Effect of STEM Integrated Curriculum on Student's IQ: An Experiment on Elementary School Students

Snober Sultan
M.Phil. (Education), Northern University, Nowshera, Khyber Pakhtunkhwa, Pakistan.
Email: snobersultan55@gmail.com

Tahira Sadiqi
M.Phil. Education Scholar, Department of Education, University of Jhang, Punjab, Pakistan.
Email: tahirasadiqi491@gmail.com

Sadaf Maqsood
M.Phil. Education, University of Agriculture Faisalabad, Punjab, Pakistan.
Email: sadafmaqsood445@gmail.com

Abdul Qahar
Ph.D. Scholar; Secondary Teacher Education, Allama Iqbal Open University Islamabad, Pakistan.
Email: abdulqahar045@gmail.com

Received on: 28-10-2023 Accepted on: 02-12-2023

Abstract

In modern times, where everything is progressing, new researches are also being done in the field of education, and new ideas are being formed. In the same way, instead of focusing on common languages, literature, and sociology, children should be given a full taste of science, technology, engineering, and math from the beginning. Thus, a STEM-integrated curriculum is crucial in enhancing children's intelligence at the elementary level. For this purpose, experimental research was set up, and two groups consisting of 30, 30 students of the seventh class were formed; one was taught by the traditional curriculum, and the second was given the teachers made STEM integrated notes. After five months of treatment, the current level was checked by taking the IQ performance test of the children; the IQ level of the children taught through STEM integrated notes was surprisingly high. It is recommended that children at the school level should be taught a STEM-integrated curriculum instead of focusing on general literature, languages and sociology; thus, children will perform well in all fields of science, including science, technology, engineering and math in the future.

Keywords: STEM integrated curriculum, Students IQ Enhance, STEM Effects on IQ, Elementary Schools Students.

Introduction

Math, science, technology, and engineering make up STEM. By combining these fields, STEM curricula aim to provide students with the "21st-century abilities" they'll need to thrive in the "future" job. The premise is that students in Pakistan need to develop skills in problem-solving, evidence-finding, collaboration, and critical thinking so they can compete with students from across the globe for employment and internships. Competencies, so the reasoning goes that they are covered in such courses (Zizka et al., 2021; Changtong et al., 2020; Utami et al., 2020).

Even so, STEM fields aren't always easy to summarise. Since it's used so frequently, many people have their own interpretations of what it means (Atkins et al., 2020). While the biological, chemical, and mathematical components of the acronym may be readily apparent, the engineering and technology components may present more of a challenge. The fields of computer science, analytics, and design are all part of technology. The fields of civil engineering, electronics, and robotics all fall under the umbrella of engineering. For STEM discussions, "integration" is the operative word. These fields are purposefully combined in STEM curricula. It's a hybrid method that includes both traditional classroom instruction and more experiential learning opportunities for students to acquire and apply "real-world" knowledge (Stretch, 2023; Umar et al., 2023; Amir et al., 2022; Hussain et al., 2022).

The world's economic landscape is evolving. On a worldwide scale, existing employment is being replaced by machines, while new ones are being created daily as a consequence of technological progress (Benanav, 2020). The way students study, communicate, and engage is always evolving due to the constant advancements in technology. The STEM disciplines help students build transferable skills that will serve them well in school and beyond (Boss & Krauss, 2022).

Qualifications and abilities in STEM are highly sought after by employers and are expected to remain so going forward. People with STEM skills are in high demand since they are required for 75 percent of positions in the fastest-expanding sectors right now (Black et al., 2021).

Through its emphasis on STEM (science, technology, engineering, and mathematics) subjects, schools are able to motivate their pupils to think critically and develop their problem-solving abilities. Students learn more effectively and develop their cognitive capacities when they have opportunities to participate in real-world projects. Academic achievement is dependent on a person's cognitive capacity. To read, think, prioritize, comprehend, plan, recall, and solve issues effectively and effortlessly, one's underlying cognitive abilities must be in good working order (Hafeez et al., 2023; Fan et al., 2021; Saleh et al., 2020).

Providing STEM education in Pakistan is primarily driven by the need to create a workforce capable of solving real-world challenges by combining academic knowledge with practical experience (Ali et al., 2023). Students enrolled in STEM programs are expected to develop a well-rounded set of abilities, including the ability to communicate effectively, work together, solve problems, take the lead, be creative, and innovate. People who have studied science, technology, engineering, and mathematics (STEM) in college will have a leg up when it comes to starting STEM-focused enterprises, solving challenges that call for a multidisciplinary approach as engineers, and answering theoretical and practical concerns as scientists (Aslam et al., 2022; Hammad, 2020).

The term "IQ categorization" refers to the process of assigning descriptive labels to

individuals based on their IQ scores, such as "average" or "superior" (Cook, 2021). As it stands, the present IQ scoring system uses a sample of test-takers of around the same age as the ones used to norm the exam; thus, a score of 100 indicates that the test-performance taker on the test is average. If your IQ is 115, your performance is one standard deviation higher than average; if it's 85, it's one standard deviation lower, and the process continues thereafter in the same manner. Because it provides a universally accepted definition of intelligence for both adults and children, the "deviation IQ" technique has replaced all others in terms of standard scoring for IQ tests. About two-thirds of test-takers get scores between 85 and 115 on the current "deviation IQ" standard of IQ tests, while about five percent of the population gets scores over 125 (i.e., according to normal distribution) (Shakeel & Peterson, 2022; Reynolds & Livingston, 2021; Singh, 2021; Warne, 2020).

Early IQ test creators, like Lewis Terman, saw that, across testing procedures, the majority of children's IQ scores came out to about the same figure (Lubinski & Benbow, 2021). When the same person takes the same test many times, the results could be different each time. Furthermore, when people take exams given by various publishers at the same age, there is a little discrepancy in their marks. When it comes to IQ score categories, no two test producers use the same terminology (Gonthier, 2022).

Attempts to categorize individuals into intelligence groups based on their everyday behaviour predate the invention of IQ testing (Deary, 2020). Validating categories based solely on IQ test results previously required those other sorts of behavioural observation. The original intent of IQ tests was to categorize people's levels of intellect, which hinged on the specific term "intelligence" used. The categorization process takes the reliability and inaccuracy of estimates into consideration, according to modern IQ test publishers (Kreitchmann et al., 2023; Reynolds et al., 2021).

Most individuals maintain about the same IQ score throughout their lives, and that's because IQ tests are typically accurate (Mercer, 2022). Examples of IQ tests with high reliability across all age groups are the WAIS-IV and the Stanford-Binet Intelligence Scale (Chen & Hua, 2020). Many different kinds of big and "use fair measures, use samples that are representative of the population, and provide scores that are free of bias (Reynolds et al., 2021). Therefore, the scores produced by these instruments typically measure the constructs they claim to measure in a reliable and valid manner. There are some people whose results vary greatly depending on whether they take the same test at different periods or if they take multiple types of IQ tests at the same age. Retests show that 42% of students improve their scores by 5 points or more (Weiss & Saklofske, 2020).

As an example, several of the youngsters who participated in Lewis Terman's renowned 1921 longitudinal Genetic Studies of Genius showed a decrease in IQ over the course of the study's duration. After receiving recommendations from educators, Terman administered his Stanford-Binet IQ test to students. The research included children whose IQ scores were higher than 140 on that particular exam. The primary research group included 643 kids. On average, the 503 children who were able to be retested at the high school level had a 9-point decline in Stanford-Binet IQ. A few kids' IQs plummeted by as much as 25 points. But those kids' parents still felt they were brilliant—if not more so. But since then, the reliability of modern testing has greatly increased. A test-retest correlation of.96 was found for the WAIS-IV (Hollingworth, 2022; Nagy et al., 2022).

Every intelligence test has some measurement error; hence, when administering an IQ test, it is important to tell the test taker what the confidence interval is around their result (Kranzler & Floyd, 2020). IQ scores are not shown in an interval measurement unit since they are ordinal scores. An IQ score might be deceiving if the test-giver does not adhere to standardized methods of administration and scoring, in addition to the claimed error interval around IQ test results (Reynolds et al., 2021). When administering IQ tests, it is common for test-takers to be excessively forgiving, leading to a higher score than the test-taker really deserves. However, there are test administrators who make the mistake of exhibiting a "halo effect," which causes high-IQ people to get inflated results and low-IQ people to get even lower scores than if standardized techniques were used (Archambault et al., 2021).

Since the labels for the categories of IQ score ranges are brand-specific, the categories of IQ differ between IQ test publishers (Kasneci et al., 2022). There is a lack of consistency across test publishers when it comes to the way IQ score ranges are labeled and when it comes to the size and boundary scores used to divide up the ranges. Psychologists should be sure to include the test used when reporting a person's IQ category rather than just the raw result. When reporting IQ score ranges, psychologists should use the nomenclature of each test publisher, according to IQ test writers and psychologists (Reynolds et al., 2021).

Although IQ is a significant predictor of success in many contemporary endeavours, test results should not be seen as conclusive evidence of a test taker's future achievement or as the only criterion for admission to educational or occupational programs (Bates & Gignac, 2022). Data on how people's actions vary according to their IQ levels is currently scarce. Individual assessments may also use criteria other than IQ when deciding where to put a student in school, making a medical diagnosis, or offering career advice (Foley-Nicpon & Assouline, 2020).

Based on his work with previous IQ tests, David Wechsler created the Wechsler intelligence scales (Freeman, 2021). David Wechsler developed a battery of IQ tests by drawing on his experience as a psychology examiner during World War I and the clinical and statistical training he received from Charles Spearman. Eventually, they were the most popular and extensively utilized intelligence evaluation methods for a long time, surpassing all others. In 1939, the Wechsler-Bellevue Scale was established as the first Wechsler exam. In the English-speaking world, the Wechsler IQ tests for both children and adults are the most utilized individual IQ tests. Their translated counterparts are even more popular across the globe. For a long time, the Wechsler exams were considered the best way to measure intelligence. In 2008, The Psychological Corporation released the Wechsler Adult Intelligence Scale—Fourth Edition (WAIS-IV) (Merz et al., 2021). The Psychological Corporation released the Wechsler Preschool and Primary Scale of Intelligence—Fourth Edition (WPPSI-IV) in 2012 and the Wechsler Intelligence Scale for Children—Fifth Edition (WISC-V) in 2014. (Ryan & Gontkovsky, 2023). The Wechsler tests, like other modern IQ tests, use a "deviation IQ" as the mean full-scale IQ score; a norming sample raw score of 100 is considered normal, IQ 115 is one standard deviation higher, and IQ 85 is one standard deviation lower (Kaufman, 2021; Cermak, 2020).

Adult IQ testing became widely used in the United States to evaluate conscripted troops in 1917, during the First World War (McCauley et al., 2022). The American psychologist Robert Yerkes was tasked with creating Army Alpha and Army Beta group-based examinations as a

means of using psychometrics to assign recruits to various levels of military service. Contemporary intelligence test series may trace their roots back to the work of Binet, Simon, Terman, and Yerkes (Rogele, 2020).

In 2003, Riverside Publishing released the Stanford-Binet Scales, Fifth Edition (SB5), which was created by Gale H. Roid (Shahin et al., 2021). The SB5 IQ scoring differs from earlier Stanford-Binet tests in that it uses deviation scoring, similar to the Wechsler tests, where each standard deviation from the norming sample median score equals 15 points from the median score of 100. After five years of research and development, the standard SB5 was created to "confront potential prejudices, including those based on gender, race/ethnicity, culture, and religion. This exam was administered by around 500 certified examiners hailing from each of the fifty states. The age range of the 4,800 participants included in the average sample group was 2–85+. With the US economy in the year 2000 (Livingston, 202; Peterson et al., 2020). According to the census statistics, the sample accurately reflected the nation's demographics in terms of age, area, race/ethnicity, and socio-economic status."

Richard W. Woodcock, Kevin S. McGrew, and Nancy Mather created the Woodcock-Johnson a III NU Tests of Cognitive Abilities (WJ III NU), which were published in 2007 by Riverside (Layzer Yavin et al., 2022).

The English-language Stanford-Binet IQ test was created by Lewis Terman and based on the French-language Binet-Simon exam that was created by Alfred Binet (Kaufman et al., 2022). It was Charles Spearman's (1904) "general intelligence" concept that Terman thought his exam assessed (General, 2020). Following the recommendation of German psychologist William Stern in 1912, Terman reported test results that were different from Binet's. He used an intelligence quotient formula, which is "mental age" divided by chronological age (Rogele, 2020). Terman chose the titles of the categories for the Stanford-Binet test scores. Before IQ tests were popular, he looked to writers who had written about people who couldn't care for themselves in adulthood as a basis for his first categorization of score levels. Norming samples used by Terman to develop the original Stanford-Binet exclusively included white, native-born Americans hailing mostly from the Pacific Northwest, Nevada, and California (Caemmerer et al., 2023; Gentry et al., 2021).

Literature Review

There has been a dramatic increase in both the supply and demand for individuals with backgrounds in STEM fields, according to a recent report by the Pew Research Center (Kennedy et al., 2021). Nevertheless, statistics show that American STEM competence has been declining (Athanasia and Cota, 2022). The United States needs about one million more STEM professionals than it is prepared to create in order to solve this obvious shortage (Kennedy et al., 2021). Also, an extra 11% of STEM professionals will be required for STEM occupations between 2020 and 2030.

The number of studies looking at how STEM subjects pique students' interests and lead them to pursue STEM jobs has grown in the last few decades. Students may not be exposed to the many STEM job opportunities at a young age, which discourages them from pursuing these fields (Christensen & Knezek, 2017). If we want our middle school children to be successful in high school and beyond, we must ensure that they are exposed to STEM fields at an early age. The basis for the ever-changing skills required for the workforce is laid early on, and

students' success and test scores are boosted as a result (STEM Education Works, 2021). Middle school children from minority groups who are already at a disadvantage need this exposure much more than their peers. Among adults, Blacks and Hispanics have a lower rate of STEM degree completion and a lower proportion of STEM graduates compared to their adult population share, according to the Pew Research Center (Kennedy et al., 2021). March for Scientific (2017) reports that minority students often drop out of STEM programs because they struggled in elementary school with basic math and science concepts, faced cultural obstacles on campus, and saw few diversified career paths leading into STEM fields.

In order to combat the issue of children not being exposed to STEM fields at a young age, informal education initiatives have been essential in introducing pupils to these subjects in the early grades. When it comes to promoting inclusion and broadening representation in STEM areas, Cheryan et al. (2017) state that informal STEM encounters may help counter negative preconceptions and encourage positive attitudes and interests in the subject. A student's enthusiasm for STEM fields may influence their interest in and achievement in these fields in the future. Working with middle schoolers is crucial, according to Demir et al. (2021), since that's when students start to think about their futures in terms of jobs. "One of the most fundamental problems that restrict the United States' capacity to remain ahead of the STEM curve is the absence of exposure to these educational disciplines at an early age," adds Sidharth Oberoi, President & Chief Academic Officer of Zaniac (19). A study conducted by Xie et al. (2015) found that STEM education, especially for historically marginalized populations, is crucial to the long-term economic growth and prosperity of the United States. Arousing kids' interest via creative programming is a critical factor in igniting their inspiration for STEM among elementary and middle school pupils. Students entering high school and universities with this foundational STEM knowledge should be better prepared to take on STEM-related coursework and jobs when they graduate.

Early exposure to STEM education has tremendous impacts and may increase interest in STEM-related occupations, according to Valverde and Davidow (2022), but there is a lack of evidence that shows this. Community- and institution-based STEM initiatives are strong instruments for providing essential access to early STEM education. Providing STEM activities for elementary-aged students has been a priority for many local and institutional initiatives. Club Invention, Inc. is one example of a successful STEM program that operates out of the National Inventors Hall of Fame in North Canton, Ohio. Children in grades one through six are welcome to participate in E.Z. Science and other after-school STEM programs that provide students with opportunities for strong, hands-on, engaging experiences (Respress, 2022). Boulder Builders is another program that gives students the opportunity to play the role of engineers and architects via the construction and testing of different buildings. They can also build sustainable homes for animals and humans (Respress, 2022). Programs that include engineering, technology, creativity, and teamwork in their curricula have a much higher rate of student involvement and interest in STEM fields. At this early stage, however, it's hard to tell if these initiatives have succeeded in piquing students' interest in STEM fields.

Curriculum or model kinds that pique students' interests have also been the subject of research. Concerning the K-12 curriculum, for instance, researchers have found useful programs that combine robots with engineering ideas. The findings supported favourable connections that were associated with STEM expertise and the enhancement of analytical

development, critical thinking, communication, and collaboration abilities (Kimmel et al., 2014). Additional research on the efficacy of engineering-integrated STEM curriculum designs for after-school settings was conducted by Moreno (2016). The "Think Like an Astronaut lesson" was the focus of this research, which concluded that after-school programs like this are beneficial for fifth graders and have the ability to improve their understanding of STEM subjects (Respress et al., 2023). While several studies have examined the effects of early STEM exposure on children's development, few have examined how middle school might best encourage underrepresented minority students to choose STEM fields as a profession. Middle school children in Nashville's underprivileged neighbourhood are the primary target of Tennessee State University's (TSU) STEM education initiative, which aims to address the dearth of literature on the subject (Gwinn & Gary, 2021).

Statement of Problem

Instead of traditional education, if children are taught a STEM-integrated curriculum, not only is their personality nurtured, but also their IQ is increased. STEM integrated curriculum is not only effective in higher education but also plays a role in school education. Experimental research on STEM integrated curriculum was set up to check its effects on school-level children, especially children aged 11 to 13 years. This research was truly experimental and aimed at making new explorations. The results obtained from this research will be beneficial not only for teachers, children, and stakeholders but also for parents. With the changing times, the upgradation of education is also necessary and increasing the mental abilities of children is the need of the day.

Objectives of the Study

The following were the objectives of the study;

1. To see the Effect of STEM Integrated Curriculum on Students' IQ.
2. Gave suitable suggestions about the STEM Integrated Curriculum at the School Level.

Hypothesis of the Study

The following were the hypotheses of the study;

Ho.1 STEM Integrated Curriculum has no effect on Student's IQ.

Methods and Procedures

This study was experimental. The study aimed to explore the effect of the STEM Integrated Curriculum on Student's IQ class 7th. For this purpose, class 7th students of Al-Rafique Public High School were selected for the experiment. The 7th Fatima-Secon class was chosen for the experiment through cluster sampling class. First of all, students who pre-tested, high achievers and low achievers, were excluded from the study; only average scorer students were selected for this experiment. According to suggestions by Krejcie & Morgan (1970), only 60 average scorer students were chosen out of 130 students for the experiment. Through the fishbowl simple random sampling method, two groups were made. Thirty students were selected for the control group, and thirty students were chosen for the experimental group.

Experiment Procedure

For the experiment, the STEM Integrated Curriculum was made, and teachers made STEM notes that were prepared for teaching and distributed to students; for this purpose, all other books were collected from students and kept under lock while the control group taught according to the traditional curriculum.

Treatment

According to the experiment plan, the teachers handed the STEM Integrated notes to students and taught them in new ways like problem-solving and exploratory methods.

Experiment Duration

This experiment was planned for five months. Every month, new notes were prepared and given to students; teachers taught students according to the new STEM integrated curriculum way and also gave guidance about STEM and its importance.

Development of Tools

Two IQ STEM performance tests were made for data collection; both tests were standardized. The first test was used as a pre-test, and the second was for a post-test.

Validity and Reliability of the Tools

Both pre and post-tests were validated by experts, who also ensured the reliability of the tests. The reliability of the first test was .91, and the second test was .92; both were excellent.

Data Analysis Procedure

Two IQ performance tests were made to check the student's IQ. The first test was used for the pre-test, and the second for the post-test. The results of only post-tests were compared to check the student's actual current IQ difference. This difference was compared with the help of descriptive and inferential statistical tests, and an independent sample t-test was used to see the mean value difference in the IQ of both the control and experimental group students.

Table No. 1

Ho1. STEM Integrated Curriculum has no effect on Student's IQ.

Independent Sample t-test					
Groups	*f*	μ	σ	t	Sig.
Controlled	30	7.2000	7.96600	-4.214	.000
Experimental	30	20.1333	8.82259		

Table No. 1 describes the results of the study. It was found that the experimental group's mean was higher than the control group, and a significant difference between both mean scores was found. The mean value of the experimental group was (20.1333), and the standard deviation was (8.82259). The mean value of the control group was (7.2000), and the standard deviation was (7.96600). The t-test value was (-4.214), $p < .05$; the null hypothesis was not accepted.

Conclusions

It was concluded that the mean score of the experimental group was high as compared to the control group in the IQ performance test. The t-test also infers the data and concludes a

significant difference between both groups of students. Students who were taught through the STEM-integrated curriculum performed well in IQ tests, which means the STEM-integrated curriculum performed well in the age group of 11 to 13 students of the 7th class.

Recommendations

Some significant recommendations were made according to the conclusions of the study;

1. It is recommended that a STEM-integrated curriculum should be developed in schools at the elementary level. The STEM-integrated curriculum enhances students' IQ significantly, which is necessary for the future performance of students in any field of science, technology, engineering, and math.
2. There should be qualified and trained staff for a STEM-integrated curriculum.

References

1. Ali, Z., & Rehmat Shah, D. N. A. (2023). Determining The Science, Technology, Engineering, And Mathematics Teaching Capabilities of Educators in Karachi, Pakistan. *Journal of Positive School Psychology*, 11-28.
2. Amir, M., Hussain, S., & Muhammad, S. (2022). Identification of the Need for Teacher Training at The Primary School Level. *International Research Journal of Education and Innovation*, *3*(1), 165-176.
3. Archambault, C., Tullo, D., Clark, E., Faubert, J., & Bertone, A. (2021). Assessing the feasibility of a classroom-based visual attention training program targeting academics for students with extremely low IQ. *Pilot and Feasibility Studies*, *7*(1), 1-14.
4. Aslam, S., Saleem, A., Kennedy, T. J., Kumar, T., Parveen, K., Akram, H., & Zhang, B. (2022). Identifying the Research and Trends in STEM Education in Pakistan: A Systematic Literature Review. *SAGE Open*, *12*(3), 21582440221118545.
5. Athanasia, G., & Cota, J. (2022). The US should strengthen STEM education to remain globally competitive. *Center for Strategic and International Studies. https://www. csis. org/blogs/perspectives-innovation/us-should-strengthen-stem-educationremain-globally-competitive*.
6. Atkins, K., Dougan, B. M., Dromgold-Sermen, M. S., Potter, H., Sathy, V., & Panter, A. T. (2020). "Looking at Myself in the Future": how mentoring shapes scientific identity for STEM students from underrepresented groups. *International Journal of STEM Education*, *7*, 1-15.
7. Bates, T. C., & Gignac, G. E. (2022). Effort impacts IQ test scores in a minor way: A multi-study investigation with healthy adult volunteers. *Intelligence*, *92*, 101652.
8. Benanav, A. (2020). *Automation and the Future of Work*. Verso Books.
9. Black, S. E., Muller, C., Spitz-Oener, A., He, Z., Hung, K., & Warren, J. R. (2021). The importance of STEM: High school knowledge, skills and occupations in an era of growing inequality. *Research policy*, *50*(7), 104249.
10. Boss, S., & Krauss, J. (2022). *Reinventing project-based learning: Your field guide to real-world projects in the digital age*. International Society for Technology in Education.
11. Caemmerer, J. M., Young, S. R., Blemahdoo, E., & Winter, E. L. (2023). Intelligence Tests. In *Handbook of Clinical Child Psychology: Integrating Theory and Research into Practice* (pp. 327-346). Cham: Springer International Publishing.
12. Cermak, S. (2020). Norms and scores. In *Developing Norm-Referenced Standardized Tests* (pp. 91-123). Routledge.
13. Changtong, N., Maneejak, N., & Yasri, P. (2020). Approaches for Implementing STEM (Science, Technology, Engineering & Mathematics) Activities among Middle School Students in

Thailand. *International journal of educational methodology*, *6*(1), 185-198.
14. Chen, H., & Hua, M. S. (2020). Selecting tetradic short forms of the taiwan wechsler adult intelligence scale IV. *Assessment*, *27*(7), 1633-1644.
15. Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? *Psychological bulletin*, *143*(1), 1.
16. Christensen, R., & Knezek, G. (2017). Relationship of middle school student STEM interest to career intent. *Journal of education in science environment and health*, *3*(1), 1-13.
17. Cook, W. S. (2021). The intelligence concept and racial classification as sociological products of Western education. *Sociology Compass*, *15*(12), e12941.
18. Deary, I. J. (2020). *Intelligence: A very short introduction* (Vol. 39). Oxford University Press, USA.
19. Demir, C. G., Önal, N. T., & Önal, N. (2021). Investigation of Middle School Students' Attitudes towards Science, Technology, Engineering and Mathematics (STEM) Education and Determination of the Predictors. *Journal of Science Learning*, *4*(2), 101-112.
20. Fan, S. C., Yu, K. C., & Lin, K. Y. (2021). A framework for implementing an engineering-focused STEM curriculum. *International Journal of Science and Mathematics Education*, *19*, 1523-1541.
21. Foley-Nicpon, M., & Assouline, S. G. (2020). High ability students with coexisting disabilities: Implications for school psychological practice. *Psychology in the Schools*, *57*(10), 1615-1626.
22. Freeman, S. (2021). Wechsler preschool and primary scale of intelligence. In *Encyclopedia of autism spectrum disorders* (pp. 5172-5181). Cham: Springer International Publishing.
23. General, O. (2020). Chapter One Abrief History of Theory and Testing of General and Specific Mental Abilities Dennis Mcfarland. *General and Specific Mental Abilities*, 1.
24. Gentry, M., Desmet, O. A., Karami, S., Lee, H., Green, C., Cress, A., ... & Gray, A. (2021). Gifted education's legacy of high stakes ability testing: Using measures for identification that perpetuate inequity. *Roeper Review*, *43*(4), 242-255.
25. Gonthier, C. (2022). Cross-cultural differences in visuo-spatial processing and the culture-fairness of visuo-spatial intelligence tests: an integrative review and a model for matrices tasks. *Cognitive Research: Principles and Implications*, *7*(1), 11.
26. Gwinn, A. F., & Gary, T. (2021, July). The Path from Community College to Engineering Bachelor's Degree Through Partnerships and NSF S-STEM Funded Scholarships. In *2021 ASEE Virtual Annual Conference Content Access*.
27. Hafeez, A., Hussain, S., Muhammad, S., & Hussain, S. (2023). Effect of PEC Exams on Quality Education in Public and Punjab Education Foundation Funded Secondary Schools. *International Research Journal of Management and Social Sciences*, *4*(3), 358-374.
28. Hammad, S. (2020). School Leaders Perceptions about STEAM Education to develop STEAM Schools in Pakistan. *LC International Journal of STEM (ISSN: 2708-7123)*, *1*(4), 155-165.
29. Hollingworth, L. S. (2022). *Children above 180 IQ Stanford-Binet: origin and development*. DigiCat.
30. Hussain, S. (2021). Quality of Education in Public and Daanish Schools at Secondary Level. *International Research Journal of Education and Innovation*, *2*(2), 160-169.
31. Hussain, S., Ahmad, M. S., & Hussain, S. (2022). Relationship of Teacher-Student Interaction, Learning Commitment and Student Learning Comfort at Secondary Level. *International Research Journal of Education and Innovation*, *3*(2), 156-169.
32. Hussain, S., Ahmad, M., Ul Zaman, F., & Ahmad, A. (2023). Comparative Study of Administrators' Supervisory Skills and Teachers' Pedagogical Skills Towards Quality Education in Public and Punjab Education Foundation Funded Schools at Secondary Level. *Journal of Education & Educational Development*, *10*(2).
33. Hussain, S., Hafeez, A., Zaman, F. U., & Seerat, S. S. (2023). Why Quality of Education is Low at the Secondary Level in Pakistan: A Group Discussion. *International Research Journal of Management and Social Sciences*, *4*(4), 190-205.
34. Hussain, S., Zaman, F. U., Muhammad, S., & Hafeez, A. (2023). Analysis of the Initiatives taken by

HEC to Implement Associate Degree Program: Opportunities and Challenges. *International Research Journal of Management and Social Sciences*, *4*(3), 193-210.

35. Kasneci, E., Kasneci, G., Trautwein, U., Appel, T., Tibus, M., Jaeggi, S. M., & Gerjets, P. (2022). Do your eye movements reveal your performance on an IQ test? A study linking eye movements and socio-demographic information to fluid intelligence. *Plos one*, *17*(3), e0264316.
36. Kaufman, A. S. (2021). Wechsler, David. In *Encyclopedia of Autism Spectrum Disorders* (pp. 5183-5188). Cham: Springer International Publishing.
37. Kaufman, A. S., Choi, D., Kapoor, H., & Kaufman, J. C. (2022). A brief history of IQ testing: Fixed vs. malleable intelligence. In *Intelligence in Context: The Cultural and Historical Foundations of Human Intelligence* (pp. 59-92). Cham: Springer International Publishing.
38. Kennedy, B., Fry, R., & Funk, C. (2021). 6 facts about America's STEM workforce and those training for it.
39. Kimmel, H. S., Burr-Alexander, L. E., Hirsch, L., Rockland, R. H., Carpinelli, J. D., & Aloia, M. (2014, October). Pathways to effective K-12 STEM programs. In *2014 IEEE Frontiers in Education Conference (FIE) Proceedings* (pp. 1-6). IEEE.
40. Kranzler, J. H., & Floyd, R. G. (2020). *Assessing intelligence in children and adolescents: A practical guide for evidence-based assessment*. Rowman & Littlefield Publishers.
41. Kreitchmann, R. S., de la Torre, J., Sorrel, M. A., Nájera, P., & Abad, F. J. (2023). Improving reliability estimation in cognitive diagnosis modeling. *Behavior Research Methods*, *55*(7), 3446-3460.
42. Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement*, *30*(3), 607-610.
43. Layzer Yavin, L., Shechter, A., & Rubinsten, O. (2022). Mathematical and Negative Information Are Similarly Processed: Pupil Dilation as an Indicator. *Journal of Intelligence*, *10*(4), 79.
44. Livingston, S. A. (2021). *Exploring the role of social belonging in college by racial minority group: An examination of academic and psychosocial outcomes* (Doctoral dissertation, University of Oregon).
45. Lubinski, D., & Benbow, C. P. (2021). Intellectual precocity: What have we learned since Terman? *Gifted Child Quarterly*, *65*(1), 3-28.
46. March for Science. (2017, April). Diversity in STEM Part 2: Barriers to Success for Underrepresented Minority Students. *https://milwaukeescience.org/diversity-in-stempart-2-barriers-to-success-for-underrepresented-minority-students*.
47. McCauley, M., Kennedy, C., & Zillmer, E. (2022). A History of Military Psychology. *Military Psychology: Clinical and Operational Applications*, 1.
48. Mercer, J. R. (2022). *Labeling the mentally retarded: Clinical and social system perspectives on mental retardation*. Univ of California Press.
49. Merz, Z. C., Van Patten, R., Hurless, N., Grant, A., & McGrath, A. B. (2021). Furthering the understanding of Wechsler adult intelligence scale-factor structure in a clinical sample. *Applied Neuropsychology: Adult*, *28*(1), 12-23.
50. Nagy, A., Kalmár, M., Beke, A. M., Gráf, R., & Horváth, E. (2022). Intelligence and executive function of school-age preterm children in function of birth weight and perinatal complication. *Applied Neuropsychology: Child*, *11*(3), 400-411.
51. Peterson, K. C., Peterson, M., & Carducci, B. J. (2020). Stanford-Binet Intelligence Scale. *The Wiley Encyclopedia of Personality and Individual Differences: Measurement and Assessment*, 451-455.
52. Respress, T., Johnson, O., Boyd, L., & Roberts, T. (2023). Early Exposure/Long-Term Gains: Encouraging Underrepresented Middle School Students to Pursue STEM Careers. *The Journal of the Research Association of Minority Professors*, *25*(2), 2.
53. Respress, T., Johnson, O., Boyd, L., & Roberts, T. (2023). Early Exposure/Long-Term Gains: Encouraging Underrepresented Middle School Students to Pursue STEM Careers. *The Journal of the Research Association of Minority Professors*, *25*(2), 2.
54. Respress, T., Johnson, O., Boyd, L., & Roberts, T. (2023). Early Exposure/Long-Term Gains:

Encouraging Underrepresented Middle School Students to Pursue STEM Careers. *The Journal of the Research Association of Minority Professors*, *25*(2), 2.

55. Reynolds, C. R., & Livingston, R. A. (2021). *Mastering modern psychological testing*. Springer International Publishing.
56. Reynolds, C. R., Altmann, R. A., & Allen, D. N. (2021). The Basic Statistics of Measurement. In *Mastering Modern Psychological Testing: Theory and Methods* (pp. 49-89). Cham: Springer International Publishing.
57. Reynolds, C. R., Altmann, R. A., & Allen, D. N. (2021). The problem of bias in psychological assessment. In *Mastering Modern Psychological Testing: Theory and Methods* (pp. 573-613). Cham: Springer International Publishing.
58. Reynolds, C. R., Altmann, R. A., & Allen, D. N. (2021). The problem of bias in psychological assessment. In *Mastering Modern Psychological Testing: Theory and Methods* (pp. 573-613). Cham: Springer International Publishing.
59. Reynolds, C. R., Altmann, R. A., & Allen, D. N. (2021). The problem of bias in psychological assessment. In *Mastering Modern Psychological Testing: Theory and Methods* (pp. 573-613). Cham: Springer International Publishing.
60. Rogele, A. M. (2020). Biographies of a scientific subject: The intelligence test. In *Oxford Research Encyclopedias: Psychology*. Oxford University Press.
61. Rogele, A. M. (2020). Biographies of a scientific subject: The intelligence test. In *Oxford Research Encyclopedias: Psychology*. Oxford University Press.
62. Ryan, J. J., & Gontkovsky, S. T. (2023). 18 Wechsler Adult Intelligence Scale (WAIS-IV) And Wechsler Memory Scale (WMS-IV): A Critique. *The SAGE Handbook of Clinical Neuropsychology: Clinical Neuropsychological Assessment and Diagnosis*.
63. Saleh, S., Muhammad, A., & Abdullah, S. M. S. (2020). STEM project-based approach in enhancing conceptual understanding and inventive thinking skills among secondary school students. *Journal of Nusantara Studies (JONUS)*, *5*(1), 234-254.
64. Shahin, A. M., Fayed, S. M., Awad, R. A., & Soliman, M. A. (2021). Drawing Performance in Relation to Motor Skills and Zinc Level of Primary School Children in Benha City. *Benha Journal of Applied Sciences*, *6*(1), 115-121.
65. Shakeel, M. D., & Peterson, P. E. (2022). A half century of progress in US student achievement: Agency and Flynn effects, ethnic and SES differences. *Educational Psychology Review*, *34*(3), 1255-1342.
66. Singh, M. K. (2021). *Introduction to Social Psychology*. KK Publications.
67. Stretch, E. J. R. (2023). *"Everything Would Have Worked if it Wasn't for That Crap Mirror": The Intersection of Failure and Creativity in Integrated STEM Education* (Doctoral dissertation, University of Minnesota).
68. Umar, Z., Hussain, S., Khan, I., & Perveen, F. (2023). Parents' Involvement Effect on Students' Academic Achievement and Quality Education in Public and Private Schools at Elementary Level. *International Research Journal of Management and Social Sciences*, *4*(3), 400-411.
69. Umar, Z., Sadiqi, T., Hussain, S., & Qahar, A. (2023). Compare the Quality of Infrastructure on Student Outcomes in Public and Punjab Education Foundation Funded Schools at Secondary Level. *International Research Journal of Management and Social Sciences*, *4*(4), 26-39.
70. Utami, A., Rochintaniawati, D., & Suwarma, I. R. (2020, March). Enhancement of STEM literacy on knowledge aspect after implementing science, technology, engineering and mathematics (STEM)-based instructional module. In *Journal of Physics: Conference Series* (Vol. 1521, No. 4, p. 042048). IOP Publishing.
71. Valverde, F. J., & Davidow, J. (2022). Teachers' Perception of College and Career Education Exposure on Middle School Students.
72. Warne, R. T. (2020). *In the know: Debunking 35 myths about human intelligence*. Cambridge

University Press.

73. Weiss, L. G., & Saklofske, D. H. (2020). Mediators of IQ test score differences across racial and ethnic groups: The case for environmental and social justice. *Personality and Individual Differences*, *161*, 109962.
74. Xie, Y., Fang, M., & Shauman, K. (2015). STEM education. *Annual review of sociology*, *41*, 331-357.
75. Zizka, L., McGunagle, D. M., & Clark, P. J. (2021). Sustainability in science, technology, engineering and mathematics (STEM) programs: Authentic engagement through a community-based approach. *Journal of Cleaner Production*, *279*, 123715.