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Evaluating the Impact of Science Curriculum on First-Grade Students' Science Literacy and Engagement

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Abstract

Globally, science education is undergoing significant transformation, particularly at the primary level, to ensure students receive the best foundational knowledge. Over the past decades, China has modernized its science education to develop students' scientific literacy through inquiry-based teaching. This study aims to assess the impacts of the 2017 primary science curriculum on students' science literacy and engagement in first-grade primary schools. A cross-sectional design was employed to collect data from first-grade students across 23 provinces, 5 autonomous regions, and 4 municipalities in China. The survey gathered 132,756 questionnaires, with 121,757 valid responses, resulting in an effective rate of 91.7%. Data analysis using SPSS version 25 revealed that the 2017 curriculum positively impacts science literacy, especially when students are actively engaged in hands-on activities. The study found that frequent science classes and interactive learning experiences were strongly correlated with higher literacy levels. However, traditional book-related activities had a weaker impact on literacy. Additionally, the curriculum significantly enhanced student engagement, particularly through fun and hands-on activities, while book-related engagement was less effective. These findings suggest that while traditional methods are important, they should be complemented with more interactive approaches to maximize literacy and engagement outcomes. The study is limited to first-grade students, as the 2017 curriculum was first implemented for this group. Future research should explore these findings across different grades and investigate ways to enhance the impact of book-related activities on science literacy.

Introduction

Textbooks are crucial for students' mastery of scientific knowledge and for organizing learning activities (Havu-Nuutinen et al., 2022). They influence academic performance and help teachers implement curriculum standards (Hill, 2001), making their examinations essential (Sun & Li, 2021). Science education has attracted more and more international attention, and the cultivation of scientific literacy has become an important part of education in various countries (Hariyadi et al., 2023). Science textbooks are an indispensable part of science education, so researchers have explored science textbooks from different perspectives (Akçay et al., 2020; Darayseh & AlHawamdeh, 2024; Maladona & Ilmiyati, 2022).

In 2017, China began teaching science from first grade, revising the previous curriculum that started in grade 3 (Ministry of Education, 2017). Since then, various publishers have released new science textbooks aligned with this curriculum. As we approach 2024, it is crucial to assess the impact of this curriculum on students' scientific literacy and engagement. Understanding these outcomes will provide valuable insights for policymakers to refine further and enhance science education in the future.

Science education in China has made significant strides in recent years, earning increasing global recognition for its commitment to excellence. The British Broadcasting Corporation's documentary "Are Our Kids Tough Enough? Chinese School" sparked widespread debate about the contrasts between Eastern and Western education when it aired in 2015. China's efforts were further validated by the Programme for International Student Assessment (PISA) results in 2012, where students in Shanghai achieved top rankings in mathematics, reading, and science, showcasing the effectiveness of Shanghai's educational system (Sun & Li, 2021). The Organisation for Economic Co-operation and Development (OECD) also highlighted China's educational reforms in its report, "Strong Performers and Successful Reformers in Education," recognizing Shanghai's innovative approaches to addressing educational equity (Law & Xu, 2020). Notably, the 'mandatory administration' policy was praised as an effective strategy to uplift students in rural schools, helping them reach the same academic standards as their urban peers (OECD 2013). These achievements underscore China's dedication to enhancing its science education, setting a global benchmark for educational reform and progress (Marginson, 2021). China is actively working to eliminate gender disparities between rural and urban areas by providing quality education to all regions (Liu et al., 2020). To compete globally, the government has launched several projects aimed at improving education standards. As part of its long-term educational reforms, China aims to achieve equity and enhance core competencies across the nation. By 2020, significant strides were made in ensuring universal preschool education, consolidating compulsory schooling, and improving access to high school and higher education (Dong & Wei, 2023). These efforts are part of China's broader strategy to build a modern education system that supports lifelong learning and equal opportunities for all citizens, ensuring that every child, regardless of background, has access to high-quality education.

Conceptual Framework

In the context of science education, the availability and quality of educational resources play a crucial role in delivering high-quality education (Garira, 2020). Essential resources such as textbooks, lab equipment, and digital tools are foundational to providing students with comprehensive and engaging science learning experiences (Rehman et al., 2020). Alongside these, the physical infrastructure, including school buildings, classrooms, and laboratories, serves as the fundamental base for implementing effective science curricula (Ngeno et al., 2021). The adequacy of these resources directly influences the implementation of science classes and the effectiveness of teaching and learning processes (Shaw et al., 2020). Moreover, well-structured and resource-rich environments facilitate the delivery of the curriculum and not only facilitate the delivery of the curriculum but also enhance student engagement, leading to improved science literacy and overall educational outcomes (Asano et al., 2021). This framework considers the interplay between these resources, the execution of science education, and their impact on student engagement and learning outcomes, particularly in the context of the 2017 science curriculum reforms in China. Figure 1, represents that the availability and quality of resources like textbooks, lab equipment, and digital tools are crucial for improving students' understanding of scientific concepts and their ability to apply scientific reasoning. Along with that, engaging in various science-related activities helps build a deeper understanding of scientific principles, thus directly contributing to science literacy (Adarlo et al., 2022; Rehman et al.,2024). The frequency and regularity of science classes provide more opportunities for students to learn and understand science content, thereby enhancing their literacy in the subject. Students' engagement in science activities is crucial for developing 21st-century skills, like critical thinking, problem-solving and collaborative skills (Rehman et al., 2023). This refers to how students interact with and are motivated by reading and learning from science textbooks and other reading materials, contributing to their overall engagement in science (Kim et al., 2021). Students engage in hands-on activities, actively participating in experiments, lab work, and other practical science activities, which often increase their interest and motivation in the subject (Rehman et al., 2021). Science fun also plays a crucial role in engaging students in scientific learning (Zeng et al., 2020). This aspect measures how enjoyable and stimulating students find science classes and activities, which can significantly influence their overall engagement and interest in science. Science Literacy can increase by factors that directly contribute to students' understanding and knowledge of science (e.g., resource availability, science activities, number of science classes) (Valladares, 2021). Science Engagement can also be improved by factors that measure how involved and interested students are in science, often through their interaction with various types of science-related activities (e.g., book-related engagement, hands-on activities, and overall enjoyment of science) (Maestrales et al., 2021). It is crucial to know how much first-grade students have developed science literacy and are engaged in scientific literacy.

The present study highlights educational resources such as textbooks, lab equipment, and digital tools are foundational for delivering high-quality science education. The physical infrastructure, including school buildings and laboratories, further supports the effective implementation of the curriculum. The adequacy of these resources not only influences the delivery of science education but also enhances student engagement and learning outcomes. Frequent and well-structured science classes, coupled with engaging and varied science activities, are essential for developing science literacy among students. Furthermore, different types of science engagement, such as reading textbooks, participating in hands-on experiments, and finding enjoyment in science classes, play a significant role in fostering students' interest and motivation in the subject.

This study addresses the following research questions:

1. What are the impacts of the 2017 science curriculum on science literacy among first-grade primary school students?
2. What are the impacts of the 2017 science curriculum on science engagement among first-grade primary school students?

Understanding the extent to which first-grade students have developed science literacy and are engaged in scientific activities will provide crucial insights for further improving science education in China. This study will help policymakers, curriculum developers, and educators assess students' engagement levels and literacy development, enabling them to make informed changes in upcoming curriculum reforms.

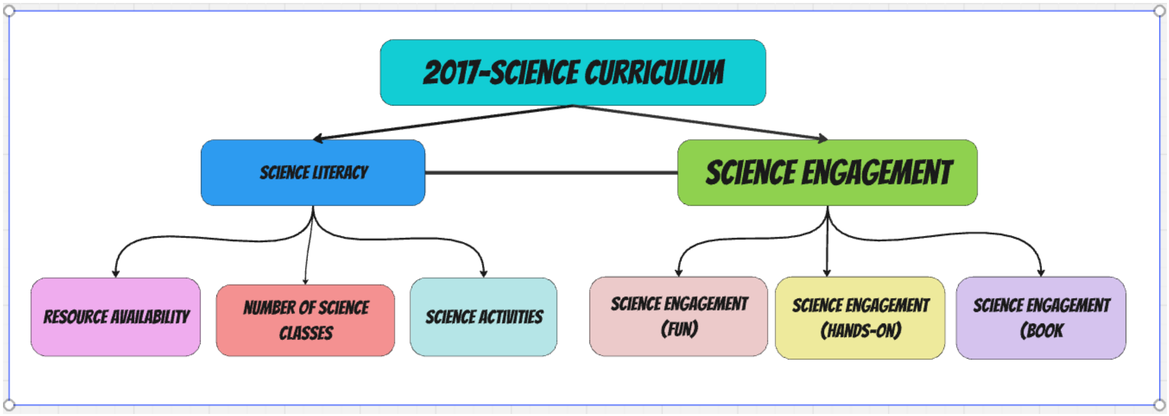

Figure 1. Conceptual framework

Methodology

In the present study, Cross-Sectional Design is used to analyze the data. A cross-sectional study analyzes data from a specific point in time, looking at the relationships between variables such as science literacy, engagement, and the science curriculum (Hunziker & Blankenagel, 2024). The study aims to examine how the current state of the 2017 science curriculum correlates with students' literacy and engagement levels, without needing to track changes over time. A cross-sectional design is suitable to compare the current state of science literacy and engagement among first-grade students at a single point in time. This design is particularly useful for identifying correlations between variables (e.g., educational resources, science class implementation, textbook effectiveness) and outcomes (e.g., science literacy and engagement) without requiring long-term tracking. The survey questionnaire was used to collect the data from the students. Zhejiang Normal University supported this study under the supervision of the Ministry of Education based on the national economic, geographical, and educational levels. The survey selected first-grade primary school students from 23 provinces, five autonomous regions, and four municipalities across China. A total of 132,756 questionnaires were collected, with 121,757 valid responses, resulting in an effective rate of 91.7%.

Data Analysis

Correlation analysis is conducted to find the correlation between the independent variables and the dependent variables related to science literacy and engagement (Mihalik et al., 2022). To determine the strength and significance of the relationships, multiple regression is conducted (Baek & Chung, 2020).

Results

Demographic Characteristics of the Sample

Table 1 indicates the demographic characteristics information of the participants, divided into two variables: age and gender. The participants included in this study are 52.8% males and 47.2% females. The age distribution ranges from 6 to 10 years old, with the majority being 7 or 8. The distribution indicates that the sample is representative and meets the requirements for a sample survey.

Table 1. Demographic Variables of Sample

Variable	Value	Number of samples	Percentage (%)	Average value	Standard deviation
Gender	Male	64308	52.8	1.47	0.499
	Female	57449	47.2		
Age	6	11358	9.3	7.54	0.830
	7	48388	39.7		
	8	47696	39.2		
	9	13768	11.3		
	10	547	0.4		
Total		121757	100.0		

Table 2 presents the summary statistics for the key variables in the study, including science literacy, student engagement, the 2017 science curriculum, respondent gender, and respondent age. The mean score for science literacy is 5.753, with a standard deviation of 1.080, indicating moderate variability in literacy levels among first-grade students. Student engagement has a mean value of 0.852 with a standard deviation of 0.146, suggesting that most students exhibit relatively similar engagement levels. The 2017 science curriculum variable, with a mean of -0.000 and a standard deviation of 0.325, reflects that all students were exposed to the same curriculum, though the variations in implementation or reception may be influencing other variables. The respondent gender variable shows a mean of 1.472, representing a relatively balanced distribution between male and female students. Lastly, the respondent age variable shows a mean of 7.538 years, which is consistent with the expected age (7-9 years) for first-grade students. These statistics provide a foundational understanding of the dataset, demonstrating that while science literacy and student engagement vary among the participants, the distribution of gender and age is relatively uniform.

Table 2. Descriptive Statistics for Key Variables

Variables	N	Mean	SD	p25	Median	p75
Science Literacy	121757	5.753	1.080	5.091	5.818	6.455
Student Engagement	121757	0.852	0.146	0.737	0.842	0.947
2017-Science Curricula	121757	-0.000	0.325	-0.221	-0.044	0.179
Respondent Gender	121757	1.472	0.499	1.000	1.000	2.000
Respondent Age	121757	7.538	0.830	7.000	8.000	8.000

Table 3 displays the correlation matrix, which shows the relationships between science literacy, student engagement, the 2017 science curriculum, respondent gender, and respondent age. The 2017 science curriculum demonstrates a moderate positive correlation with both science literacy ($r = 0.300$, $p < 0.01$) and student engagement ($r = 0.450$, $p < 0.01$). This indicates that exposure to the 2017 science curriculum is associated with higher literacy and engagement levels among first-grade students, addressing the research questions about the curriculum's impact. Moreover, there is a strong positive correlation between science literacy and student engagement ($r = 0.550$, $p < 0.01$), suggesting that higher levels of engagement are linked to better literacy outcomes. This finding supports theories emphasizing the role of active participation in learning and how engagement in science-related activities enhances literacy. Additionally, respondent age exhibits a moderate positive correlation with both science literacy (r = 0.400, $p < 0.01$) and student engagement (r = 0.350, $p < 0.01$), implying that older students in this sample tend to perform better in science literacy and participate more actively in science activities. Finally, the relationship between respondent gender and both literacy and engagement is statistically significant, but the correlations are extremely weak (r = -0.015, $p < 0.01$ for literacy; r = -0.003 for engagement). This suggests that gender plays a minimal role in predicting science literacy or engagement among first-grade students.

Table 3. Correlation Matrix of Science Literacy, Student Engagement, 2017 Science Curricula, Respondent Gender, and Respondent Age.

Variables	(1)	(2)	(3)	(4)	(5)
(1) Science Literacy	1.000				
(2) Student Engagement	0.550***	1.000			
(3) 2017-Science Curricula	0.300***	0.450***	1.000		
(4) Respondent Gender	-0.015***	-0.003	-0.010***	1.000	
(5) Respondent Age	0.400***	0.350***	0.136***	-0.026***	1.000

**** p<0.01, ** p<0.05, * p<0.1*

Table 4 presents the results of Ordinary Least Squares (OLS) regression models predicting science literacy and student engagement, with the 2017 science curriculum, respondent gender, and respondent age as predictors. In Model 2, the 2017 science curriculum has a significant positive effect on science literacy (β = 0.300, SE = 0.01, $p < 0.001$, t = 18.69), addressing the first research question. This finding indicates that the curriculum contributes to improved science literacy among students, supporting the view that curriculum reforms have a measurable impact on educational outcomes. The effect size is moderate, and the high level of statistical significance underscores the importance of the curriculum in shaping literacy outcomes. Respondent gender has a small but significant negative effect on science literacy (β = -0.015, $p < 0.001$), suggesting that male students, on average, have slightly lower literacy levels than female students. Respondent age has a significant positive effect on science literacy (β = 0.400, $p < 0.001$), indicating that older students tend to perform better in literacy assessments.

In terms of student engagement, Model 4 shows that the 2017 science curriculum has a significant positive effect on student engagement (β = 0.450, SE = 0.001, $p < 0.001$, t = 21.76), providing a clear answer to the second research question. The curriculum appears to strongly promote higher engagement in science activities among first-grade students. Respondent gender has no significant effect on student engagement, as indicated by the near-zero coefficient and lack of statistical significance (β = 0.000, p = 0.977). However, respondent age has a significant positive effect on student engagement (β = 0.350, $p < 0.001$), suggesting that older students are more engaged in science activities. This may reflect a developmental trend where older students are better able to participate actively in classroom activities. The R-squared values for these models are relatively low (ranging from 0.007 to 0.014), indicating that while the models are statistically significant, a large portion of the variance in science literacy and student engagement remains unexplained by the included variables. Nonetheless, the F-values are significant, confirming that the overall models fit the data well.

Table 4. Coefficients of OLS Regressions Predicting Science Literacy and Student Engagement

	Science Literacy						Student Engagement					
Variables	Model 1	P value	T value	Model 2	P value	T value	Model 3	P value	T value	Model 4	P value	T value
2017-Science Curricula				0.300•••	0.000	18.69				0.450•••	0.000	21.76
				(0.01)						(0.001)		
Respondent Gender	-0.015***	0.000	-6.15	-0.015***	0.000	-6.03	0.000	0.977	0.03	0.000	0.977	0.18
	(0.006)			(0.006)			(0.001)			(0.001)		
Respondent Age	0.400***	0.000	29.36	4.00***	0.000	31.67	0.350***	0.000	34.74	0.350***	0.000	31.52
	(0.004)			(0.004)			(0.001)			(0.001)		
Constant	6.632•••	0.000	222.14	6.703•••	0.000	223.04	0.721•••	0.000	179.27	0.732•••	0.000	180.92
	(0.03)			(0.03)			(0.004)			(0.004)		
Observation	121757			121757			121754			121754		
R-squared	0.007			0.01			0.01			0.014		
Adj-squared	0.007			0.010			0.009			0.013		
F value	445.50•••	0.000		414.25•••	0.000		603.96•••	0.000		562.08•••	0.000	
AIC	363,398.8			363,052.1			-124,754.1			-125,224.9 -		
BIC	363,428			363,091			-124,725			125,186		

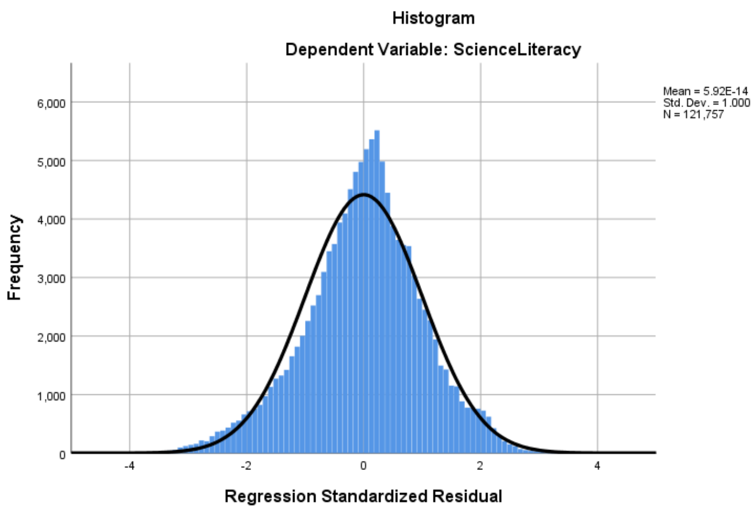

Figure 2. Histogram of Regression Standardized Residuals for Science Literacy

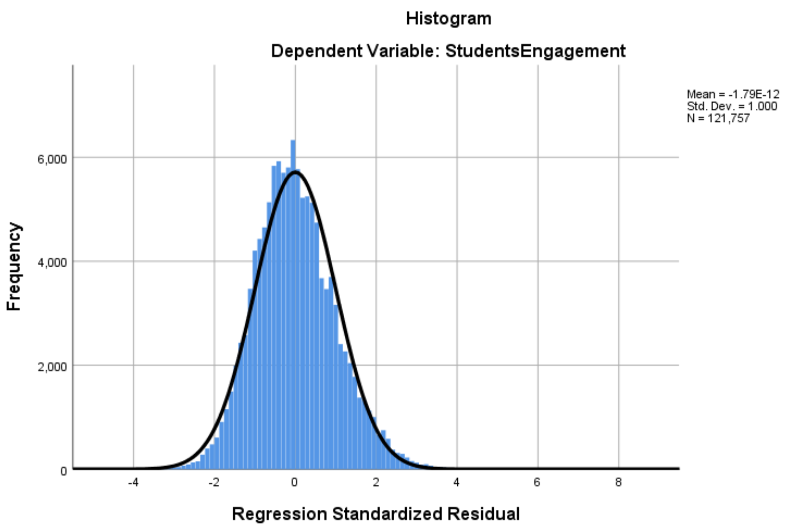

Figure 3. Histogram of Regression Standardized Residuals for Student Engagement

To ensure that the assumptions of the Ordinary Least Squares (OLS) regression were met, we examined the distribution of the residuals for both models predicting science literacy and student engagement. Figure 2 presents the histogram of the regression standardized residuals for science literacy, and Figure 3 presents the same for student engagement. Both histograms show that the residuals are approximately normally distributed, with the mean close to zero and a standard deviation of one. This suggests that the assumption of normality in the residuals is satisfied, further validating the regression models used in this study.

Discussion

In the present study, students' science literacy and engagement were examined using both correlation and multiple regression analyses. These methods provided a comprehensive understanding of the relationships between various factors in the 2017 science curriculum and their impact on educational outcomes, specifically science literacy and student engagement.

Relation between Students' Science Literacy and Engagement

The correlation analysis aimed to understand how different aspects of student engagement, such as fun level, participation in book-related activities, and involvement in hands-on activities, are related to overall science literacy. The results indicated a moderate positive correlation between science literacy and student engagement ($r = 0.550$, $p < .001$), suggesting that students with higher engagement levels tend to have better literacy outcomes. Additionally, the 2017 science curriculum has a positive correlation with both science literacy ($r = 0.300$, $p < .001$) and student engagement ($r = 0.450$, $p < .001$), indicating that students exposed to the curriculum show increased literacy and engagement.

Interestingly, respondent age was found to be positively correlated with both science literacy ($r = 0.400$, $p < .001$) and student engagement ($r = 0.350$, $p < .001$), suggesting that older students in the first-grade sample performed better in these areas. However, respondent gender had a small but significant negative correlation with science literacy ($r = -0.015$, $p < .001$), indicating that female students slightly outperformed male students in literacy, though this effect is minimal. These findings align with prior studies such as Bae and Lai (2020), which emphasize the importance of student engagement in science learning, particularly through hands-on, interactive activities. Active learning fosters a deeper understanding and enhances the retention of scientific knowledge. This study found that when students had more opportunities to participate actively in science lessons, their engagement levels increased significantly, which in turn positively influenced their science literacy (Bae & Lai, 2020).

Impact on Science Literacy

The regression analysis revealed that the 2017 science curriculum significantly predicts science literacy ($\beta = 0.300$, $p < 0.001$), highlighting that the curriculum positively impacts literacy outcomes. However, the effect size is moderate, explaining approximately 1.0% of the variance in science literacy (R-squared = 0.010). The significant F-statistic ($p < 0.001$) indicates that the model is a good fit for the data. The small effect size suggests that other factors, such as a number of science classes, resource availability, and certain science activities, contribute to science literacy but do not dominate the effect. These results underscore the importance of a well-rounded curriculum that includes frequent and engaging science activities. This finding is supported by Cho (2022), who emphasized the need for a structured science curriculum that fosters literacy by focusing on the scientific process, including experiment design, data collection, and interpretation. Additionally, respondent age was found to have a significant positive effect on science literacy ($\beta = 0.400$, $p < 0.001$), indicating that older students in the first grade tend to perform better in literacy. On the other hand, respondent gender had a small but significant negative effect on science literacy ($\beta = -0.015$, $p < 0.001$), consistent with the finding that female students slightly outperform male students.

Impact on Science Engagement

The regression model predicting student engagement was stronger, explaining 1.4% of the variance (R-squared = 0.014), with the 2017 science curriculum having a significant positive effect on engagement ($\beta = 0.450$, $p < 0.001$). This suggests that the curriculum substantially enhances student engagement, especially through fun and hands-on activities, which were identified as strong predictors of engagement. Students who frequently participated in these activities showed higher engagement, reinforcing the curriculum's emphasis on interactive and practical learning experiences. Although book-related activities also positively impacted engagement, their influence was weaker compared to more dynamic and interactive methods. Bae and Lai (2020) similarly found that hands-on and collaborative activities were significant predictors of student engagement. This supports the notion that interactive experiences, as emphasized in the 2017 science curriculum, play a key role in increasing student engagement. Additionally, respondent age had a significant positive effect on student engagement ($\beta = 0.350$, $p < 0.001$), suggesting that older students are more likely to engage in science activities. Respondent gender, however, had no significant effect on engagement ($\beta = 0.000$, $p = 0.977$), indicating that both male and female students engage in science activities at similar levels (Anthony, 1996).

Conclusion

The findings from both the correlation and regression analyses align with the study’s conceptual framework, emphasizing the role of resource availability, science activities, and the number of science classes in fostering science literacy and student engagement (Shofiyah et al 2020; Rehman et al.,2024). The results suggest that enhancing the enjoyable and hands-on aspects of science education is crucial for improving literacy and engagement outcomes. While traditional methods, such as reading and textbook use, are still beneficial, integrating them with more interactive and engaging approaches can maximize their effectiveness and lead to better educational outcomes.

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References

Adarlo, G., de Leon, M., & Favis, A.M. (2022). Exploring Students 'Attitudes toward Science and Course Engagement as Predictors of Science Literacy. Proceedings of the International Multi-Conference on Society, Cybernetics and Informatics, IMSCI, 39-44. https://doi.org/10.54808/IMSCI2022.01.39

Mahmood, A., Huang, X., Rehman, N., & Zamani, N. (2024). *Effect of Strategic Memory Advanced Reasoning Training (SMART) therapy for enhancing Final-Year High School Students Career Choices*. 15 October 2024, PREPRINT (Version 1) available at Research Square [https://doi.org/10.21203/rs.3.rs-5245229/v1]

Anthony, G. (1996). Active learning in a constructivist framework. *Educational Studies in Mathematics*, *31*, 349–369. https://doi.org/10.1007/BF00369153

Asano, R., Amponsah, K. D., Baah-Yanney, O., Quarcoo, F., & Azumah, D. A. (2021). *Using Quality Teaching and Learning Resources for Effective Integrated Science Education among Senior High Schools in Ghana* (SSRN Scholarly Paper 3887147). https://papers.ssrn.com/abstract=3887147

Bae, C. L., & Lai, M. H. (2020). Opportunities to participate in science learning and student engagement: A mixed methods approach to examining person and context factors. *Journal of Educational Psychology*, *112*, 1128–1153. https://doi.org/10.1037/edu0000410

Baek, J.-W., & Chung, K. (2020). Context Deep Neural Network Model for Predicting Depression Risk Using Multiple Regression. *IEEE Access*, *8*, 18171–18181. IEEE Access. https://doi.org/10.1109/ACCESS.2020.2968393

Cho, E. (2022). Cultivating Science Literacy Through the General Education Curriculum. *The Korean Association of General Education*. https://doi.org/10.46392/kjge.2022.16.5.203

Dong, K., & Wei, N. (2023). Modernization of the Basic Public Education Service System. In K. Dong & N. Wei (Eds.), *Transforming China's Public Services: A Plan for 2030* (pp. 39–90). Springer Nature. https://doi.org/10.1007/978-981-99-3943-5_3

Garira, E. (2020). A Proposed Unified Conceptual Framework for Quality of Education in Schools. *Sage Open*, *10*(1), 2158244019899445. https://doi.org/10.1177/2158244019899445

Hariyadi, S., Rofiâ€™i, A., Santosa, T. A., Taqiyuddin, & Sakti, B. P. (2023). Effectiveness of STEM-Based Mind Mapping Learning Model to Improve Students' Science Literacy in the Era of Revolution 4.0. *Jurnal Penelitian Pendidikan IPA*, *9*(10), Article 10. https://doi.org/10.29303/jppipa.v9i10.5125

Havu-Nuutinen, S., Kewalramani, S., Veresov, N., Pöntinen, S., & Kontkanen, S. (2022). Understanding Early Childhood Science Education: Comparative Analysis of Australian and Finnish Curricula. *Research in Science Education*, *52*(4), 1093–1108. https://doi.org/10.1007/s11165-020-09980-4

Hunziker, S., & Blankenagel, M. (2024). Cross-Sectional Research Design. In S. Hunziker & M. Blankenagel

(Eds.), *Research Design in Business and Management: A Practical Guide for Students and Researchers* (pp. 187–199). Springer Fachmedien. https://doi.org/10.1007/978-3-658-42739-9_10

Iqbal, M., Khalid, M. S., Rehman, N., & Yanping, L. (2021). Parental divorce: Impact on socio-psychological behavior and academic performance of students in teacher's perception. *Journal of Divorce & Remarriage*, *62*(6), 475-492. https://doi.org/10.1080/10502556.2021.1925854

Law, W.-W., & Xu, S. (2020). Re-examining teaching and learning in citizenship education: A tale of two Chinese cities. *Journal of Curriculum Studies*, *52*(1), 138–159. https://doi.org/10.1080/00220272.2019.1605410

Liu, Y., Jiang, Q., & Chen, F. (2020). Children's gender and parental educational strategies in rural and urban China: The moderating roles of sibship size and family resources. *Chinese Sociological Review*, *52*(3), 239–268. https://doi.org/10.1080/21620555.2020.1717942

Maestrales, S., Dezendorf, R. M., Tang, X., Salmela-Aro, K., Bartz, K., Juuti, K., Lavonen, J., Krajcik, J., & Schneider, B. (n.d.). *U.S. and Finnish high school science engagement during the COVID-19 pandemic*. https://doi.org/10.1002/ijop.12784

Marginson, S. (2021). National modernisation and global science in China. *International Journal of Educational Development*, *84*, 102407. https://doi.org/10.1016/j.ijedudev.2021.102407

Mihalik, A., Chapman, J., Adams, R. A., Winter, N. R., Ferreira, F. S., Shawe-Taylor, J., & Mourão-Miranda, J. (2022). Canonical Correlation Analysis and Partial Least Squares for Identifying Brain–Behavior Associations: A Tutorial and a Comparative Study. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, *7*(11), 1055–1067. https://doi.org/10.1016/j.bpsc.2022.07.012

Ngeno, B., Mweru, M., & Mwoma, T. (2021). Availability of Physical Infrastructure in Implementation of the Competence-Based Curriculum in Public Primary Schools in Kericho County. *East African Journal of Education Studies*, *3*(1), Article 1. https://doi.org/10.37284/eajes.3.1.344

Rehman, N., Zhang, W., Mahmood, A., & Alam, F. (2021). Teaching physics with interactive computer simulation at secondary level. *Cadernos de Educação Tecnologia e Sociedade*, *14*, 127. https://doi.org/10.14571/brajets.v14.n1.127-141

Rehman, N., Zhang, W., Mahmood, A., Fareed, M. Z., & Batool, S. (2023). Fostering twenty-first century skills among primary school students through math project-based learning. *Humanities and Social Sciences Communications*, *10*(1), 1–12. https://doi.org/10.1057/s41599-023-01914-5

Rehman, N., Zhang, W., & Sher, S. (2020). Mapping Implementation of National Curriculum for Early Childhood Education in Private Schools of District Gilgit. *JECCE*, *4*. https://doi.org/10.30971/jecce.v4i.450

Rehman, N., Huang, X., Mahmood, A., AlGerafi, M. A., & Javed, S. (2024). Project-based learning as a catalyst for 21st-Century skills and student engagement in the math classroom. *Heliyon*.

Rehman, N., Huang, X., Batool, S., Andleeb, I., & Mahmood, A. (2024). *Assessing the Effectiveness of Project-Based Learning: A Comprehensive Meta-Analysis of Student Achievement between 2010 and 2023*. 2024015. https://doi.org/10.12982/CMUJASR.2024.015

Shaw, M. S., Fields, D. A., & Kafai, Y. B. (2020). Leveraging local resources and contexts for inclusive computer science classrooms: Reflections from experienced high school teachers implementing electronic textiles. *Computer Science Education*, *30*(3), 313–336. https://doi.org/10.1080/08993408.2020.1805283

Shofiyah, N., Afrilia, I., & Wulandari, F. (2020). Scientific Approach and The Effect on Students Scientific Literacy. *Journal of Physics: Conference Series*, *1594*. https://doi.org/10.1088/1742-

6596/1594/1/012015

Sun, L., & Li, L. (2021). The Alignment between Third-Grade Primary School Science Textbooks and Curriculum Standards in China and Japan. *Journal of Baltic Science Education*, *20*(3), 507–518. https://eric.ed.gov/?id=EJ1300348

Valladares, L. (2021). Scientific Literacy and Social Transformation. *Science & Education*, *30*(3), 557–587. https://doi.org/10.1007/s11191-021-00205-2

Zeng, J., Parks, S., & Shang, J. (n.d.). *To learn scientifically, effectively, and enjoyably: A review of educational games*. https://doi.org/10.1002/hbe2.188

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