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Unearthing the Academic Time Capsule: Delving into the Evolution of Science Education Among Indonesian Students

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ABSTRACT The Indonesian education system, in general, still has many challenges in learning science. The results of the 2018 PISA survey put Indonesia in 74th place, which is sixth from the bottom. Indonesian students' reading ability, with a score of 371, is in the 74th position; Mathematics, with 379, is in the 73rd position; and Science, with a score of 396, is in the 71st position. This situation is intriguing to explore how history influences the education system's current conditions, especially in science learning. The article will explore the effect of changes in the education system on science learning in Indonesia. Exploration of science learning will start from the education system before the independence of Indonesia to the current education system. Using a historical approach, and this article concludes that political power influences change in the ideological orientation of the system and the direction of education, especially in education policy, curriculum changes, and learning activities. This change in situation plays a huge role in determining the achievements of current science learning and achievements.

Keywords: Indonesian students, Science education evolution, Science learning, Historical perspective

1. INTRODUCTION

Education in Indonesia is still experiencing many challenges (Pramana, Chamidah, Suyatno, Renadi, & Syaharuddin, 2021; Suratno, 2014). Although changes in the application of the education system, especially in the learning curriculum, have been made repeatedly, until now, the education problem in Indonesia has not been fully resolved. This condition is, of course, very worrying because education and academic achievement are components that determine a country's future success. Moreover, academic achievements are significant because a country with high academic achievements is closely related to good economic conditions (Suharno, Pambudi, & Harjanto, 2020). On the other hand, Indonesia's education problems are complex, including infrastructure, costs, systems, quality, management, and policy issues (Pramana et al., 2021; Suharno et al., 2020; Suratno, 2014).

Regarding science learning achievements, the 2018 Program for International Student Assessment (PISA) survey results put Indonesia in 74th place, sixth from the bottom (OECD, 2018). The results of the 2018 PISA study published by The Organization for Economic Co-operation and Development (OECD) show that the reading ability of Indonesian students reaches an average score of 371, with an average OECD score of 487. Then, for an average score in mathematics, Indonesian students got 379, with an average OECD score of 487. Also, for science, the average score of Indonesian students was 396, with an average OECD score of 489. The other findings from the survey indicate several exciting findings in explaining the PISA 2018 results, including that Indonesia is in the underperforming quadrant with high equity. Then, it was also found that the gender gap in achievement and the gap in learning performance between female and male students were not significant. Female students outperformed male students in all areas of the PISA survey. Female students exhibit superior academic performance compared to their male counterparts, manifesting a statistically significant discrepancy of 25 points in reading, 10 in mathematics, and 7 in science.

This finding is interesting because although the female students performed better, the difference was insignificant. When linked to modern science learning, this information

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helps plan science learning for Indonesian students. Learning science in the modern era is a complex process because learning science not only delivers science content but also needs to pay attention to each student's unique characteristics as a learner (Park, Wu,& Erduran, 2020). However, what is happening now is that many science classes focus more on memorizing theories and facts in science than on the nature of science and science process skills (Tytler & Osborne, 2012).

In science learning, instead of memorizing science content, students should practice doing scientific investigations, gathering facts, and conducting research (Tytler & Osborne, 2012). Students must be able to develop questions, make hypotheses, and retest existing scientific explanations. On the other hand, science teachers must be able to carry out science learning activities that make students literate in science, meaning that students are literate in scientific phenomena that occur daily. For example, sunlight is an energy source for photosynthesis so plants can produce food. In addition, teachers must make students observers who are always curious about how scientific phenomena occur. Finally, science teachers must open up great learning opportunities that enable students to implement how science works (Park et al., 2020).

Developed countries at the top in PISA results have been able to carry out established science learning. This is, of course, influenced by many factors, especially the education system. The education system in a nation is strongly influenced by several primary factors: economic, political, social, cultural, and historical. Economically, resource allocation challenges have affected infrastructure and access, prompting government initiatives to address disparities. Politically, shifts in leadership and decentralization have led to regional variations in education. Socially, cultural diversity and norms have influenced curriculum and student choices. Culturally, religion and traditional values are integrated into the system. Historically, colonial legacies and the struggle for independence have left indelible marks on Indonesia's national identity and language use in education. The interplay of these multifaceted factors continues to mold Indonesia's educational landscape, necessitating a nuanced understanding of effective policy and educational development. In Indonesia, historical elements are one of the factors that significantly affect the characteristics of the Indonesian education system (Syaharuddin & Susanto, 2019).

Education in Indonesia has existed and transformed since the pre-independence period until today. During the pre-independence period, religious teachings, including Hindu-Buddhist, Islam, and Christianity, were the basic foundation of the education system (Bjork, 2005). Meanwhile, political power and ideology significantly influenced the education system during colonization. The ideological orientations that emerged and influenced the direction of the education system in Indonesia during the colonization can be identified as nationalism and democracy (Subkhan, 2018). Nationalism is the embodiment of the struggle to be free from colonialism and efforts to build the identity and character of the Indonesian nation. At the same time, democracy leads to a democratic education that contrasts with the colonial education system, which was discriminatory.

After independence, Indonesia continued democratic education, allowing children from various backgrounds to achieve the highest possible education. This article will explore the changes from learning science then to learning science today, explicitly examining how historical influences affect current science learning and students' achievements. Finally, this article provides information to prepare and improve science learning specifically for Indonesian students to compete with developed countries that have successfully achieved good science learning.

2. METHOD

This article employs the Systematic Literature Review (SLR) methodology, a rigorous approach that entails systematically identifying, reviewing, evaluating, and interpreting all available resources on one particular topic. This study is particularly distinguished by its distinctive approach, which integrates contemporary observations with historical data to derive insights into the evolutionary trajectory of science education among Indonesian students. The study facilitates a comprehensive grasp of the educational system's historical transformations, attendant challenges, and progressive developments over time by scrutinizing past practices and a comparative analysis of the present state of science pedagogy.

3. SCIENCE LEARNING PRIOR TO INDEPENDENCE

The development of the education system in Indonesia is significantly associated with the development of the education system in Asia, especially in the Southeast Asia region. Before Indonesia's independence, the education system was influenced by religious factors, mainly Hinduism, Buddhism, Islam, and Christianity (Bjork, 2005). In ancient times, education in the archipelago was carried out with education in the family and community environment. Structured education first appeared during the influence of Hindu and Buddhist kingdoms, followed by Islamic and Christian education, which took on a role in society in that period.

3.1. Science Learning during the Hindu-Buddhist Period

In the fifth century, the influence of Indian immigrants affected the lives of the inhabitants of the archipelago, which is now Indonesia, with the existence of Hindu-Buddhist teachings in terms of theology, literature, language, and science (Ricklefs, 1991). Apart from religion's influence, learning activities at this time were

practical, imitative, and static (Syaharuddin & Susanto, 2019). This means that education was aimed at survival skills in society at that time by teaching that imitated their ancestors and experienced very little change. The implementation of Hindu-Buddhist religious education is in hermitages. The characteristics of education during the Hindu-Buddhist period consisted of being informal and aristocratic, and the education administrators were Brahmins for Hinduism and Monks for Buddhism (Muharani & Hudaidah, 2021). Brahmins were designated as the priestly class as they served as priests

In studying science, science was applied science in which science material is spread out into various components such as religious education, specifically for Brahmins to master religious knowledge; chivalry education, specifically for the nobility of the royal court family related to governing the country; and war techniques. And vocational education for ordinary people through their parents' expertise, such as carvers, sculptors, fishermen, farmers, etc. During the heyday of Hinduism and Buddhism in Indonesia, there was a very high development of science and art, which gave birth to masters, poets, and high-quality works of architecture (Budiarti, 2018). Applied science at that time was remarkable, for example, the precise mathematical calculations and science behind the buildings they erected. However, these tremendous scientific skills leave many mysteries to research and investigate.

3.2. Science Learning during the Islam and Christianity Period

In the thirteenth century, Islamic traders began to influence the color of education in Indonesia until Islam became a religion that dominated the Indonesian archipelago. Islam developed a mass education system, namely pesantren (see Figure 1), emphasizing the doctrine of Islam and the Islamic way of life (Hicks & Peacock, 1973). The influence of Christianity entered the Maluku region in the sixteenth century. The Christian religion strengthens the local population's literacy by teaching mathematics, science, reading, and writing (Bjork, 2005).

Figure 1 Students studying at Pesantren on Java Island
Source: Kompas.com (Credit Tropenmuseum)

Islam and Christianity are Abrahamic religions with much in common regarding seeing nature and science (Stenmark, 2005; Tinker, 2004). In terms of science, the developing science is very much colored by the differences in each religion. Still, the two religions have universal and neutral science so that all groups can accept it (Stenmark, 2005). Scientific achievements encompassed a wide range of subject areas, especially astronomy, mathematics, and medicine.

3.3. Science Learning during Colonialization

Since the Portuguese came to Indonesia's archipelago, they set up schools to provide reading, writing, and arithmetic education. However, when the Dutch began to enter the Indonesian archipelago, the Portuguese' teaching activities began to stop and were replaced with schools established by the Dutch. Entering the 16th century, the Dutch expanded education to the island of Java by establishing schools. Entering the 19th century, the Dutch had established many schools. Under the Dutch, access to education is differentiated based on social status: the lower class includes peasants, laborers, and servants, while the upper class includes white-collar workers and Indonesian civil servants working for the Dutch administration (Koentjaraningrat, 1975; Suratno, 2014).

In 1899, the Governor-General of the Dutch East Indies, Van Deventer, implemented an Ethical Policy in Indonesia, which implies the implementation of education (Syaharuddin & Susanto, 2019). The Dutch then established several schools for the natives to fulfill this policy. Both lower, middle, and high-level classes of locals had the right to access education. As a result, the development of education became more progressive after entering the nineteenth century (Bjork, 2005; Djojonegoro, 1997; Syaharuddin & Susanto, 2019). However, although the natives were allowed to attend school, the differences in behavior towards the native people were still prominent. The difference can be seen in entering school for the upper and lower classes. To enter certain schools, people from the lower classes are still complicated by burdensome rules. The rules were deliberately made so the local people only occupied low-level schools.

Since the 17th century, modern science was truly born, marked by scientific research that has used research instruments such as telescopes, microscopes, clocks, and barometers. During this period, science and science education were to be carried out in a structured manner. This is because the science learning activities are similar to those in Europe (Goss, 2009). Although whites and their descendants still dominate it, people's interest in science has also developed. Schools were equipped with laboratories for students to learn science. The Industrial Revolution greatly influenced the development of science at that time (Timmons, 1996). Students who continue their studies in Europe must study science as a requirement for continuing education in tertiary institutions.

After the Dutch colonial, the archipelago was ruled by the Japanese government. Under the Dutch, a social class separation system to access education was implemented. By the Japanese, this system was abolished (Djojonegoro, 1997). However, education aimed to provide a low-cost workforce and soldiers to help fight the war for the Japanese. Therefore, students are required to do physical and military training (Bjork, 2005). Education was even worse than education during the Dutch colonial period. For example, schools have decreased drastically (Djojonegoro, 1997). The concept of education carried out is to prepare for war and be loyal to the Japanese government. At that time, the use of the Dutch language was prohibited. Indonesian (Malay) is the official language of instruction used in offices and schools. Although Japanese became the second language, at this time, Indonesian (Malay) began to develop and be modernized to become a social language and scientific language (Syaharuddin & Susanto, 2019).

During the Japanese occupation, simplifying the education system provided wide-open learning opportunities for all locals to get equal education opportunities (Djojonegoro, 1997). However, under Japanese governments, schools were organized to support the needs of the occupying power, not to promote the intellect of the local people (Bjork, 2005). Nevertheless, simultaneously, the Japanese occupation helped the development of Islamic education.

Japanese colonial gave much tolerance for Islamic education in Indonesia. Many educational and Islamic teaching institutions were established at this time, and places of worship were built. Educational institutions could be developed, and children were allowed to study religion. Religious institutions focus on religious studies and moral education and are not an alternative to colonial teaching, thus isolating these institutions (Bjork, 2005). Science and learning science were not advancing in this period because school learning activities focused on producing personnel that contributed to fulfilling Japan's ambitions (Setiawan & Suwandi, 2022). During colonization, Japan had a science curriculum called the old curriculum containing kagaku (natural sciences), which was changed to rika (science) in the new curriculum in 1943 (Ramli, 2010). Science based on Islamic theology flourished in this period because Japan allowed Islamic religious education. When Indonesia gained independence from Japan in 1945, the education system was fragmented between colonial and Islamic education.

4. SCIENCE LEARNING POST TO INDEPENDENCE

The education system in Indonesia has changed upon independence. As a newly independent country, Indonesia gained the power to rebuild and form an education system that represents its values. Syaharuddin and Susanto (2019) grouped the implementation of the education system after the independence into several stages: (1) Independence Period Education (1945-1950), Old Order Period Education (1950-1966), New Order Period Education (1967-1998), and Post Reformation Period Education (1999-present).

4.1. Science learning during the Independence period (1945-1950)

Education during the Independence Period (1945-1950), the education system in Indonesia still adopted the colonial education system and was heavily influenced by the Dutch education system. However, this time, Indonesia's first government pushed every Indonesian child to access education without separating social status and minimized the obstacles to education. The government declared that education is the way to remove social barriers and eliminate the gap between rich and poor (Postlethwaite & Thomas, 1980). This period was a difficult time with an unstable political situation. The primary purpose of education in the early days of independence was to educate and improve the quality and ability of the nation, accompanied by a spirit of patriotism focused on filling the order of life and development (Syaharuddin & Susanto, 2019). Although only in a short time, the arrival of the Japanese for Indonesian education has a very significant meaning. Because it is through Japanese education, the education system is unified, and there is no longer any difference in education for foreigners and natives.

Religion must have a special place in the Indonesian education system, returning to the long history of religious education (Djojonegoro, 1997). The implication was that the government supports religious education, such as Islamic education in Madrasah and Pesantren, to co-exist in the Indonesia education system. 5 years after independence, the number of students attending schools more than doubled, with dramatic increases in attending primary schools (Djojonegoro, 1997). During this period, science learning again adapted to science learning in Western countries, but Indonesia already had the first education curriculum. Some Indonesian students who excelled then can even continue their education in many Western countries.

4.2. Science Learning during Old Order Period (1950-1966)

Education in the Old Order (1950-1966), a government based on socialism, became the essential reference for how education would be formed and run to provide the basis that education is the right of all community groups regardless of social class (Syaharuddin & Susanto, 2019). In 1951, thousands of people participated in teacher training, and existing teachers got re-training to prepare them to fit into the new education system (Djojonegoro, 1997). At this time, teacher training institutes and educators pushed to provide textbooks and printed materials to fulfill the heavy demand for teachers and educators with a background in

teacher education. Consequently, teacher training institutes focus on mastery of curricular content rather than instructional methodology (Bjork, 2005). In 1965, the Old Order regime set the national goal of Indonesian education to produce socialist citizens (Suratno, 2014). Nonetheless, this was a crucial initial period in the education system to form an identity as the Indonesian education system.

In terms of science, science learning in this period primarily focused on delivering science content. From 1947 to 1964, the government did not focus on science and mathematics. The government's focus was on civil and historical education (Setiawan & Suwandi, 2022). Only in the late 1960s did the government start to focus on science and mathematics. This time, the government had successfully achieved dramatic growth in education and schools, but the quality of education was still underrated and unsatisfactory (Syaharuddin & Susanto, 2019). This situation is also analogous to most of the other government sectors.

Nevertheless, at the same time, unemployment and inflation were at a critical rate. Most people thought that the government only delivered inspiring speeches rather than managing the government. Starting in 1965, people pushed the government under President Soekarno to leave power because Indonesia had been in political, economic, and social chaos (Bjork, 2005).

4.3. Science learning during the New Order period (1967-1998)

Education during the New Order era (1967-1998) was identical to the ideology or slogan of development during the New Order era (Syaharuddin & Susanto, 2019). Likewise, the direction and policies of education were adapted to the development movement. In addition, in this era, the emphasis on the ideology of Pancasila (the pillar of the Indonesian nation) was very dominant (Emmerson, 1999). Likewise, the direction and policies of education are adjusted to the development movement. The word development comes before Pancasila, which indicates that although development is not officially an ideology, it has become the basis for the New Order in directing the course of government and education other than Pancasila. The development became symbolic, and President Soeharto was recognized as "Bapak Pembangunan Indonesia" [The Father of Indonesian Development].

Using the development movement, the New Order Government established a distinctive national culture for all Indonesians. The formed culture is based on material and cultural uniformity (Guinness, 1989). Education plays a significant role in creating a national culture with a strong emphasis on Pancasila. Most government workers, soldiers, teachers, lecturers, doctors, lawyers, and college students were required to attend a training/seminar to internalize the values of Pancasila and become Pancasila loyalists (Emmerson, 1999). The consequences were that the government workers' participation in the political process constantly declined. Government workers were subjected to become government loyalists and were absent from any political organizations (Bjork, 2005). As government workers, teachers have the status of civil servants, become the projection of government policies, and cannot represent the community (Emmerson, 2021).

Strengthening the loyalty to Pancasila, in 1971, the government released President Decision No. 2 and established the Corps of Civil Servants of the Indonesian Republic (Korp Pegawai Negeri-Korpri). All civil servants from every level of government nationwide were required to become corps members. In addition, the teacher Union (Persatuan Guru Republik Indonesia-PGRI) was also required to join the corps because teachers have civil servant status. As a result, the government could monitor teachers' actions and not become a forum for teachers to improve the teaching profession (Emmerson, 2021). They led the civil servants as a distinguished group during the New Order government era. Although the salaries were considered lower in the private sector, civil servant status won as a secure job (McLeod, 2000). The profession of civil servant was a highly valued social identity and status, represented by many other benefits such as access to health care services (Budiman, Roan, & Callan, 2013).

The new order government had successfully defined the characteristics of Indonesia's education system (Bjork, 2005). Schools become the perfect medium for internalizing national ideology, history, and values as Indonesians. Every school's component recognized their identities as Indonesians and put respect to the central government. School teaches curricular content and the importance of prioritizing national identities and loyalties over religion, ethnicity, and social status (Watson & Kipp, 1995). The government had succeeded in internalizing national ideology and remarkably successfully expanded the numbers of schools, teachers, and students dramatically (Djojonegoro, 1997; Suratno, 2014). Every five years, the government has a development program known as Pembangunan Lima Tahun-Pelita (Five-Year Development). The Pelita program identified the strengths and weaknesses for improvement in the next five years (Syaharuddin & Susanto, 2019).

During this period, curriculum changes occurred on an ongoing basis, starting from the implementation of the 1968 Curriculum, 1975 Curriculum, 1984 Curriculum, and 1994 Curriculum. In addition to formal education, religion-based education experienced rapid development during the New Order era. Madrasah Ibtidaiyah, Tsanawiyah, Aaliyah (equal to primary and secondary education), Pesantren, and Religious universities multiply (Syaharuddin & Susanto, 2019). Religion education must be implemented at every level to strengthen Indonesian moral values as the representation of the first pillar of Pancasila, which is the belief in a supreme God. Institutionally, religious-based education was under the Ministry of Religion, in contrast

to general education, which was under the Ministry of Education.

Since the order was started, Indonesia has continued to develop until it reached the peak of development in the middle of the new order. As a result, there has been a significant jump in primary education, with the Presidential Instruction establishing many new primary schools nationwide (Safei & Hudaidah, 2020). Public and religious schools and universities experienced rapid developments during this period. In 1975, there was a significant change in the Indonesian curriculum. The teacher's position becomes more centralized. Each teacher must detail the goals to be achieved throughout the learning process. This curriculum makes the entire teaching and learning process systematic and gradual. The 1984 curriculum carries a process skill approach with the teaching model called Student Active Learning (SAL). Students become central in this curriculum, so learning activities such as observation and discussion are carried out with student activities. This effort has been accompanied by applying a final exam that aims to determine student graduation and choose their path for further education. However, schools have an authority level in determining student graduation. The 1994 curriculum resulted from efforts to integrate the previous curricula, especially the 1975 and 1984 curricula. The 1994 curriculum turned into a highly dense curriculum. Many student learning loads must be complete, and they have no choice but to accept or reject the large learning load (Setiawan & Suwandi, 2022).

In terms of science learning, science learning is specific to chemistry, physics, and biology, starting in high school and university. Then, at a lower level, science is taught as integrated (Setiawan & Suwandi, 2022). Indonesia's scientific achievements are growing, and is considered competitive with other countries in developing science and technology. Since the early 1970s, the progress of science and technology experienced an increase supported by the government due to economic development, agricultural expansion, and socio-cultural changes (Oktaviyanti et al., 2014). The New Order era was known for technological developments that were quite proud of, even well-known abroad, such as the satellite communication system and transportation (see Figure 2). Indonesia's leading scientists were born in this period. The success of this period was due to the existence of a common thread between the science and technology policies of the Old Order era and the New Order era, where science and technology policies have clear directions and objectives (Oktaviyanti et al., 2014).

Figure 2 Experts from Hughes who observed the launch of the Palapa satellite in Cibinong

The long power of the New Order government under President Soeharto had undoubtedly brought material and developmental benefits to Indonesian populations, but during the regime, systematic corruption also occurred (Budiman et al., 2013; McLeod, 2000). The situation was worsened by the Asian financial crisis, which struck Indonesia with a significant impact. As a result, inflation rose dangerously, leading people to force President Soeharto to leave power (Bjork, 2005). Many children leave the school to earn money for their financially strapped families. The enrollment ratios for schools and universities declined instantly (Syaharuddin & Susanto, 2019).

4.4. Science learning during post-reformation (1999-present)

Post-Reformation Education (1999-present). Education development in Indonesia during the Reformation period was strongly influenced by constitutional changes, which became one of the reform agendas (Syaharuddin & Susanto, 2019). The authoritarian centralization applied by the New Order in education will be challenged and opposed. The reform era has provided ample space for the formulation of new educational policies that are reformative and revolutionary (Bjork, 2005; Mukodi, 2016; Syaharuddin & Susanto, 2019). In the reform era, at least four education policies became the plan for improving the national education system: (1) improving the quality of education, (2) the efficiency of education management, (3) the relevance of education, and (4) equal distribution of education services (Mukodi, 2016).

Syaharuddin and Susanto (2019) summarized the change during the post-reformation period. President B. J. Habibie started to lead in 1999; he freed tuition fees for elementary to high school. Meanwhile, the rules that hinder students' creativity and freedom regarding the normalization of campus life are repealed. In addition, scientific institutions, such as university campuses, are freed from outside intervention and influence. Then, the government of President Abdurrahman Wahid (Gus Dur) issued a law on the balance of central and provincial finances (decentralization). With this law, education is in the regions' hands as policy executors at the local level. The government launched school Operational assistance funds based on the calculation of the cost of each student unit. Gus Dur's government was notorious for significantly increasing teachers' salaries. Megawati's government

drafted the National Education System Law, which later became the National Education System Law.

In the era of decentralization, the government created the 2004 curriculum, which was then submitted to independent institutions, the National Education Agency standard, to formulate core subjects' competencies and develop a school-based curriculum in 2006 (Suratno, 2014). This is an era in which teachers have the authority to make curricula based on learning experience and context. However, the administrative approach to the quality assurance of the school curriculum was criticized during implementation. As a result, many teachers are overwhelmed in developing syllabi, which prevents them from improving their teaching practices.

In the reformation era, the privatization of universities emerged. The privatization of universities means the gradual removal of education subsidies for five years starting from 1999. Since then, universities have been required to find funds independently to finance their education. In its development, this problem later became the basis for the commercialization of the world of education (Mukodi, 2016). It made the world of education more expensive to access by low-class economic citizens. The direct impact of this policy includes soaring costs. In addition, higher education at state universities is getting further away from the expectations of people experiencing poverty to receive quality higher education (Syaharuddin & Susanto, 2019).

In 2005, a significant event occurred in the Indonesian education system, namely the project of establishment of Rintisan Sekolah Bertaraf Internasional (RSBI) [International Standard Pilot Schools] and Sekolah Bertaraf Internasional (SBI) [International Standard Schools]. Discussions about the schools started in late 1999 and early 2000s (Dharmaningtias, 2013). The formation of RSBI refers to Law Number 20 of 2003 concerning the National Education System Article 50 Paragraph 3. One study found that this project had helped boost education outcomes in Indonesia. The government develops the schools with goals and expectations: (a) the school's graduates can continue their education at international standard education units, both at home and abroad; (b) the school's graduates can work at international institutions and other countries, and (c) the school's graduates international level medals in various science, mathematics, technology, arts, and sports competitions. After seven years of operation, this program began to generate resistance because it was considered to have discriminated against schools. The government is too focused on this program, ignoring schools not involved. In addition, this project has created exclusivity schools with expensive tuition fees, and only students from the upper middle class can enroll (Dharmaningtias, 2013). Finally, in 2013, this program was terminated through a constitutional court decision.

Regardless of the controversies, this program has had a positive impact in the form of lessons learned that need to be continued (Dharmaningtias, 2013). For example, the majority of RSBI graduate students score above average on the national exam and are widely accepted at the best state universities; schools improve governance management, discipline, and quality culture; teachers are more active in correcting, giving comments, returning students' work results, as well as the sister school program in collaboration with schools abroad. In science learning, RSBI positively impacts science learning activities because science learning becomes oriented towards an international curriculum using references to educational evaluation standards from OECD countries (Dharmaningtias, 2013). During the RSBI period, science learning activities were often carried out in experiments in the laboratory by doing research-based projects, and students' assignments were given feedback and returned as material for improvement.

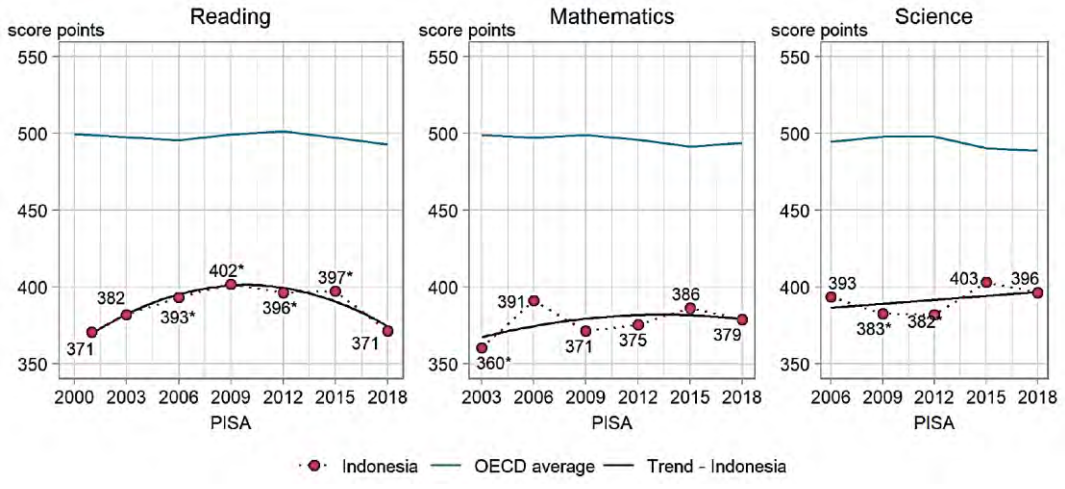

Figure 3 Indonesia trends in performance in reading, mathematics, and science
Source: Programme for International Student Assessment (PISA) – OECD
https://www.oecd.org › pisa › PISA2018_CN_IDN.pdf

Even though it requires a more in-depth study, looking at Figure 3. During the implementation of the RSBI, there was a slight increase in the achievements of Indonesian students in the PISA survey. Performance in science has fluctuated but has remained flat overall, while performance in reading and math has been hump-shaped in the RSBI period, namely 2005-2013. Nevertheless, after that period, reading achievement in 2018 returned to 2001 after peaking in 2009, while math achievement fluctuated more in the early years of PISA but has remained relatively stable since 2009.

During the post-reformation period, there were several curriculum changes: the Competency-Based Curriculum in 2004, the Education Unit Level Curriculum in 2006, the 2013 Curriculum, and the revised 2013 Curriculum, which are still valid today. The 2013 curriculum emphasizes mastering core competencies by implementing a project and scientific-based approach. In addition, the government provides syllabi, student textbooks, and teacher handbooks. In addition to rapid changes in curriculum, there is a controversy about national examinations. The government conducts a national exam to map the quality of education by setting minimum standards for passing one subject. However, it has the most significant role in determining student graduation. This is the point criticized by the alliance of parents, teachers, and students (Suratno, 2014).

The change in the National Education curriculum has been proven in the long history of the Indonesian education system. Since 1947, Indonesia has made at least ten changes. This change aims to improve the quality of each generation's education (Adha, Gordisona, Ulfatin, & Supriyanto, 2019). From time to time, Indonesia has continued to experience improvements in the quality of education by transforming its curriculum. However, the results of the achievements of Indonesian students in recent decades internationally still show stagnation, as shown in Figure 3. (Adha et al., 2019; Mukodi, 2016).

Furthermore, changes to the education curriculum are considered unsuccessful because the policy dynamics are unstable when there is a regime change (Istanti, 2019). Policy change is often said to be only a hegemony to maintain power. This stagnation is also accompanied by stagnation in the development of science and technology produced by Indonesia compared to other countries. The pattern of science and technology policies in the post-reformation era tended to lose direction and the policies did not place science and technology as a top priority like during the old and new orders (Oktaviyanti et al., 2014).

5. THE CURRENT SCIENCE LEARNING

Learning science today is known as science learning in the 21st century. The 21st century was marked by the rapid development of science and technology, especially information and communication technology (Lavi, Tal, & Dori, 2021). As a result, the characteristics of 21st-century learning demand a variety of main competencies that students need to have, including learning and innovation skills, mastery of media and information, and life and career skills. The complexity of the competencies that students must have in 21st-century learning demands a change in the learning paradigm, namely from the teaching paradigm to the learning paradigm (Fendler & Gläser-Zikuda, 2013). In addition, learning science integrates the latest technology, such as computer programming, virtual reality, and artificial intelligence.

In the Indonesian context, learning science has now reached that level. This happens because the transfer of information via internet technology has occurred very quickly and is massive. So, learning science in one country is quickly recognized by other countries. Learning science at schools that use the latest technology can easily be found in big cities in Indonesia, especially in schools that apply and are affiliated with an international curriculum. However, the gaps, inequality, and disparities in Indonesia's education quality are extensive (Pramana et al., 2021; Suratno, 2014). Technology has advanced so much in big cities that none of the newest technologies have been overlooked. However, in other remote areas far from cities, technology is still expensive, and even in extreme cases, many schools have not received adequate electricity supply. This impacts the quality of learning so that good results cannot be obtained. The Covid-19 pandemic has further clarified this inequality. While schools in cities compete to use the latest technology and applications for online classes, schools in remote areas are not even doing lessons because of limited access to technology.

Learning activities are closely related to learning outcomes (Darling-Hammond, 2000; Gerritsen, Plug, & Webbink, 2017; Gershenson, 2016; Harris & Sass, 2011; Rockoff, 2004). In the context of science learning in Indonesia, the lessons have not provided opportunities for students to develop critical reasoning abilities. Science learning is still characterized by the transfer of science as a product (facts, laws, and theories) that must be memorized so that aspects of science as a process and attitude are wholly neglected (Tytler & Osborne, 2012). As a result, learning is less related to real-life contexts, rarely departs from actual problems, and science learning actions tend only to master the science content.

Most areas in Indonesia indicated that science learning tends to be a conventional activity. Therefore, the quality of Indonesian science learning and science teachers needs to be improved. As an indication, the teacher test results in 2015 showed that only 10 out of 34 provinces could pass the threshold value set by the government (Maulipaksi, 2016). In Indonesia, one of the main factors is that teaching is not the primary choice and is considered a profession for students who do not excel at school. In addition, when working as a teacher, access to professional development is

still limited, and salary is low (Pramana et al., 2021; Suratno, 2014). The link between salary is an old issue that has been proven in research to have a relationship with teacher performance (Akiba, Chiu, Shimizu, & Liang, 2012; Ding & Sherman, 2006; Turner, Camilli, Kroc, & Hoover, 1986).

Summing up, Indonesia's education problems are complex (Suratno, 2014), including the factors influencing student learning outcomes. To overcome this problem, great courage is needed to make politically strong policies, including teacher reform, especially teacher status. It is time to upgrade the level of teachers to become a prestigious profession. There is a solid relationship between student achievement and teacher quality (Darling-Hammond, 2000; Gerritsen et al., 2017; Gershenson, 2016; Harris & Sass, 2011; Rockoff, 2004). Because of this very close relationship, it is time to produce effective and quality teachers (Darling-Hammond, Newton, & Wei, 2010; White, 2014). Therefore, teacher education policies must focus on improving teacher quality (Darling-Hammond & Lieberman, 2013; Gutierrez, Fox, Alexander, Colette, & Alexander, 2019). Thus, teacher education institutions must also be considered a contributing group because these institutions produce teachers today.

Multiple parties have made various efforts to improve the quality of education in Indonesia, including the ongoing revision of the 2013 curriculum (Hamidah, Junaedi, Mulyono, & Kusuma, 2021). The government has worked with universities to improve teacher quality through programs such as the Teacher Profession Program (TPP), technical guidance, and certification (Hoesny & Darmayanti, 2021). The government also involves the private sector, such as Program Organisasi Penggerak [Initiation Organization Program] (Ministry of Education, Culture, Research, and Technology, 2020). In this program, some funds were given to private parties to conduct teacher and school principal training. The government's programs focus on curriculum, teacher training, and professional development (Hoesny & Darmayanti, 2021). The government recently implemented the Merdeka Curriculum [The Independent Curriculum] to apply from the 2022-2023 Academic Year. However, because it is still new, further studies and time are needed to see how this curriculum performs.

6. LESSONS LEARNED FROM THE HISTORY

The rise and fall of Indonesian education from before independence until now has provided many lessons for taking steps and policies to improve the quality of Indonesian education. Equality of fate drove independence, post-independence succeeded in forming a national identity, rapid organized development during the new order era made Indonesia a respected nation, and the reform movement overthrew absolute power. All of that is enough lessons to change for the better. In the context of education, lessons learned that education gave birth to fighters-thinkers, leading to independence; the massive content of subject matter after independence about the nation gave the Indonesian government a national identity; the 1984 curriculum employing active student learning gave birth to progress in the field of science and technology; and during the post-reformation period, the RSBI program showed that with focused policies, Indonesia could produce quality teaching and international standard schools.

Apart from the controversy, the last is the RSBI policy, which has been implemented for about seven years. It has been proven that the current Indonesian education system can produce several quality schools (Dharmaningtias, 2013). Undeniably, Indonesian schools can become high-quality and even be pushed further by being given special treatment by the government policy. The RSBI learning standards that adapt learning in OECD countries have created quality learning activities in RSBI schools. In addition, the high teaching standards, such as having a master's degree, speaking English, and mastering technology at RSBI schools, encourage improving the quality of Indonesian education human resources. However, creating international-class education does not have to be equated with the school system in developed countries that are ready regarding human resources, facilities, and community culture (Dharmaningtias, 2013). However, with this example, an essential lesson was learned: The existing Indonesian education system could produce quality schools in terms of resources if pushed seriously. So, all that remains is for this policy to be implemented better in all schools in Indonesia.

Concerning learning science, given the vast disparities and inequality in the quality of education in Indonesia. So, learning science in schools must be able to narrow this gap, especially for schools in the outermost regions of Indonesia. This gap can be reduced for remote schools by learning science by utilizing local materials and returning to the roots of science. Using local materials in science learning in developing countries is recommended (Quive et al., 2021). Technology does help the development of science, but for the context of science in schools, there is no need to depend too much on technological advances because the roots of developing science are ignorance and curiosity. Science can be taught as a body of knowledge (the things that have already been discovered) and the process of acquiring new knowledge (through observation, testing, hypothesizing, and experimentation). Therefore, teacher education institutions, such as universities in the context of science teacher education, not only provide courses and training with the latest learning advancements but also provide courses and training for science teachers in maximizing the potential of local materials; this is because many regions of Indonesia are remote and do not have good access to technology.

Indonesia's local material potential is extraordinary, considering Indonesia's geographical bonus. The use of local materials need not be deemed to be left behind because what is fascinating about science is that it is never finished. Every discovery leads to more questions, new mysteries, and something else that needs explanation. Therefore, the scientific approach can make students understand themselves and their world and recognize how nature works using their local materials because there will always be questions to be answered. It is time for all parties to work hand in hand. Looking at history, the government is still the primary component that can drive change through political power by making policies clear and systematically implemented. Other parties, especially teacher education institutions, must continue to develop research and science learning innovations that utilize local materials and potential. The grassroots movement can also contribute to improving the quality of science learning in Indonesia because the grassroots movement can provide alternative solutions that complement the ruling power's policies.

Indonesia's geographic diversity and abundant natural resources provide a strong foundation for scientific achievements. The country's rich biodiversity, natural resources, marine ecosystems, and agricultural diversity offer opportunities for research in various fields, including biology, geology, renewable energy, and environmental science. Collaborations between academia, government, and industry are essential to harness Indonesia's scientific potential and address global challenges while promoting sustainable development. Meanwhile, a grassroots movement for science success in Indonesia involves engaging local communities to promote and support scientific education, research, and innovation. It includes initiatives such as science communities, science projects, advocacy for science funding, effective science communication, and promoting STEM education. The movement aims to inspire interest in science, address local challenges, and nurture a culture of curiosity and critical thinking. Additionally, it encourages collaboration, resource access, and environmental conservation efforts at the local level.

Regarding the latest PISA results in Indonesia, the results are influenced by the country's historical context, including its colonial legacy, post-independence challenges, language policies, socioeconomic factors, educational reforms, cultural influences, and infrastructure development. While history has shaped the educational landscape, contemporary factors such as policies, curriculum, teacher quality, and socioeconomic disparities also contribute to PISA scores. Analyzing PISA results in the context of Indonesia's history provides insights into the country's educational challenges and opportunities for improvement.

7. CONCLUSION

A long history has colored learning science in Indonesia, accompanied by challenges and problems. The Western science learning system is the identity of learning science in Indonesia today. This happened because of the long history of Western colonization in Indonesia. Moreover, the West is still the mecca of world trends in many ways today. The current situation of learning science needs special attention because the results of an international assessment show that science students' achievements are still below that of other countries, especially in the Southeast Asia region. Multiple parties have done various ways but are still far from achieving the goal. All parties must work together to make a comprehensive plan and implement it consistently, especially in maximizing the potential of local materials. Hopefully, these historical perspectives can be used as information to improve the quality of science learning in the future.

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