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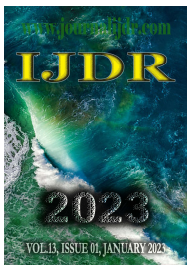

RESEARCH ARTICLE OPEN ACCESS

COMPARISON OF MONTESSORI & NON-MONTESSORI EDUCATED STUDENTS HIGHER ORDER THINKING SKILLS

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ABSTRACT

It is essential to interpret information, determine its veracity, and assess its significance in today's society. Children need not acquire more information to be successful in the modern world; instead, they must develop higher-order thinking skills (HOTS). This study aims to establish whether or not children with a Montessori background have higher levels of HOTS than students with a non-Montessori background. The study analyzes data from a competency-based test in English, mathematics and science conducted for 78 fourth-grade students. It was discovered that the Montessori-educated children performed better in English and Science. Yet the difference in mathematics, where Montessori students scored higher, did not achieve much statistical significance.

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INTRODUCTION

The world is currently experiencing the fourth industrial revolution, which is being driven by artificial intelligence, deep learning, big data, robots, and other technologies. These alterations affect not only the earth but also the lives of children (Noe, 2019). According to Yuval Harari, we cannot prepare our selves or our children for the future due to humanity's rapid technological expansion. The world is undergoing unprecedented upheaval, and we have no idea what skills to teach our children to live and thrive in 2050, let alone get employment (Harari, 2018, pp. 299 - 30). Before the industrial revolution, information was scarce due to the absence of printing. Each city used to have only one library, and most books were censored. As a result, basic geography, history, and biology were taught in schools alongside reading and writing. In the twenty-first century, we are overwhelmed with vast volumes of information, and sometimes we are distracted by the prevalence of misinformation. Students are inundated with Wikipedia, TED talks, and other free internet resources. Each tells stories that contradict the other, making it impossible for students to determine what to trust and what not to believe. Additionally, all distractions are just a click away (Carr, 2008). In such a society, additional knowledge is the last thing a student needs. Immediate requirements include the ability to interpret information, judge if it is right or erroneous, and evaluate the significance of data.

Children must possess the four C's: critical thinking, communication, collaboration, and creativity (Harari, 2018; Chalkiadaki, 2018; Noe, 2019). These four C's, also known as Higher-order Thinking Skills (HOTS), are crucial for acquiring and applying knowledge and work performance (Bialik, Bogan, Fadel, & Horvathova, 2015). Critical thinking is the capacity to evaluate and question rather than blindly accept something as true (Elder & Paul, 2008). Collins claims that critical thinking is the process of determining what to accept or disbelieve by comparing, linking, revealing complexity, and considering other points of view (2020). It is also a skill required to use one's discretion to come up with a well-reasoned critique.

Non-Montessori Approach and HOTS: Since Socrates' time, critical thinking has been a part of education. Teachers in today's classrooms incorporate critical thinking based on Bloom's taxonomy. Benjamin Bloom divided educational objectives into three categories: cognitive domain, affective domain, and psychomotor domain. The cognitive domain includes objectives that recognize knowledge and develop intellectual abilities and skills; the affective domain includes objectives that describe changes in interests, attitudes, and values (Bloom, Engelhari, Furst, & Krathwohl, 1956, pp. 8 - 9). The third domain is about motor skills, which Bloom claims is seldom in secondary schools and colleges. Bloom's cognitive taxonomy originally included six categories: knowledge, comprehension, application, analysis, synthesis, and evaluation (Krathwohl, 2008).

Anderson and Krathwohl revised it to remembering, understanding, applying, analyzing, evaluating, and creating. Learning to recall necessitates thinking, allowing students to gain knowledge and apply it to new situations (Collins, 2020). India has recognized the changing employment landscape and global ecosystem and realized that learning how to learn is as vital as learning itself. The National Education Policy 2020 took a bold step towards reforming the Indian education system to produce people with logical thought and action, compassion and empathy, courage and resilience, scientific temper and creative imagination, and strong ethical convictions. To accomplish this lofty goal, the Policy emphasized developing higher-order thinking skills in children, essential cognitive skills such as literacy and numeracy, and social, ethical, and emotional capacities. As a result, the state intends to generate active, productive, and contributing citizens who will establish an egalitarian, inclusive, and plural society as envisioned by the Indian constitution (2020, pp. 3 - 4). In traditional schools, a textbook is one of the most essential components of the learning process. According to Bloom's taxonomy, teachers teach lessons in the textbook to achieve the objectives. However, the teacher's understanding and knowledge of HOTS are lacking (Prathama & Retnawati, 2018). Angeline Lillard argues that the traditional school system is based on the industrial and empty vessel models, in which the teacher believes that she is the authority and the child is just a learner. Lillard points out that textbooks continue to follow Thorndike's belief that knowledge can and should be contained in textbooks as a collection of disembodied, unconnected written facts that children must memorize to become educated (Lillard, 2017, pp. 9 - 10). This notion prevents teachers from going beyond Bloom's taxonomy's remembering and understanding stages and makes them focus on merely passing on information. Hence, the National Educational Policy attempts to correct this error in teaching and stresses "less" content and "more" learning (2020).

Montessori Approach and HOTS: The Montessori method of education has been in practice since 1907. It is based on child psychology and the developmental needs of children. The main features of the Montessori method are that classrooms consist of mixed age groups, manipulative Montessori equipment, and trained teachers who know to further the development using the two, with minimal interference (Standing, 1957). The Montessori method's fundamental principle is how it distinguishes the child from the adult. According to Maria Montessori, the child is in a "constant state of growth and metamorphosis," whereas the adult has "already reached the norms of the species". The child, during his development, passes through different stages of uniform growth that alternate with metamorphoses in mental, physical and social aspects (Standing, 1957, pp. 87 - 89). Montessori identifies four planes of development of six years each until a child turns 24. These four stages are from birth to six years, six to twelve years, twelve to eighteen, and eighteen to twenty-four. The child in each stage develops on the foundation laid during the preceding stage and has different needs. While the younger child is a sensory child, interested in the "what" and "where" of things, and learns many names, the older child will not be satisfied with mere names. This child is curious about "why" and "how". He or she wants to discover the causes of all phenomena, all behaviours, and all actions. This youngster appreciates imagination, has wider boundaries and has stronger legs. He explores moral issues and is eager to learn the results of his actions. He wants to know what is right and wrong. His fascination with mundane things changes to include extraordinary things (Montessori, 2007). Therefore, he needs a different kind of assistance from the preceding age group. The elementary classroom is structured to meet the developmental needs of six- to twelve-year-olds. Angeline Lillard has identified nine characteristics all Montessori schools share (2017, pp. 28–32). The first principle, movement and cognition, are closely entwined and are fundamental to the Montessori method. The second principle is choice. Montessori classrooms give children choices, allowing them to direct their own learning. The third principle is the development of the executive function (Lillard, 2017, p. 29). The fourth principle is interest. Children get precisely what they desire depending on their developmental requirements, making learning attractive. The fifth principle is that there are no extrinsic benefits. The sixth and seventh principles are that children learn from their peers and through context-based learning. In contrast, to traditional institutions, Montessori teaches the big picture first and, later, the details. The children then construct their own "whole" and are motivated to learn more. The eighth principle is the unique teacher-child relationship: rather than authoritarian, the instructor establishes clear boundaries and allows the students to be independent. The ninth and final principle is order in the mind and environment. The arrangement and utilization of objects in a Montessori classroom are extremely organized. Maria Montessori is highly regarded in India, and it is here that she created the groundwork for her Elementary program. According to Mahatma Gandhi, Montessori schools existed in India as early as 1915, even before she arrived in 1939. (India Montessori Foundation, 2009). Montessori schools are becoming increasingly popular in India. Stakeholders frequently want to know how Montessori-educated students differ from traditionally educated students.

REVIEW OF LITERATURE

A study in Rawalpindi examined 100 students from ten preschools and discovered that while the Kindergarten children were superior in social skills, the Montessori children were superior in language skills (Abbas & Tahir, 2013). A year later, Ahmadpour and Mujembari investigated the impact of the Montessori approach on the IQ of 5-year old children and found that Montessori children had substantially higher IQs than that of traditionally educated children (2015). Montessori children enjoy more freedom of movement compared to children in traditional schools. Concerning this observation, Pate et al. noticed higher activity in Montessori children than in traditional school children (2014). Another study examined the base ten knowledge, place value and arithmetic accuracy and strategy used among early elementary children from Montessori and non-Montessori methods. The approaches did not differ (Laski, Vasilyeva, & Schiffman, 2016). Researchers argued that the very Montessori's manipulative materials made the children dependent on them and could not think beyond them. However, Montessori children indicated significantly higher emotional intelligence than those not involved in Montessori education. Dhiksha & Shivkumara investigated the impact of children's schooling on their emotional intelligence and found that it significantly impacted their mental development (2017). The social and moral development of elementary Montessori students in Peshawar, Pakistan, was compared with that of non-Montessori children. Although the study discovered some differences between the groups, it was not statistically significant (Ahmad & Reba, 2018). Similarly, a study in India indicated no significant difference between the Montessori and traditional school approaches in delay gratification, executive function, social problem solving and drawing abilities. Nevertheless, in the same study, some other tools indicated a significant difference between the two approaches in social development (Munireddy S. R., 2018).

Alburaidi and Ambusaidi used Montessori Science activities to teach traditionally educated 4th Graders and found this method to be effective in teaching Science from 1st to 4th Grade students (2019). The effectiveness of the Montessori reading and math instructional method to African American students in Public schools was evaluated by Brown & Lewis. The study found that public Montessori schools scored significantly higher in reading, whereas their mathematics scores were not significantly different (2022). Recently Snyder et al. compared the standardized test proficiency of Montessori schools with district schools and found that the Montessori schools performed reliably better in English Language Arts (ELA) tests at both grade levels (Snyder, Tong, & Lillard, 2021). Comparing the Montessori method with traditional schooling is difficult because the two systems are very different. Non-Montessori students are prepared for examinations from the day they step into the school. Using the same yardstick to measure the performance of Montessori students is unfair. Researchers Angeline Lillard, Edouard Gentaz, Sylvie Richard, Chloe Marshall and others have discussed studies that have

contradictory results. While one study says Montessori students are significantly better, another proves it completely wrong. Lillard, Marshal and Gentaz have presented detailed reasoning for the contrasting results by the researchers (Marshall, 2017) (Lillard, 2019). (Gentaz & Richard, 2022).

Objective: Living in the 21st century requires the development of Higher-Order Thinking Skills. There have been numerous studies on how Montessori education impacts children's social skills, executive function, and IQ, but fewer on critical thinking skills a component of HOTS. This research aims to determine if there is any difference between the HOTS scores of students with and without the Montessori experience.

METHOD

As Lillard points out, comparing the students in Montessori classrooms to those in non-Montessori is difficult (2019). Current research studies students in a school where Montessori and non-Montessori students study in the fourth standard. Both are following the XSEED curriculum, which is new to them. The test is meant to measure the children's competency. The sample consisted of 84 fourth-grade students. Five girls and one boy were from the Right To Education (RTE) Act scheme aimed to educate children from low socio-economic groups. These six children were excluded from the study. Finally, of the 78 students, 34 had attended the Montessori method either at the primary or lower elementary level, and 44 were from a non-Montessori background. Out of 78 students, 44 were boys, and 34 were girls (Table 1). The Montessori children were from a school recognized by the Indian Montessori Centre, and the non-Montessori students were from a school affiliated with the Central Board of Secondary Education (CBSE). A digital test, known as a Learnometer, based on Structured Assessment for Analyzing Learning (SAFAL), was used.

The SAFAL: SAFAL (Structured Assessment for Analysing Learning) is a CBSE-developed skill and competency-based assessment that evaluates students' learning outcomes in relation to key competencies (Minsitry of Education, 2023). SAFAL assesses core competencies and provides schools with diagnostic data and student development insights. The key features of SAFAL are competency-based assessments that track progress on core concepts such as reading comprehension applications and critical thinking. Students are evaluated at grade level below and above their own. The assessment has no bearing on the students' promotion to the next grade, and students will not face any exam pressure or stress. High-quality competency-based questions are included in the assessment. SAFAL aims to track students' progress throughout the school year to benefit students, parents, teachers, principals, and the entire school system in planning school and teaching-learning process improvements. Rather than relying on rote memorization, these exams assess the achievement of fundamental learning outcomes by evaluating fundamental concepts and knowledge from national and local curricula and relevant higher-order thinking skills and knowledge application in real-world settings.

The Learnometer: SAFAL only evaluates children in Grades 3, 5, and 8. Consequently, XSEED created a Learnometer based on SAFAL for kids in other grades. The Learnometer is administered annually to all classes fromgrade 1 to grade 8. Since Montessori students and non-Montessori students joined grade 4, and there is no SAFAL test, their Learnometer scores were used for this study.

RESULTS

This study aimed to determine if there is a difference between Montessori-educated and non-Montessori-educated children's higher-order thinking skills (HOTS). The students took the test online at school, and the digital reports were generated online. The data was analyzed using SPSS. The Shapiro-Wilk test results ($p = <0.001$) and an analysis of their histograms, conventional Q-Q plots, and box plots revealed that the English, mathematics, and science scores were not normally distributed. Hence, Mann-Whitney U Test, a nonparametric test, was conducted to analyze the data. The test found a significant difference between the groups at a threshold of 0.05 (Table 2). Students without Montessori experience scored an average of 80.4 in English, 69.7 in maths, and 76.7 in science. The children who had Montessori experience began with an average score of 88.1 in English, 75.3 in maths, and 83.9 in science. More than half of the students without Montessori experience scored 86, 74 and 83 in english, mathematics and science, respectively. More than half of students with Montessori experience scored 94, 84 and 89 in English, mathematics and science, respectively.

DISCUSSION

The difference in the English and science scores is significant at the level of 0.05. This could be ascribed to the fact that the two philosophies of education have different ideas about what education is and the model they are based on. Non-Montessori education is based on the "factory" or/and "blank slate" model and focuses more on teacher teaching and child learning (Lillard, 2007).

Table 1. ***Sample Characteristics***

Gender	Non-Montessori	Montessori	Total
Boys	23	21	44
Girls	21	13	34
Total	44	34	78

Note: There are 78 students in all, 44 boys and 34 girls. Students who didn't go to a Montessori school were 44. There were 23 boys and 21 girls in the group. Students who went to Montessori schools were 34. There were 13 boys and 21 girls.

Table 2. Mean, S.D. Median and Mann Whitney U Test Significance of Non-Montessori and Montessori Educated Studentsand Subjects

Particulars	Non-Montessori		Montessori		p-value
	Mean SD	Median	Mean SD	Median	
English	80.4 ± 18.4	86	88.1 ± 15.4	94	0.033*
Mathematics	69.7 ± 18.2	74	75.3 ± 17.7	84	0.116
Science	76.7 ± 20.4	83	83.9 ± 18.4	89	0.029*

Note: Students who didn't go to a Montessori school got an average score of 80.4 in English, 69.7 in math, and 76.7 in Science. Students who had been to a Montessori school got 88.1 in English, 75.3 in Math, and 83.9 in Science. In English, math, and Science, the median scores for non-Montessori students were 86, 74, and 83, respectively. The median for students with a Montessori background in English, Math, and Science were 94, 84, and 89, respectively. The p-values for English, Math, and Science were 0.033, 0.116, and 0.029.
*Significant at 0.05 level (2-tailed)

Montessori education, on the other hand, is based on the constructivist theory, which believes that the child has the ability to construct himself and that the goal of education is to help him construct his life (Montessori M. , 2017, p. 66). Accordingly, the layouts of the two classrooms are different. While the Montessori classroom helps the students to be self-reliant, the non-Montessori classes focus on helping the students with an external goal like passing an examination (Lillard, 2019). Movement is another big difference between the two. Montessori said that movement is significant and that there is a strong link between movement and intelligence. In a Montessori classroom, every activity involves moving around (Lillard, 2017, p. 38). The non-Montessori classes, which do not have the freedom to move, focus too much on memory (Standing, 1957, p. 339). So teachers spend much time achieving the first two levels of Bloom's taxonomy. Purposeful movement helps people understand each other better. As the child moves around, his social development improves, and he becomes more aware of his surroundings (Lillard, 2017, p. 56). Also, learning critical thinking, an essential component of higher-order thinking skills is a feature of the Montessori environment. Children begin developing this skill as early as two and a half years, beginning with Exercises of Practical Life. Practical Life Exercises are daily activities such as pouring, mopping, washing, sweeping, folding, etc. While executing these activities, the child becomes his own critic, analyses his work, and seeks to carry out these actions flawlessly by controlling any possible errors (Ramachandran, 1994, p. 58). By performing these, the child improves his movement, coordination and willpower (Montessori, 2017, pp. 95 - 96).

The child who works with sensorial activities learns to make decisions by observing, comparing and drawing tentative conclusions (Montessori, 2017, p. 205; Muni Reddy S. R., 2018). Building a Pink Tower is a rational process rather than a mechanical one. The child practically learns how to select one of the multiple alternatives. At the end of Primary Montessori, the six-year-old is ready to be astounded by the world around him (Montessori, 2007, p. Location 1889 & 1972). This is when the child is presented with the marvels of the universe. The Cosmic Education of Elementary Montessori arouses the pupils' curiosity and gives them essential and adequate opportunities to explore (Duffy & Duffy, 2018, pp. 15 - 18). Maria Montessori saw the world based on five critically essential developments: the creation of the universe, the beginning of life, the coming of human beings, and two stellar achievements of human civilization – the development of language and the development of numbers. In understanding this network of relationships, the child finds that he or she is a part of the whole, he has a part to play, and contribution to make (Lillard, 2007, p. 130). The Great Lessons are stories designed to ignite the child's interest and spark his will to follow up. The stories are open-ended and leave the children with more questions than answers, inspiring them to inquire more. These stories act as skeletons of lessons, which children engage,in over the years and create their understanding of the world. The Great Lessons in the Montessori elementary curriculum encourage the child to ask questions and seek answers, i.e. to become a critical thinker. Lillard contends that this interest is critical for children's development (Lillard, 2007, p. 131). Non-Montessori schools, on the other hand, follow a standardized curriculum prescribed by the education board, and children learn from the National Council of Educational Research and Training (NCERT) books or books published by private publications. These books present details gradually and fail to pique children's interests. Teachers build students' thought processes by explaining everything incrementally (Eissler, 2009, p. 4). Children's memory is tested to determine how much they can remember and recall. As a result, Bloom's Taxonomy is used for assessment rather than learning.

The analysis indicates no statistically significant difference between the mathematics results of Montessori and non-Montessori kids. Laski et al. suggested that Montessori students' overreliance on manipulatives could be a contributing factor (2016). However, this assertion does not apply to these individuals because they were weaned from concrete materials to abstract levels before entering fourth grade. It is possible, as Lillard suggests that a variation in cultural mentality influenced the ratings. The Montessori culture cultivates a mindset distinct from the conventional mindset, which is prepared for remembering and recalling knowledge necessary for passing any test. The non-Montessori techniques emphasize memorization of mathematical facts, whereas the Montessori method emphasizes conceptual comprehension. Thad A Polk of Great Courses maintains that both memory and conceptual comprehension are essential for the learning (Polk, 2018). Hence, the study found no significant difference between the two approaches in mathematics. The difference in the English and science scores between the two groups is satistically significant, and the mean and median in mathematics are considerably higher in the Montessori groups. Hence, the study concludes that Montessori-educated students also continue to exhibit higher-order thinking skills in the following year. Further studies are recommended in the higher grades.

Limitations: The study's first limitation is the number of children. As only a few schools follow the Montessori method up to the fourth standard in India, getting an equal number of students is challenging. The second limitation is that Montessori and non-Montessori students attend the same school. In this study, no consideration was given to pre-and post-testing, experimental or control groups. The third limitation is that the study could not use extensive statistical analysis as the data was not normally distributed.

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