STUDYING SCIENCE LEARNING AND TEACHING SYSTEMS IN INDONESIA AND RUSSIA

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Abstract: Science education plays a crucial role in advancing technology and innovation, especially in the era of the Industrial Revolution 4.0 which demands mastery of STEM (Science, Technology, Engineering, and Mathematics) competencies. However, the implementation of science education varies greatly between countries. This study aims to compare the teaching and learning systems of science, particularly physics, in Indonesia and Russia through a qualitative comparative approach. Data were collected from literature reviews including journal articles, books, educational reports, and policy documents. The analysis reveals that Russia employs a more structured science curriculum supported by intensive teacher training and a strong research-based teaching culture from an early age. In contrast, Indonesia still faces challenges such as limited laboratory facilities, uneven teacher training, and a lack of integration between theory and practice. These disparities result in lower science literacy performance among Indonesian students in international assessments like PISA, compared to their Russian counterparts. The study concludes by offering strategic recommendations for improving science education in Indonesia, including enhancing teacher training programs, strengthening policy support, and adopting experimental learning approaches inspired by the Russian model. This research contributes theoretically to the literature on international education comparisons and provides practical insights for policymakers and educators aiming to develop more effective science teaching strategies.

Keywords: Science Education, Comparative Education, Scientific Literacy, Teaching and Learning Systems Educational Policy

INTRODUCTION

Science education plays a crucial role in driving technological progress and innovation, especially in the era of globalization that demands mastery of science and practical skills. The ability to understand and apply scientific concepts is not only an individual need, but also the basis for the progress of society as a whole. Science education not only provides theoretical understanding, but also trains critical thinking skills, creativity, and problem-solving skills needed to face rapid technological developments. According to Kompas (2024), the development of science and technology education needs to be improved from elementary school to college to support economic growth and human welfare. An effective education system plays an important role in forming a generation of competent scientists and professionals, especially in facing the challenges of the Industrial Revolution 4.0 which emphasizes STEM (Science, Technology, Engineering, and Mathematics) skills (Grahito Wicaksono, 2020). However, the implementation of science education in various countries shows significant differences, both in terms of curriculum, teaching methods, and learning evaluation. Russia, for example, is known for its strong tradition of science education, which emphasizes mastery of the basics of science from an early age and experimental-based learning methods (Kuznetsov et al., 2020). This approach has produced many scientists and innovators who have made major contributions at the global level. On the other hand, Indonesia still faces various challenges in implementing

effective science learning methods, such as limited laboratory facilities, lack of teacher training, and a curriculum that does not fully accommodate the needs of practice-based learning. This causes a gap in the quality of science education between Indonesia and developed countries. Previous studies have identified several problems in science education in Indonesia, such as the lack of integration between theory and practice, and low student interest in science (Widodo et al., 2019)). However, there is still a gap in research comparing the science education system in Indonesia with countries that have a strong tradition of science education, such as Russia. This study aims to fill this gap by exploring the science learning and teaching systems in both countries, including curriculum analysis, teaching methods, learning evaluation, and supporting and inhibiting factors. By comparing the two systems, this study is expected to provide strategic recommendations to improve the quality of science education in Indonesia.

In the era of modern education, innovation in the learning process is key to increasing student effectiveness and engagement. One approach that has proven effective is the use of visual learning media, such as image media, which can help students understand abstract concepts, especially in Mathematics. (Amiyah et al., 2024) emphasized that the development of Heyzine Flipbook-based e-modules can increase students' interest and understanding of the material presented. In addition, (Shafna Shaumuristi, n.d.) showed that the application of a structured inquiry learning model can increase student activity and learning outcomes through an approach that encourages exploration and active participation. The implementation of project-based learning model (PBL) combined with contextual media is able to significantly improve learning outcomes. Based on these findings, this study aims to examine the effectiveness of using image media in improving the activity and learning outcomes of students of SDN 2 Babat Banyuasin in Mathematics subjects.

The purpose of this study is to examine the science learning methods in Indonesia and Russia, analyze the advantages and disadvantages of each system, and provide recommendations for improving the quality of science education in Indonesia. This study is expected to provide theoretical contributions by adding to the literature on the comparison of science education systems and identifying the advantages and disadvantages of each system. Practically, this study is useful for the government, educators, students, and further researchers in developing more effective learning methods. Socially, this study supports improving the quality of human resources in the fields of science and technology and preparing a generation that is able to compete in the era of the Industrial Revolution 4.0. Thus, this study is expected to be the first step in overcoming the challenges of science education in Indonesia and opening up opportunities for international collaboration in the development of science education.

LITERATURE REVIEW

This literature review is designed to provide a comprehensive overview of the concept of science education, the education system in Indonesia and Russia, and previous research findings relevant to this research topic. This section also explains the theoretical basis used, the development of concepts or theories, and the contribution of this research to the discussion on science education.

Science education is a branch of education that aims to equip students with scientific knowledge, skills, and attitudes. The goal is to enable students to understand natural phenomena, solve everyday life problems, and develop critical, analytical, and creative thinking skills (Nasution et al., 2024). According to the OECD (2023),

scientific literacy includes three main components: content knowledge (scientific facts and concepts), procedural knowledge (the ability to conduct scientific investigations), and epistemic knowledge (understanding of how science is constructed and validated). Science education also aims to shape individuals who are able to adapt to technological developments and global change.

Science plays a strategic role in national and global development. At the national level, science education supports the development of competent human resources in technology and innovation, which is important for increasing the nation's competitiveness (Yusmar & Fadilah, 2023). Globally, science literacy helps people understand important issues such as climate change, the energy crisis, and public health, and contributes to decision-making that impacts the sustainability of life (OECD, 2023).

The education system in Indonesia consists of elementary school (SD/MI), junior high school (SMP/MTs), senior high school (SMA/MA), and higher education. The Merdeka Curriculum currently implemented provides teachers with flexibility to develop learning according to student needs (Winarso et al., 2021). In Russia, basic education lasts for nine years with a focus on mastering the basics of science such as mathematics, physics, biology, and chemistry (Kuznetsov et al., 2020). After completing basic education, students can choose an academic or vocational path according to their interests.

The science curriculum in Indonesia covers science subjects at elementary school level to physics, biology, and chemistry at high school level. This curriculum is designed to provide a foundation of science before students choose a specialization at the higher education level (Eviota & Liangco, 2020). In Russia, the science curriculum is more structured with more study hours, designed to encourage in-depth understanding through analytical and experimental approaches (Nasution et al., 2024).

Teaching methods in Indonesia are still dominated by traditional approaches such as lectures and memorization. However, some schools have begun to implement project-based learning or inquiry-based learning methods to increase student engagement (Hidayah et al., 2021). In Russia, teaching methods emphasize practical experiments and research from an early age, with teachers trained to use research-based approaches to encourage students to think critically and solve problems independently (Nasution et al., 2024).

Previous studies have shown that Indonesian students' scientific literacy is still low compared to other countries, with an average score of 383 in PISA 2022 (OECD, 2023). In contrast, Russia has managed to achieve high scores in international evaluations such as TIMSS, thanks to the experiment-based learning approach implemented early on (Kuznetsov et al., 2020).

Developed countries such as Russia have a more structured science education system supported by adequate laboratory facilities. In developing countries such as Indonesia, limited resources are a major challenge in implementing an effective science curriculum (Yusmar & Fadilah, 2023).

Education policy plays an important role in determining the quality of science learning. In Indonesia, the Independent Curriculum policy aims to increase learning flexibility, but faces challenges in its implementation (Kemendikbudristek, 2022). In Russia, government policies support the development of scientific research in schools, thereby improving the overall quality of science learning (Nasution et al., 2024).

The theoretical basis used in this study includes the concept of scientific literacy (OECD, 2023), inquiry-based and experimental learning approaches (Nasution et al.,

2024), and a comparison of education systems between developed and developing countries (Yusmar & Fadilah, 2023). This study contributes to the discussion on science education by analyzing the differences in science education systems in Indonesia and Russia, and identifying factors that influence the quality of science learning in both countries. In addition, this study provides recommendations

METHOD

This study is a comparative study with a qualitative approach that aims to compare the science learning and teaching systems, especially physics, in Indonesia and Russia. Data were collected through literature reviews (scientific journals, books, education reports, and policy documents). The analysis technique used is qualitative descriptive analysis, which includes three main steps: (1) describing the science learning systems in both countries, (2) comparing traditional and modern didactic methods, and (3) exploring the influence of culture on learning practices. The validity of the study was maintained through triangulation of data sources (literature review), while reliability was guaranteed by the use of standardized instruments and systematic data analysis.

RESULTS AND DISCUSSION

Based on the results of the literature review, there are several fundamental differences between the science learning and teaching systems in Indonesia and Russia. In Indonesia, the approach to science learning is still dominated by lecture and memorization methods, while in Russia there is more emphasis on experiments and research from an early age. This has an impact on the level of science literacy of students in both countries, where Russian students perform better in international assessments such as TIMSS and PISA (OECD, 2023).

The science curriculum in Russia is designed systematically and integrated from the elementary level, with more study hours and more in-depth material. Teachers in Russia also receive intensive training to apply research-based approaches and encourage students to think critically. In Indonesia, although the Independent Curriculum gives teachers the freedom to innovate, its implementation is still limited due to limited facilities, uneven teacher training, and low student interest in science.

In addition, the academic culture in Russia supports collaboration between schools and research institutions, which enriches students' learning experiences. Meanwhile, in Indonesia there is still a gap between theory and practice, where science learning is not fully based on solving real problems or experiments.

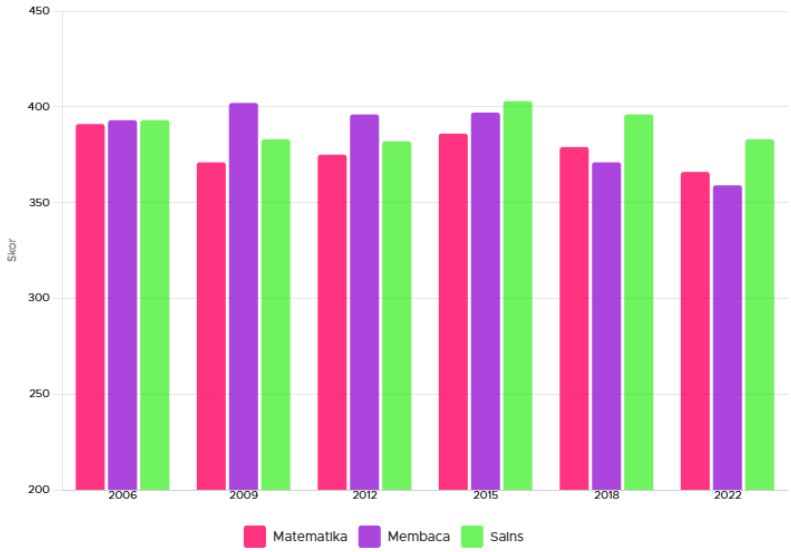
In general, the findings of this study indicate that the success of the science education system in Russia depends not only on the curriculum, but also on the supporting education ecosystem, from teacher training, laboratory facilities, to government policy support. Indonesia can learn important lessons from Russia's approach to improving the quality of science education, especially in fostering a scientific culture from an early age and improving the quality of teacher training.

Tabel 1. Comparison of Indonesian and Russian Science Education Systems

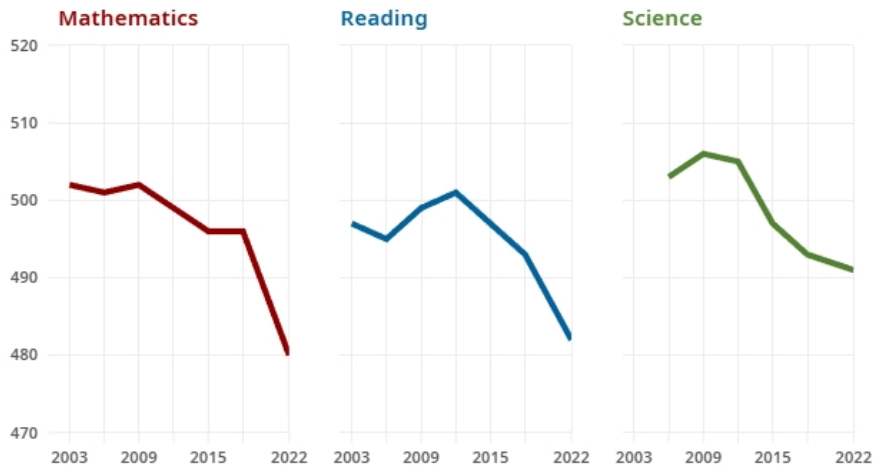
Aspect	Indonesian	Russian
Learning Approach	Lectures, memorization	Experimentation, early research
Curriculum	Flexible (Independent Curriculum)	Structured and integrated
Teacher Training	Not evenly distributed	Intensive and sustainable

Laboratory Facilities	Limited	Complete and supportive of experiments
Academic Culture	Focused on theory	Collaborative with research institutions
Assessment Results (PISA	Low	High

Picture 1: Diagram of Science Education Ecosystem in Russia



Picture 2: PISA 2022 Score Comparison Chart Between Indonesia and Russia



CONCLUSION

This study concludes that there are significant differences between the science learning and teaching systems in Indonesia and Russia. The Russian system tends to be more structured, supported by strong education policies, intensive teacher training, and integration between theory and practice through experiments. On the other hand, the Indonesian system still faces challenges in terms of facilities, teacher training, and learning approaches that are not yet optimal.

The contribution of this study lies in the comparative analysis that provides a clear picture of the advantages and disadvantages of each science education system. This study provides recommendations for Indonesia to adopt good practices from the Russian science education system, such as improving research-based teacher training, integrating the curriculum with experimental practices, and strengthening support for education policies.

This study has limitations because it only uses literature reviews as the main data source. Therefore, further research is recommended to use field study methods or interviews with education practitioners from both countries to obtain a more in-depth and empirical perspective.

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