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DEVELOPMENT OF THINKING LEVEL OF SECONDARY LEVEL STUDENTS

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ABSTRACT:

A key objective of education is to facilitate the development of students' higher-order thinking abilities, which are essential for addressing the challenges encountered in everyday life. In the Nagpur region, the primary aim of the Science Curriculum is to enhance these higher-order thinking skills. This study was conducted to evaluate the level of higher-order thinking skills among 9th-grade students. To assess students' higher-order thinking skills, a test was designed based on Bloom's Taxonomy of the cognitive domain. The test comprised 20 multiple-choice questions and was administered to a randomly selected sample of 100 9th-grade students in the Nagpur region. The results indicated that the majority of the 9th-grade students exhibited lower-level thinking skills (n = 40, 40.00%). Interestingly, a higher number of male students demonstrated lower-level thinking skills compared to female students. However, no statistically significant difference was observed in the level of higher-order thinking skills between students of different genders (p > 0.05). The findings from this study suggest that nearly all students need to enhance their higher-order thinking skills, with a particular focus on improving skills related to synthesis and evaluation. These skills are crucial for fostering students' creativity in the field of science.

Key words: ***Cognitive skills, higher order thinking skills, secondary school students, higher order thinking level test.***

INTRODUCTION:

Science education comprises two fundamental components: scientific knowledge and the process of acquiring scientific knowledge. Scientific knowledge encompasses facts, laws, hypotheses, and theories. The acquisition of scientific knowledge, on the other hand, involves the application of this knowledge to various contexts, utilizing problem-solving skills and a range of science process skills. These processes encourage students to engage their higher-order thinking skills during their scientific learning journey. A central objective of science education is to empower students with the ability to develop their higher-order thinking skills, which are essential for addressing the challenges they encounter in their daily lives. This is achieved by incorporating activities into the curriculum that stimulate the utilization of higher-order thinking skills, including critical thinking, reasoning, reflection, and science process skills. Unfortunately, there exists a common misconception among educators that this important goal is only suitable for high-achieving students. There is a prevailing belief that tasks demanding higher-order thinking are appropriate solely for those who excel academically, while students with lower academic performance, struggling to grasp basic facts, are often seen as incapable of handling such tasks.

Studies focused on cognitive skills have revealed that nurturing students' higher-order thinking abilities during the learning process not only increases their awareness of their own thinking but also enhances their overall learning performance and cognitive development. Moreover, these higher-order thinking skills come into play when students are faced with unfamiliar problems, uncertainties, questions, or dilemmas. The effective application of these skills within the science classroom leads to the creation of explanations, decisions, performances, and products that are grounded in the context of existing knowledge and experience. Furthermore, this process facilitates ongoing growth in these and other intellectual skills. It's worth noting that these skills necessitate students' ability to transfer their scientific knowledge and apply it to novel situations.

Promoting higher-level thinking skills among students has been a central theme in the redesign and reform of educational systems. In line with this objective, in 2009, there was a comprehensive overhaul of the educational system in the region, with a specific focus on revamping the science curriculum. The revised science curriculum placed a significant emphasis on nurturing students' higher-order thinking abilities by incorporating various activities that necessitate the utilization of these skills. Furthermore, given the absence of any existing program to evaluate these skills, it became imperative to assess students' performance in these areas. This assessment would provide empirical data to gauge the extent to which the science curriculum has successfully achieved its objectives, thereby offering valuable insights for policy decisions. Consequently, the primary goal of this study was to evaluate the level of higher-order thinking skills among secondary school students in the Nagpur region. Additionally, the study aimed to explore any potential associations between students' cognitive skill levels and their gender.

The notion of higher-order thinking is rooted in the Bloom taxonomy of the cognitive domain, which was first introduced in 1956. This cognitive domain encompasses both knowledge acquisition and the cultivation of intellectual capabilities. It encompasses the ability to recall or recognize specific facts, procedural sequences, and fundamental concepts, all of which contribute to the advancement of intellectual aptitude and competencies. Within this framework, there are six primary categories of cognitive processes, ranging from the most basic to the most intricate. Bloom organized intellectual activities into six levels of thinking: knowledge, comprehension, application, analysis, synthesis, and evaluation.

The categories within the Bloom taxonomy for cognitive development follow a hierarchical arrangement, progressing from concrete to abstract levels. This hierarchical structure delineates the continuum of cognitive processing from lower-order to higher-order thinking. The initial three levels of Bloom's taxonomy knowledge, comprehension, and application are considered lower-level thinking skills, as they primarily involve basic recognition or recall.

In contrast, the subsequent three levels of Bloom's taxonomy analysis, synthesis, and evaluation—demand the application of higher-order thinking skills, which, in turn, enhance students' learning performance. Research focusing on the cognitive development of secondary school students has identified the first three categories of the Bloom taxonomy knowledge, comprehension, and application as measures of lower-order thinking skills, often referred to as Low-Order Thinking Status. Conversely, the remaining three levels analysis, synthesis, and evaluation measure higher levels of thinking skills, known as High-Order Thinking Status. It's worth noting that in the revised Bloom's taxonomy, the three higher levels are labeled as analyzing, evaluating, and creating.

OBJECTIVE OF THE STUDY

The overall aim of the study this study was to assess the level of higher order thinking skills among students in science learning as well as to identify if there is any association between students' level of cognitive skills and their gender. In order to achieve this objective two research questions were formed:

1. What is the current level of higher order thinking skills among 9th grade students in the Nagpur region?
2. Is there any association between students' gender and their higher level of higher order thinking skills in science learning?

METHODOLOGY:

The participants in this research consisted of ninth-grade students from secondary schools in the Nagpur region. The selection of schools in the Nagpur region was done through a random sampling process, and from each of these schools, ninth-grade classes were randomly chosen. The participants in this study were in the age range of 15 to 16 years. The total sample size for this study comprised 100 secondary-level students who were ultimately selected for participation. To assess the thinking skills of these ninth-grade students, a higher-order thinking level test was developed based on Bloom's Taxonomy of the cognitive domain. Previous research has indicated that the first three levels of Bloom's taxonomy—knowledge, comprehension, and application—measure students' lower-order thinking skills. Conversely, the upper three levels of Bloom's taxonomy—analysis, synthesis, and evaluation—assess students' higher-order thinking skills.

After reviewing various tests assessing thinking skills, the researcher developed a 25-item test comprising multiple-choice questions. Multiple-choice questions have been widely employed in previous studies to evaluate students' cognitive abilities. To assess students' lower-order thinking skills, 13 questions were allocated to the first three categories of Bloom's taxonomy: knowledge, comprehension, and application. Meanwhile, 12 questions were specifically designed to gauge students' higher-order thinking skills, aligning with the last three categories of Bloom's taxonomy within the cognitive domain. To determine a student's total score in the High-Order Thinking Level Test, the researcher employed a scoring system commonly used for multiple-choice items. Under this system, one point was awarded for each correct response, while a score of zero was assigned to incorrect answers, unanswered questions, or questions marked with more than one answer. Consequently, the total scores for the lower-order thinking skills level ranged from 0 to 13 points, and for the higher-order thinking skills level, the scores ranged from 0 to 12 points.

Data collection was carried out through the self-administration of the finalized version of the High Order Thinking Level Test (HOTLT) after obtaining ethical approval from the respective school headmasters to conduct the study in secondary schools. The test was distributed to a total of 100 ninth-grade students, with data collection from each school being completed in a single day. Prior to the administration of the test, all participants were provided with information about the study's objectives and procedures. In this study, descriptive statistics were employed to evaluate the cognitive development levels of the students. Additionally, a chi-square test was utilized to explore any potential associations between students' levels of higher-order thinking skills and their gender, employing appropriate statistical techniques.

RESULTS

Table 1.1

Students' Results on Cognitive Domain Constructs

Construct	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
Mean	2.01	1.98	1.27	1.15	1.11	1.32
SD	1.180	1.140	.920	.730	.880	.821
Range	5	4	4	4	4	4
Skewness	.158	-.036	.462	-.105	.464	.170
Kurtosis	-.408	-.650	-.107	-.844	.371	.096
Median	2.00	2.00	1.00	1.00	1.00	1.00

Table 1.2

Results of Student's Level of Thinking Skills in Science Learning

Level	N	Mean	Std. Deviation
Low Order Thinking	100	5.240	2.072
High Order Thinking	100	3.570	1.631

Table 3:

Association between Students' Level of Thinking Skills and Gender

Gender	Level of thinking skills	
	Lower (%)	Higher (%)
Girls	75.90	24.10
Boys	84.00	16.00
Total	79.70	20.30

The study instrument was distributed to 100 ninth-grade students in the Nagpur region, and all 100 responses were thoroughly analyzed, resulting in a 100% response rate. To determine the normality of the data, the skewness and kurtosis values were examined. According to Hair et al. (2010), data distribution is considered normal when the empirical z-value falls within the range of ±2.58 at a significance level of 0.01 or ±1.96 at a significance level of 0.05. In this study, the skewness and kurtosis values, as presented in Table 1.1, fall within the recommended range of ±1. Subsequently, descriptive statistics were employed to evaluate students' cognitive skill levels based on the six constructs of the taxonomy for the cognitive domain. This analysis also helped identify whether students' thinking skills were categorized as higher or lower level.

Previous research on High-Order Thinking has established that the first three constructs—knowledge, comprehension, and application—correspond to lower-order thinking levels, while the last three constructs—analysis, synthesis, and evaluation—correspond to higher-order thinking levels. Consequently, the researcher categorized the items into two groups: the first three constructs, consisting of 13 items, were classified as representing a lower-order thinking level, while the last three constructs, comprising 12 items, were categorized as indicative of a higher-order thinking level. This classification was made using descriptive statistics.

The results of the Higher Order Thinking Level Test, based on Bloom's taxonomy, revealed that the scores for all the constructs were notably low. Among the constructs, the highest mean score was observed for the "knowledge" construct, with a score of 2.01 out of a maximum possible score of 5. This was followed by the "comprehension" construct with a mean score of 1.98 and the "application" construct with a mean score of 1.27. Conversely, the "synthesis" construct had an average mean score of only 1.11 out of 4, and the lowest mean score was recorded for the "evaluation" construct at 1.32. In terms of students' overall level of thinking skills, as displayed in the table, the results indicated that the majority of the 9th-grade students exhibited a lower level of thinking skills, with an average score of 5.25 out of a possible 13. The scores ranged from a minimum of 1 point to a maximum of 11 points. Conversely, the score for the higher-order thinking level was 3.58 out of a possible 12, with a maximum score of 7 points and a minimum score of zero. To explore the relationship between students' levels of higher-order thinking skills and their gender, a chi-square test was employed.

As per the data presented in Table 1.3, the results from the sample of 100 students revealed that a significant majority (70%) of the students exhibited a lower level of thinking skills, while only a minority (20%) demonstrated a higher level of thinking skills. In terms of gender distribution, the total number of female students comprised 70% of those in the lower level of thinking skills (LOTL) and 24% of those in the higher level of thinking skills (HOT). The study also included 50 male students, with the majority (70%) falling into the lower level of thinking skills. However, the findings presented in the table indicate that there is no statistically significant difference in the levels of thinking skills based on gender, as evidenced by a p-value greater than 0.05.

DISCUSSION

Extensive evidence underscores the crucial role of higher-order thinking skills in facilitating effective learning, forming the core objective of education. In 2009, a comprehensive overhaul of the regional educational system was undertaken to address the challenges posed by the 21st century. As a part of this reform, the new secondary school curriculum placed a substantial emphasis on nurturing students' Higher Order Thinking (HOT) abilities. Despite these efforts, no prior studies had been conducted to evaluate students' HOT skills. Consequently, the primary aim of this study was to assess the cognitive development levels of secondary school students, while also exploring any potential associations between their cognitive skill levels and gender. However, the study's findings revealed that a significant proportion of 9th-grade students were operating at the lower level of thinking, particularly within the synthesis and evaluation constructs. These constructs are pivotal in enhancing students' creativity in the field of science. The results also suggested a minor disparity in thinking skill levels based on gender, with a higher number of male students found in the lower level of thinking skills compared to female students. Nevertheless, the chi-square test results demonstrated that this difference was not statistically significant ($p > .05$). This lack of significance could potentially be attributed to both male and female students sharing the same learning environment. These findings align with previous research on cognitive skills, further emphasizing their importance.

Research findings suggest that lower levels of cognitive skills in science learning can be attributed to two primary factors. First, the design and structure of the science curriculum play a crucial role. When the curriculum is structured to provide students with a comprehensive understanding of how the discipline of science functions, it can significantly enhance their ability to engage in higher-level thinking. Second, the learning environment also plays a pivotal role. In the realm of science education, students should be given the opportunity to adopt a scientific mindset by actively involving them in the process of thinking rather than simply presenting them with the end products of scientific disciplines.

Furthermore, to enhance students' Higher Order Thinking (HOT) in science, it is imperative that science educators employ appropriate teaching methods that encourage active student participation in the learning process. This active engagement is essential for fostering the development of higher-order thinking skills in the context of science education.

CONCLUSION AND IMPLICATION

Recognizing the vital role of cognitive skills in academic achievement, comprehending the process of High Order Thinking skills and their evaluation among students stands as a central objective within the field of science education. The outcomes of this study make a valuable contribution to the existing knowledge base by offering insights into the assessment of students' High Order Thinking skills in the context of science learning, specifically in the evaluation of 9th-grade students in the region. The findings of this research hold potential benefits for both educators and curriculum developers. First, science teachers can utilize these findings to assess the cognitive skill levels of their students, pinpoint areas of weakness, and implement learning activities that promote the development of High Order Thinking skills. This approach allows for targeted interventions aimed at enhancing students' cognitive capabilities. Secondly, curriculum designers can leverage these results to gauge the extent to which the new science curriculum has achieved its intended objectives. Armed with this information, they can formulate strategies to further foster High Order Thinking skills among science students. Additionally, the acquisition of High Order Thinking skills can be promoted through in-service professional development programs for science teachers. Such programs can focus on instructing educators on how to effectively utilize the curriculum to convey a deep understanding of scientific concepts and their practical applications in everyday life.

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