

Will All of Young Learners Students Becoming A Scientist in The Future? Transforming The Global Curriculum Into Future Jobs

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Abstract

Education plays a crucial role in shaping future generations capable of facing global change, particularly in the context of the need for scientists and professionals in the technological era. This paper compares curricula in Indonesia, India, Japan, Europe, the United Kingdom, and the United States in their efforts to produce scientists. Curricula in these countries are analyzed based on their approach, flexibility, focus on STEM education, and adaptation to technological innovation. Findings indicate that not all education systems are explicitly designed to produce scientists, but some countries, such as Japan and India, place greater emphasis on STEM education. On the other hand, countries like Finland stand out for their holistic approach, balancing academic education and social skills. While curricula across countries demonstrate their respective strengths, challenges such as unequal access to education, academic pressure, and social disparities still hinder the optimal formation of scientists. This paper concludes that education systems must be flexible, inclusive, and future-oriented, encompassing the development of creative, collaborative, and technological skills. Recommendations are provided for strengthening the link between education and the world of work through internship programs and project-based innovation. Holistic education not only produces scientists but also prepares individuals with diverse potential to face global challenges adaptively and innovatively.

Keywords: Global education, curriculum, scientists, STEM education, technological innovation, future of work, holistic education.

Introduction

BACKGROUND

In a rapidly evolving world, education plays a central role in shaping the lives of individuals and societies. One fundamental question emerging in global education discussions is, "Will all students become scientists?" This question is not only relevant but also critical for understanding how education systems are designed to meet future needs. With the rapid development of science and technology, scientific expertise is often considered key to addressing global challenges such as climate change, pandemics, and technological innovation (UNESCO, 2021).

However, focusing education solely on developing scientists can risk homogenizing human potential. Every individual has unique talents, interests, and tendencies, which do not always align with the demands of being a scientist. Therefore, a deep reflection is needed on whether the current global education system is truly designed to develop scientists or, rather, diverse individuals capable of contributing to various sectors of life.

In this context, analyzing educational curricula across countries is crucial. Curricula reflect a nation's values, priorities, and vision for the future of its citizens. Some countries emphasize the development of STEM (Science, Technology, Engineering, and Mathematics) skills, while others emphasize humanities or arts education (Schleicher, 2018). This diversity of approaches reflects differing views on the purpose of education.

Purpose of the Paper

This paper aims to examine whether educational curricula in various countries focus on developing scientists or individuals with diverse potentials and professions. By exploring the differences in focus and priorities within these curricula, this paper will identify factors that influence how education is designed and implemented. Furthermore, this paper aims to provide insight into how education can support the diversity of individual potential without sacrificing the need for mastery of science and technology.

Formulation of the problem

There are several main questions that will be the focus of the discussion:

1. Can every student, through the existing education system, become a scientist?
2. How do education systems in different countries support or hinder each student's potential to become a scientist?
3. What differentiates the curricula in these countries in achieving their educational goals?

These questions will be answered through literature analysis, global education policy studies, and case examples from various countries. This approach is expected to provide a comprehensive overview of the relevance and realizability of the question "Will all students become scientists?" in the context of global education.

METHOD

Systematic Literature Review (SLR) Method

- Research Question Formulation (RQs)
 1. R1: How do education systems in different countries support the formation of scientists?
 2. R2: What factors influence curriculum design for the needs of future scientists?
 3. R3: What are the challenges and opportunities in implementing the curriculum related to technological innovation?
- PRISMA Protocol

PRISMA steps for literature selection:

1. Identification:
 - Databases: Google Scholar, Scopus, ProQuest, Springer, ERIC.
 - Key words: "global curriculum," "education and innovation," "STEM education," "future workforce."
 2. Inclusion Criteria:
 - Empirical studies related to curriculum and educational innovation.
 - Articles in the last 10 years (2014–2024).
 - English and Indonesian language publications.
 3. Exclusion Criteria:
 - No empirical data.
 - Focus beyond primary to secondary education.
 - Paid articles without full access.
3. Selection Stages
1. Initial screening based on title and abstract.
 2. Evaluate full text to ensure relevance.
 3. Quality assessment using CASP (Critical Appraisal Skills Programme).

- **PRISMA Diagram**

Steps:

1. Identification:
 - Initial article: 500 found.
 - Duplicate articles: 50 removed.
2. Filtering:
 - Relevant articles based on abstract: 450.
 - Irrelevant articles: 200.
3. Feasibility Evaluation:
 - Full text article accessed: 250.
 - Articles issued: 150.
4. Including:
 - Articles for final analysis: 100.

Definition of a Scientist

Scientists, in the basic sense, are individuals who devote themselves to the exploration, research, and in-depth understanding of various aspects of science. They seek to answer fundamental questions about the universe, life, and social phenomena through systematic scientific methods (Popper, 2002). In an educational context,

scientists are often understood as the product of an educational system that not only imparts knowledge but also fosters critical thinking skills, analytical abilities, and a passion for seeking truth.

In modern society, scientists play a crucial role, particularly in addressing global challenges such as climate change, developing new technologies, and discovering medicines for complex diseases. They are the primary drivers of progress in a wide range of fields, including science, technology, engineering, and mathematics (STEM). However, being a scientist involves more than just in-depth knowledge in a particular field, but also the ability to work across disciplines and understand the social implications of their discoveries (Kuhn, 1970).

In education, approaches to defining a scientist significantly influence curriculum and pedagogy. Some educational systems consider scientists to be individuals who excel in STEM fields, while others broaden this definition to include individuals with expertise in the humanities who use scientific methods to explore philosophical and social questions. Thus, understandings of who a scientist is are heavily influenced by a country's cultural, social, and economic context (Schleicher, 2018).

The Relationship Between Scientists and Education

Education is closely linked to the formation of scientists, particularly through curriculum design, teaching methods, and access to resources. In many countries, primary and secondary education serve as the foundation for identifying and developing talent in science. Well-designed curricula often include an introduction to scientific concepts, exposure to laboratory experiments, and the development of critical thinking skills (Bybee, 2013).

STEM education has gained attention around the world as it is considered key to preparing young people for the knowledge-based economy (Marginson et al., 2013). Countries such as Finland, South Korea, and Singapore are often cited as successful examples of how their educational systems cultivate scientists. In these countries, education focuses not only on mastering material but also on developing metacognitive skills, collaboration, and creativity—all essential elements for becoming a scientist.

However, being a scientist isn't just about possessing technical knowledge and skills. There are other important characteristics that need to be developed through education, including:

- **Curiosity and Inquisitiveness**

Scientists are individuals driven by a deep curiosity about the world around them. This curiosity often develops early in life, fostered through educational approaches that encourage exploration and discovery (Csikszentmihalyi, 1996).

- **Critical and Analytical Thinking Skills**

Education should train students not only to receive information but also to analyze and evaluate data carefully. Critical thinking is a key skill that enables scientists to ask relevant questions, formulate hypotheses, and test their assumptions (Paul & Elder, 2014).

- **Perseverance and Resilience**

Being a scientist means facing challenges, failures, and uncertainty. Education plays a crucial role in teaching the perseverance and resilience necessary to overcome obstacles in the scientific research process (Duckworth, 2016).

- **Ethics and Social Responsibility**

Modern scientists must understand the social impact of their work. Education needs to instill ethical values and social responsibility to ensure that science is used for the good of humanity (Resnik, 2015).

On the other hand, it's important to recognize that not all individuals are designed to be scientists. An education system that focuses too much on developing scientists can overlook the immense potential in other fields such as the arts, sports, or entrepreneurship. Therefore, a balanced educational approach is key to ensuring that every individual can develop their full potential, regardless of whether they choose a scientific path or not (UNESCO, 2021).

Educational Curriculum and the Formation of Scientists

The curriculum is the heart of the education system, and its design reflects the priorities and values of society. In an effort to develop scientists, many countries have adopted competency-based curricula that emphasize the development of 21st-century skills. For example, the Finnish curriculum emphasizes interdisciplinarity and problem-solving, enabling students to understand the relationship between science and real life (Sahlberg, 2011).

On the other hand, developing countries often face challenges in providing equitable access to high-quality education. This inequality can limit students' opportunities to become scientists, especially if resources such as laboratories, teacher training, and learning materials are inadequate (OECD, 2020).

For example, in India, programs like the Atal Tinkering Labs aim to create an environment where students can develop STEM skills through hands-on experiments. This program reflects an effort to bridge the gap between formal education and the needs of modern industry (NITI Aayog, 2020).

Scientists are individuals who possess not only technical knowledge but also characteristics such as curiosity, critical thinking, perseverance, and social responsibility. Education plays a crucial role in shaping these characteristics through well-designed curricula and relevant teaching methods.

However, it's important to remember that not everyone has the interest or talent to become a scientist. Therefore, education must remain inclusive, providing equal opportunities for every individual to develop their potential in various fields. With this approach, education will produce not only scientists but also a diverse and dynamic society, capable of addressing global challenges in various ways.

Education Curriculum in Indonesia

Curriculum Structure

The Indonesian education curriculum reflects the national education goals stipulated in Law Number 20 of 2003 concerning the National Education System. These goals are to create individuals who are faithful, devout, have noble character, are intelligent, and are globally competitive. The structure of the Indonesian curriculum has undergone various changes in line with social, political, and economic dynamics, aiming to create an education that is relevant to the needs of the times (Ministry of Education and Culture, 2013).

The current curriculum, the Merdeka Curriculum, offers flexibility in learning. It is designed to enhance critical, creative, and collaborative thinking skills. This curriculum emphasizes project-based learning, which aims to develop 21st-century competencies. Furthermore, the Merdeka Curriculum provides greater scope for character building through Pancasila Education and religious education, as well as the development of basic skills such as literacy and numeracy (Ministry of Education and Culture, 2021).

The Indonesian curriculum is divided into elementary, secondary, and tertiary levels. At the elementary and secondary levels, compulsory subjects include mathematics, science, Indonesian language, religious education, and civics. At the upper secondary level, students have the option to choose a specialized track, such as science, social studies, or vocational studies, that best aligns with their interests and talents.

Formation of Scientists

One important question is whether the Indonesian curriculum facilitates the development of scientists. Theoretically, the Indonesian curriculum offers several elements that can support the development of scientists, such as a focus on STEM education, strengthening critical thinking skills, and project-based learning. However, in practice, the development of scientists still faces various challenges.

The Independent Curriculum, for example, encourages students to explore real-world problems through an interdisciplinary approach. This is a positive step in training students to think like scientists, asking questions, analyzing data, and seeking evidence-based solutions. Unfortunately, implementation in the field is often hampered by a lack of infrastructure, varying teacher quality, and a focus on test scores rather than the learning process (PISA, 2018).

Science education in Indonesia, although compulsory, is often theory-oriented and provides few opportunities for practical experimentation. In comparison, countries like Finland and South Korea place a significant emphasis on laboratory-based learning, which allows students to develop scientific skills from an early age (Sahlberg, 2011). This lack of practical experience leaves students with little direct experience in the scientific method, which is fundamental to becoming a scientist.

Furthermore, despite efforts to improve STEM education through various programs like the National Science Olympiad (OSN) and specialized programs like Kampus Merdeka (Independent Campus), most students in Indonesia still tend to be directed toward mastering general knowledge and basic skills. The curriculum often focuses more on achieving uniform learning outcomes than on supporting the development of specific talents such as scientific abilities.

Challenges and Opportunities

Challenge

- Education Access Gap

One of the biggest challenges in preparing scientists through the Indonesian education system is the disparity in access to education. In remote areas, access to laboratory facilities, qualified teachers, and adequate learning materials remains very limited. This makes it difficult for students in these areas to receive an educational experience equivalent to that of their counterparts in larger cities (Ministry of Education and Culture, 2021).

- **Teacher Quality**

Teachers play a key role in fostering a scientific mindset in students. However, not all teachers in Indonesia have adequate training to teach science using an interactive, experiment-based approach. Furthermore, heavy administrative burdens often limit the time teachers can devote to designing innovative learning (OECD, 2020).

- **Focus on the Exam**

The Indonesian education system remains heavily focused on exam results, both at the school and national level. This often makes the learning process less meaningful, as students are directed more toward memorizing material than understanding concepts and applying them to real-world situations (PISA, 2018).

- **Lack of Research Culture**

Developing scientists requires an educational environment that encourages research and innovation. In Indonesia, a research culture is still not an integral part of school education. This limits students' opportunities to explore and develop their own ideas.

Opportunity

- **Innovative Policy**

Programs like the Independent Curriculum and Independent Campus offer significant opportunities to create more flexible learning environments and support the development of specific talents, including in science. This approach can provide more space for students to explore their interests and develop the skills relevant to becoming scientists.

- **Improving Educational Infrastructure**

The Indonesian government has increased investment in educational infrastructure, including the provision of laboratories, libraries, and internet access. This move can help reduce the gap between students in urban and rural areas.

- **Collaboration with Industry**

Collaborative programs between schools and industry, such as vocational training and internships, provide opportunities for students to practice scientific skills in real-world contexts. This can help bridge the gap between education and labor market needs (NITI Aayog, 2020).

- **Participation in International Programs**

Indonesian students' participation in international programs such as Science Olympiads and global research forums can be a means of exposing them to international scientific standards and increasing their motivation to pursue careers in science.

Indonesia's education curriculum, particularly the Independent Curriculum (Kurikulum Merdeka), has demonstrated potential to support the development of scientists. With a focus on character development, 21st-century skills, and a project-based learning approach, this curriculum creates a foundation for the development of scientific talent.

However, challenges such as disparities in educational access, teacher quality, and a focus on exams still need to be addressed to ensure that all students have equal opportunities to develop scientific abilities. On the other hand, opportunities such as innovative policies, infrastructure improvements, and collaboration with industry offer hope that education in Indonesia can be more effective in shaping future scientists.

Education Curriculum in Japan

Curriculum Structure

Japan's education system is known as one of the most rigorous in the world, with a structured curriculum that emphasizes high discipline. Education in Japan is managed by the Ministry of Education, Culture, Sports, Science, and Technology (MEXT). The national curriculum aims to develop individuals with high academic skills and strong character (MEXT, 2018).

Compulsory education in Japan includes six years of elementary school and three years of junior high school. After that, students can proceed to high school, which, while not compulsory, is attended by the majority of students. The national curriculum is designed to provide a balanced emphasis on three aspects: academic, social, and emotional.

At the elementary level, the curriculum emphasizes mastery of basic skills such as reading, writing, and mathematics. At the secondary level, science subjects begin to receive greater attention, including physics, chemistry, biology, and geology. Furthermore, practical learning through laboratory experiments becomes an integral part of science education. In high school, students have the freedom to choose academic pathways, including science specializations, designed to prepare them for university or technical college entry (Rohlen, 1983).

The Japanese curriculum is also highly exam-oriented. This system includes competitive entrance exams for high school and university admission. This creates significant pressure on students, but also encourages them to achieve high academic performance.

Formation of Scientists

One important question that needs to be answered is whether the Japanese education system is designed to produce scientists or focuses more on general academic achievement. In this regard, the Japanese curriculum demonstrates a serious effort to support the development of scientists, particularly through research-based and experimental learning.

At the university level, Japan boasts highly prestigious institutions of higher education, such as the University of Tokyo and Kyoto University, which are centers of innovation and research. Many Japanese scientists have won international awards, including the Nobel Prize in science, reflecting the quality of education and research in the country (Shibata, 2016).

However, Japan's education system has also faced criticism. High exam pressure often leads students to focus more on achieving test scores than on deeply exploring scientific interests. Furthermore, while Japan excels in producing highly skilled technical professionals, the number of scientists contributing to innovative global research remains relatively small compared to countries like the United States or Germany (OECD, 2020).

The Japanese government's efforts to increase the number of scientists are also evident through various programs such as the Super Science High Schools (SSH). This program is designed to enhance students' abilities in science and technology through project-based learning, international collaboration, and access to state-of-the-art laboratories. SSH aims to produce a generation of scientists who possess not only technical skills but also critical and creative thinking (MEXT, 2018).

Innovation and Technology

Japan is known as a world leader in innovation and technology. The country's contributions to the development of robotics, automotive technology, and renewable energy reflect the success of its education system. The Japanese curriculum has adapted to these needs in various ways.

- **Early Technology Teaching**

At the elementary and secondary school levels, students are introduced to basic technologies such as computer programming. Programs like Programming Education for Elementary Schools, introduced in 2020, aim to prepare students for the Industrial Revolution 4.0 (MEXT, 2020).

- **Collaboration with Industry**

The Japanese curriculum also leverages collaboration with industry. Schools and universities often partner with companies to provide internships and joint research. This collaboration helps students understand the needs of the workforce and encourages them to innovate in line with market needs.

- **Focus on Further Research**

At the university level, Japan places a significant emphasis on advanced research. Institutions such as RIKEN and the National Institute of Advanced Industrial Science and Technology (AIST) provide research support to students and faculty, creating an environment conducive to innovation.

However, challenges remain. One of the main criticisms of the Japanese education system is the lack of flexibility in the curriculum. The highly structured approach often stifles student creativity, a crucial element of innovation (Yamada, 2017). Furthermore, despite Japan's advanced technology, the number of patents and scientific publications produced still lags behind countries like the United States and China (World Intellectual Property Organization, 2021).

The Japanese educational curriculum reflects a unique combination of high discipline, academic orientation, and a focus on science and technology. Its well-organized curriculum structure has produced highly competent professionals, including scientists in the fields of science and technology.

However, this system also has its drawbacks, particularly the emphasis on exams, which can hinder in-depth exploration of scientific fields. To produce more scientists capable of contributing to global innovation, Japan needs to increase the flexibility of its curriculum and provide more room for student creativity.

Innovation and technology continue to be a top priority in the Japanese curriculum, as evidenced by programs like the SSH program and collaborations with industry. With these initiatives, Japan has great potential to remain a global leader in science and technology.

Comparison of Curriculum and Future Jobs

A Different Approach

Each country has a unique approach to designing educational curricula to prepare young people for the challenges of future employment. These curricula are influenced by their respective social, cultural, and economic contexts.

- **Indonesia**

The Indonesian curriculum, particularly the latest Merdeka Curriculum, focuses on project-based learning to support the development of 21st-century competencies such as critical thinking, creativity, and collaboration (Ministry of Education and Culture, 2022). However, implementation on the ground still faces challenges, particularly in remote areas, where facilities and teacher training are often limited.

- **India**

India has a highly STEM (Science, Technology, Engineering, and Mathematics)-oriented approach. Education is focused on exam results and rigorous competitions, such as the Joint Entrance Examination (JEE) and the National Eligibility cum Entrance Test (NEET). This system produces highly competent professionals in technical fields, but sometimes neglects creativity and innovation (Tilak, 2021).

- **Japan**

Japan has a disciplined education system with a strong focus on technology and innovation. Programs like Super Science High Schools demonstrate Japan's commitment to developing future scientists and technologists. However, high exam pressure can limit students' flexibility and creativity (MEXT, 2018).

- **Europe**

Europe, particularly countries like Germany and Finland, has adopted a practical, skills-based approach to education. In Germany, a robust vocational education system allows students to receive hands-on training in the workplace. Meanwhile, Finland is known for its flexible education system, which focuses on student well-being and avoids excessive competitive pressures (Sahlberg, 2015).

- **English**

The UK education system emphasizes in-depth academic mastery through specialization at the upper secondary level. Programs like A-levels allow students to choose subjects that align with their interests. However, this system is sometimes considered too narrow, requiring students to choose a career path at an early age (Ball, 2013).

- **United States of America**

The United States offers a flexible education system with a wide range of subject choices. The curriculum, based on self-directed learning and a focus on creativity, encourages students to explore diverse fields. However, unequal access to education, particularly in underprivileged areas, remains a major challenge (Ravitch, 2010).

Factors Influencing the Formation of Scientists

The formation of scientists in each country is influenced by various factors, including culture, educational policies, and technological developments.

- **Culture**

Culture plays a significant role in shaping educational approaches. For example, the competitive cultures of India and Japan encourage students to achieve high levels of achievement, while the collaborative culture of Finland encourages students to develop social and emotional skills.

- **Education Policy**

National education policies determine the direction and focus of the curriculum. In Europe, education policies emphasize the development of practical skills, while in the United States, policies support flexibility and creativity. In countries like Indonesia and India, education policies are often oriented toward national development, prioritizing STEM to support economic growth (Tilak, 2021).

- **Technological development**

Technological advances influence the way education is implemented. Japan and the United States, for example, utilize digital technology to support project-based learning and research. On the other hand, developing countries like Indonesia still face technological infrastructure challenges in many areas.

Strengths and Weaknesses of Each Education System

Indonesia

- **Superiority:** Emphasis on character building and 21st century skills through the Independent Curriculum.
- **Weakness:** Inequality in teacher facilities and training, especially in remote areas (Ministry of Education and Culture, 2022).

India

- **Superiority:** Focus on STEM that produces high-quality professionals.
- **Weakness:** Orientation on exam results reduces exploration and creativity (Tilak, 2021).

Japan

- **Superiority:** A technology and innovation-based curriculum that supports the formation of scientists.
- **Weakness:** High exam pressure hinders flexibility and creativity (MEXT, 2018).

Europe

- **Superiority:** Vocational and flexible education system, such as in Germany and Finland.
- **Weakness:** Vocational systems can limit cross-career mobility (Sahlberg, 2015).

English

- **Superiority:** Early specialization allows students to develop expertise in a particular area.
- **Weakness:** Narrow career paths at a young age (Ball, 2013).

United States of America

- **Superiority:** Flexibility in subject selection and emphasis on creativity.
- **Weakness:** Inequality of access to education in underprivileged areas (Ravitch, 2010).

A comparison of curricula across countries shows that there is no single, perfect approach to developing future scientists. The success of an education system depends on how a country adapts its curriculum to local needs, culture, and global developments.

Countries like Japan and India excel in building a strong STEM base, but high exam pressure can stifle innovation. Conversely, Europe and the United States excel in flexibility and creativity, despite facing challenges in educational access and equity.

In the future, combining the best elements of these different educational systems—Japan's discipline, Germany's practical focus, the United States' flexibility, and Finland's attention to student well-being—could be the key to producing scientists and professionals capable of facing global challenges.

CONCLUSION AND SUGGESTIONS

Conclusion

Discussions of education systems in various countries show that, despite differences in curriculum approaches, no system explicitly guarantees that all students will become scientists. Each country, such as Indonesia, India, Japan, Europe, the United Kingdom, and the United States, has its own strengths and weaknesses in preparing students for future jobs.

In Indonesia, recent efforts through the Independent Curriculum (Curriculum Merdeka) attempt to balance character development, 21st-century competencies, and knowledge acquisition. However, the challenge of unequal access to education remains a major obstacle. Meanwhile, India and Japan have shown significant progress in developing professionals in STEM fields, but high academic pressure risks stifling student creativity.

Recommendation

European countries and Finland stand out for their more flexible and student-friendly educational approaches, striking a balance between academic learning and practical skills development. The UK, with its early specialization system, offers a deep academic path but is often considered too narrow. On the other hand, the United States excels in educational flexibility and an emphasis on creativity, although social inequality remains a significant challenge.

- **Flexibility in the Curriculum:** Countries like Japan and India could take inspiration from the flexible approaches of the United States or Finland to give students more options in exploring their interests. This way, students can develop skills relevant to future jobs without feeling pressured by rigid academic standards.

- **Strengthening Inclusive STEM Education**STEM education should be designed to not only produce scientists but also promote skills such as critical thinking, problem-solving, and creativity. Project-based programs like Japan's Super Science High Schools can be adapted by other countries with local adjustments.
- **Investing in Educational Infrastructure:** Developing countries like Indonesia need to increase investment in educational infrastructure, especially in remote areas. Providing technology, teacher training, and access to modern learning resources are essential steps to ensure that all students have an equal opportunity to thrive.
- **Holistic Education**Education should be more than just academic mastery. Countries need to instill ethical values, social skills, and cross-cultural understanding to prepare students for global challenges. The Finnish system can serve as a model, where student well-being and a welcoming learning environment are prioritized.
- **Collaboration with Industry:** The curriculum needs to strengthen the connection between education and the world of work. Internship programs, research collaborations, and real-world learning can help students understand job market needs and align their skills with future demands.

Reflections from this discussion affirm that holistic education is key to facing future global challenges. Education aims not only to produce scientists but also to prepare a generation capable of adapting to change, creatively solving problems, and innovatively addressing technological challenges.

With an inclusive and adaptive approach, education systems in various countries can contribute to the development of scientists and professionals from diverse fields. Investment in education that focuses on balancing academic learning with practical skills will be key to successfully creating a society ready for the jobs of the future.

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