigul Akhmetova1, Raikhan Yerkebay2, Venera Magauiyakyzy3, and Indira Ramazanova1, 2

1 Al-Farabi Kazakh National University, Department of Biophysics, Biomedicine and Neurosciences, 71 Al-Farabi Ave., Almaty, Kazakhstan
2 Al-Farabi KazNU College, 39/47 Masanchi St., Almaty, Kazakhstan
3 International Taraz Innovative Institute named after Sh.Murtaza, Department of biology and agricultural specialties, 69B Zheltoksan St., Taraz, Kazakhstan

Abstract. The standards for the personal attributes of graduates of educational institutions, especially those with special needs, evolve in response to shifts in society. After all, they integrate seamlessly into society. Graduates must cultivate socially significant personal attributes in order to boost their flexibility. The application of technological components for the growth of critical thinking facilitates this. A person's personality is formed, and the development of their critical thinking skills is useful for autonomous thought. Students in a biology class are taught to think critically, analyze arguments, assess the validity of information sources, and come up with alternative answers within the framework of critical thinking technology. Biology lessons were taught during the study via a variety of techniques to foster critical thinking. Students with special needs participated in a survey at the end to provide input. According to the study, teaching exceptional children to think critically improves their capacity for problem solving as well as their level of engagement and confidence. The study's findings demonstrate the necessity of greater investigation into strategies for teaching critical thinking in order to serve a larger number of kids with special needs.

1 Introduction

The idea of inclusive education has been progressively introduced by the educational system in recent decades, providing opportunities for children with special needs to learn alongside typical students in normal classrooms or groups. An educational strategy known as inclusive education acknowledges that every child is different and has distinct requirements. It aims to ensure that every child has equitable access to education and to remove obstacles to learning.

Children from vulnerable social groups (children from low-income families, children of immigrants, etc.) as well as children with disabilities are included in the inclusive education program and receive instruction alongside their peers in regular educational institutions.

There is a new perspective on children with special needs that is linked to the continuous advances in the field of education. The Law "On Amendments and Additions to Certain
Legislative Acts of the Republic of Kazakhstan on Inclusive Education" states that equal opportunities for every child's full development must be provided, irrespective of their social status, psychophysiological makeup, or personal traits [1]. Approximately 240 million children worldwide today struggle with issues related to their physical and mental development, according to UN data (2021) [2]. The prevalence of these children is increasing, not only in our nation but also worldwide. Around 3% of all children in our nation, totaling over 162,000 youngsters, require a special education approach. The number of children in special education has doubled in the last ten years [3]. All educational establishments must be equipped to adapt to the diverse needs of children, considering their social, emotional, psychological, and other traits. The unique demands of each student must be considered when designing the educational process. It is important to consider factors like activity, evaluability, achievable level, and realism when creating the process. Improved academic performance, social and emotional development, self-esteem, and peer acceptability can result from inclusive education when it is implemented with proper planning and organization [4]. Pedagogical technologies abound in the field of education. Based on the data, we believe that one of the most pertinent technologies in educational activities is critical thinking technology. The standards for the personal attributes of graduates from educational institutions, especially those with special needs, evolve in response to shifts in society. They do, after all, integrate seamlessly into society. Giving young people the tools they need to succeed in the workforce is essential in the field of youth education. The absence of assistive technology, transportation issues, social stigma, and inaccessible physical locations present a number of challenges for people with disabilities seeking employment in Kazakhstan. Concerning figures highlight the importance of focused efforts. Compared to their peers who fit the mold, young individuals with impairments between the ages of 15 and 29 are five times more likely to be unemployed or not in the educational system [5].

Fig. 1. Application of “Critical Thinking” technology in biology lessons.

Graduates must cultivate socially significant personal attributes in order to boost their flexibility. The application of technological components for the growth of critical thinking facilitates this. With the help of technology, pupils may realize their full potential. In
Socrates' day, the value of critical thinking was established [6]. With the use of this skill, an individual may evaluate information that they are given or acquire and utilize it to solve problems on their own, considering the advantages and disadvantages of various courses of action [7].

In a biology lecture, students learn to analyze arguments, explore issues from multiple points of view, assess the validity of information sources, and generate alternative solutions as part of the critical thinking technology (Fig. 1).

2 Methodology

Acknowledging the diverse cognitive profiles among individuals with impairments, critical thinking methodologies were adapted to effectively accommodate them. Instructions can be made simpler, visual aids can be used, music and games can be included, different interests catered to and conversation can be encouraged. These flexible techniques guarantee that everyone can engage in critical thinking, whatever their particular obstacles. Thinking critically entails questioning accepted wisdom, investigating other viewpoints, and coming up with original concepts. With this ability, one can not only examine issues but also come up with original, workable solutions.

The classes were attended by four groups. There were 47 pupils in all. There were eight special needs students. Classes on the development of critical thinking were held from September 2023 to March 2024 with college students from Al-Farabi Kazakh National University. The students' ages ranged from 15 to 17 years old. In order to get feedback, our ultimate objective was to poll special needs pupils. The «Web ask» application was used to conduct the poll. The pupils used the generated link to respond to the five-question survey.

Various techniques outlined in Table 1 were utilized to investigate the efficacy of critical thinking development.

Table 1. Technologies for developing critical thinking in biology lessons.

<table>
<thead>
<tr>
<th>Name of the technique</th>
<th>Description of the technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ishikawa Diagram (Fishbone)</td>
<td>It is a visual aid for arranging and illustrating cause-and-effect connections. The issue statement is the head, and the key cause categories are the bones, giving it an appearance akin to a fish skeleton. The Fishbone diagram is sometimes called a cause-and-effect diagram due to its function (Watson, 2004). A model of suggestive presentation for the correlations between an event (effect) and its numerous occurrence causes is primarily represented by the fishbone (Ishikawa) diagram [8].</td>
</tr>
<tr>
<td>Elimination of the superfluous</td>
<td>The method involves putting into practice steps meant to remove one additional item from a set of four after combining the other three in light of a crucial characteristic. This method exists in two forms: written (or &quot;verbal&quot;) and graphic. Since examining the illustrated drawings is more likely to lead to the discovery of secondary features and a distortion of the level of generalization than reading written words, the visual choice is better for learning in an inclusive setting.</td>
</tr>
<tr>
<td>Search for analogues</td>
<td>Students must establish analogies by drawing comparisons. Comparisons between things, phenomena, and processes allow one to think more deeply and make information more meaningful and long-lasting. By comparing ideas, procedures, and phenomena, students can learn to draw parallels and distinctions between them, which stimulates the mind and quickens the process of mental development.</td>
</tr>
</tbody>
</table>
The empirical approach of the research technique, which processed data from a questionnaire survey, was used. An examination of the data gathered throughout the course of empirical sociological study involves more than just a collection of strategies and procedures that let you see the material visually. The survey replies were analyzed, among other things, by utilizing the software “Statistical Package for the Social Sciences” (SPSS) [12]. The graphical features of the SPSS program were used to create the diagram in Figure 2. The creation of one-dimensional frequency distributions using graphical diagrams makes the patterns more visible and is mainly useful for presenting research findings.

In biology lessons, the design of them was according to the following structure (Table 2):

**Table 2.** Building a lesson structure for the development of critical thinking in biology lessons.

<table>
<thead>
<tr>
<th>The call stage enables one to:</th>
<th>The comprehension stage facilitates:</th>
<th>The reflection stage permits:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Update and summarize existing knowledge on a given topic or problem; Arouse sustained interest in the topic, motivate the student to study; Encourage the student to work actively.</td>
<td>Comprehend it; Correlate with existing knowledge and obtain new information.</td>
<td>Holistic comprehension, generalization of the information received; Assignment of new knowledge, new information by the student; Formation of each student’s own attitude to the material studied.</td>
</tr>
</tbody>
</table>
3 Results and Discussion

At the final stage, students with special needs showed feedback in the survey conducted. In total, five questions with a choice of one and multiple answers were given to the students. Using «SPSS» software, a comparative analysis of the development of critical thinking of students with special needs in the process of teaching biology was performed and the following results were obtained (Fig. 2).

![Fig. 2. The results of the comparative analysis.](image)

To the question “Which of the proposed teaching methods did you most effectively accept?” 30% of respondents highlighted the “Ishikawa Diagram”, 25% noted the “Tarsia Method”, 20% - “Bloom’s Cube”, 15% - “Elimination of the superfluous”, 5% - “Thin and thick questions”, 4% - “KWL”, the remaining 1% chose the “Search for analogues” option. After analyzing the answers to all the methods given to the students, the result was obtained that the most effective and understandable method was the “Ishikawa Diagram”.

To the next question, “Which of the techniques used in the educational process helped you remember the information best?” 35% of respondents answered “Tarsia Method”, 32% - “Ishikawa Diagram”, 21% - “Bloom’s Cube”, 6% - “Thin and thick questions”, 3% - “Elimination of the superfluous”, 2% - “Search for analogues”, the remaining 1% chose "KWL". Additionally, it was shown that in the process of applying the Tarsia Method students interested more in the subject, there was a spirit of competition in solving puzzles, which well developed an integral quality as competitiveness. Students were divided into groups, which allowed students with special needs to join the team. This method can be a means of achieving not only objective, but also personal results.

To the third question, “Which methodology helped you best develop critical thinking skills when studying material?” 23% of respondents answered “Ishikawa Diagram”, 20% - “Tarsia Method”, 18% - “Bloom’s Cube”, 15% - “Elimination of the superfluous”, 13% - “Thin and thick questions”, 7% - “KWL”, the remaining 4% chose “Search for analogues.” This indicates that the “Ishikawa Diagram” method develops the following skills in students: critical thinking, analyzing information, identifying cause-and-effect relationships, forming their own opinion and the ability to prove it, and the ability to work in a team.
To the question “Which technique was more interesting and easier for you to work with?” 22% of respondents answered “Tarsia Method”, 20% - “Bloom’s Cube”, 17% - “Ishikawa Diagram”, 15% - “Elimination of the superfluous”, 12% - “KWL”, 9% - “Search for analogues”, the remaining 5% chose “Thin and thick questions.” This result suggests that solving Tarsia puzzles can enhance cooperative learning in a group and support the generation of new knowledge.

To the final question “How do you evaluate the effectiveness of group work in the educational process?” 60% of respondents answered: “I liked working in a group,” the remaining 40% chose the option “It’s better to work independently.” Practice shows that students with less educational capabilities in groups speak out more often than usual, in 3-5 times, they are not afraid to speak and ask. This indicates an increase in their activity, which allows them to more successfully develop knowledge, skills and abilities. The group form of education has a great effect not only in educating, but also in upbringing of students. Students united in one group get used to working together, learn to find a common language and overcome communication difficulties. “Healthy” students begin to feel responsible for their less prepared inclusive comrades, and they try to support them in-group.

A milestone control was carried out every seven weeks to track and evaluate the growth of critical thinking. The control work results indicated that special children had made progress in critical thinking growth as well as in comprehending and implementing the material that they had been taught.

4 Conclusion

Thus, the development of critical thinking in inclusive education empowers people, including those with disabilities, with valuable skills and contributes to building a more inclusive and equitable society. System-activity and personality-oriented approaches to the organization of educational activities, in which the student learns universal learning activities, are included in the technology of developing critical thinking.

The discipline "Biology" is distinguished by its specific teaching methods, in which the technology of developing critical thinking of special children is well integrated. Like any other technology, this technology has its advantages and disadvantages. The following methods were used for the analysis: "Ishikawa diagram" ("Fishbone"), "Exclusion of excess", "Search for analogues", "Tarsia method", "Thin and thick questions", "KWL" (I know, I want to know, I learned), "Bloom's Cube". According to the results of a survey among inclusive children, the "Ishikawa Diagram" method was chosen as an effective method and developing critical thinking skills. This method helps to present a large amount of information in a convenient and interesting visual format. Thanks to this, students not only learn the topic better and faster, but also understand how to apply their knowledge in practice.

The study shows that introducing critical thinking to special children leads to improved problem-solving abilities, increased engagement and self-confidence. The results of this study, we recommend using the above methods in teaching biology to develop critical thinking in special children.

The results of the study highlight the need for further research on critical thinking development methods to reach more special students.

Author’s contribution
- Conceptualization: A.A., N.G., I.R.;
- Investigation and Resources: A.A., N.G., I.R.;
- Review & Editing: N.G., R.Y.;
- Writing: I.R and V.M.;
Supervision: A.A., N.G., I.R.

References


3. Skol'ko v Kazahstane detej s osobymi obrazovatel'nymi potrebnostyami [How many children with special educational needs are there in Kazakhstan?]. [Electronic resource]: Inva.kz informacionnyj portal social'nyh novostej Kazahstana [Inva.kz information portal of social news of Kazakhstan], 04/ 2023// URL: https://inva.kz/2023/04/26/skolko-v-kazahstane-detej-s-osobymi-obrazovatelnymi-potrebnostyami/


9. Tarsia maker URL: https://www.tarsiamaker.co.uk/

10. KWL Charts: Teaching Strategy that Work for your Students! [Electronic resource]: Someka Excel Solutions, 07/ 2020// URL: https://someka.medium.com/kwl-charts-teaching-strategy-that-work-for-your-students-7ed95dd22ae9
