Teaching Science Amid Global Uncertainty: Challenges and Solutions

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Abstract: This study aims to conduct an in-depth review to identify the challenges in teaching science amid global uncertainty and the solutions offered. Climate change, pandemics, social inequality, and rapid technological advancements are just a few examples of the uncertainties that pose real challenges in the 21st century. This research employs a literature review method to examine various scientific sources relevant to the discussed topic. The findings reveal that some of the challenges in science education include a lack of contextualized learning materials, disparities in facilities and technology access, low scientific literacy, and the spread of misinformation and declining trust in science. Therefore, transformation efforts are needed through curriculum reform, teacher training, and learning approaches that emphasize the interconnection between science and global realities.

Keywords: Challenges in Teaching Science, Global Uncertainty, Science Learning Transformation

INTRODUCTION

The world today faces a myriad of complex and interconnected global issues. Climate change, pandemics, social inequality, and rapid technological progress are prime examples of uncertainties that have become pressing challenges in the 21st century. According to Gibson (1997), 21st-century challenges are characterized by hypercompetition, successive technological revolutions, dislocation, and social conflict, resulting in non-linear, unpredictable conditions (Sudarisman et al., 2015). These conditions create significant uncertainty across all aspects of life, including education.

Science education is not exempt from these global issues. Science is a human endeavor to discover rational explanations for events occurring in the universe (Ismail, 2006). Teaching science involves the interconnection of teacher instruction, student learning, and curriculum. Teaching science should not be limited to knowledge transfer but must include the development of critical thinking skills and global awareness. As a key pillar in fostering rational and evidence-based thinking, science education plays a strategic role in preparing future generations to face these challenges.

However, current science education approaches have not fully adapted to rapidly changing global contexts. Curricula often lack integration with contemporary issues, and the use of educational technology remains limited. Additionally, there is insufficient emphasis on critical thinking, making it harder to produce adaptive and solution-oriented graduates. The spread of misinformation and declining public trust in science further highlight the urgency of reforming science teaching methods.

Therefore, a thorough analysis is needed to identify the key challenges in science education amid global uncertainty and to develop educational strategies that are contextual, collaborative, and focused on equipping students with the capacity to address global issues scientifically and responsibly.

METHOD

This study utilizes a literature review approach to examine scientific sources relevant to the topic. Data collection was conducted by reviewing articles, national and international journals, conference proceedings, and academic books.

The inclusion criteria for selected literature include relevance to the main topic, being peer-reviewed, and written in either Indonesian or English. Literature lacking clear methodology, irrelevant to the research focus, or originating from non-credible sources was excluded from analysis.

RESULT AND DISCUSSION

Based on the analysis of the literature review conducted, it can be concluded that disruption has significantly influenced education, including science education. The integration of technology into learning approaches, such as adaptive systems and online platforms, has transformed both the acquisition and the delivery of knowledge (Herliawati

et al., 2024). While the advancement of information technology has brought many positive impacts, it has also created challenges within the educational sphere.

In the face of global uncertainty, technology has become an essential component in sustaining and improving education. Optimizing the use of technology not only enhances the quality of education but also enables adaptation to constant changes, making it a key factor for success in the disruption era (Unik Hanifah Salsabila, Munaya Ulil Ilmi, Siti Aisyah, Nurfadila & Rio Saputra, 2020). Consequently, the learning process must be adjusted to align with ongoing dynamics. Effective planning during crises should encompass performance monitoring, the use of digital technologies, the strengthening of students' faith, and the implementation of innovative curricula, all of which must be integrated into a coherent and mutually supportive framework (Hidayat et al., 2021).

Another critical aspect of preparing students for the 21st century is the enhancement of scientific literacy. This competence is regarded as indispensable for addressing the challenges and transformations of the modern era. Six basic forms of literacy are considered vital for life in the 21st century: reading and writing, numeracy, science, digital literacy, financial literacy, as well as cultural and civic literacy. These foundational literacies should be introduced and nurtured from the earliest stages of education (Kintan Limiansih et al., 2024). Scientific literacy, in particular, is a fundamental need for every generation. As Galbreath, cited in Amin M (2017), emphasizes, scientific literacy is not only a necessity but also a tool for fostering innovation in the development of intellectual capital.

The role of teachers is highly significant in shaping students' scientific literacy. Limitations in teachers' abilities to guide students through problems and questions related to science literacy can hinder students' capacity to practice and develop these essential skills. In this regard, teachers' mastery of scientific literacy stands as a central factor in advancing students' abilities in the field (Hidayah et al., 2019; Kintan Limiansih et al., 2024).

Finally, science itself plays a crucial role in addressing global challenges. Beyond driving the advancement of knowledge and technology, science also contributes to individual growth, societal development, and the pursuit of solutions to pressing global issues (Kintan Limiansih et al., 2024). Thus, strengthening scientific literacy, supported by high-quality teachers and the effective use of technology, is indispensable in preparing future generations to navigate the complexities of the disruption era and the uncertainties of the 21st century.

Challenges in Science Education Amid Global Uncertainty

In the era of global uncertainty marked by climate change, pandemics, energy crises, and geopolitical shifts, science education faces increasingly complex challenges. Science educators are now expected not only to deliver scientific content but also to equip students with critical thinking, adaptability, and interdisciplinary understanding.

One major challenge is the outdated curriculum that often fails to respond to urgent global issues. Instruction that emphasizes rote memorization over real-world applications makes science feel disconnected from daily life. Other challenges include:

1. Lack of Contextual Learning Materials

   Science curricula often focus on theory and lab procedures without connecting them to ongoing global issues. As a result, students struggle to see the relevance of science to their lives. Bybee (2013) emphasizes that when science is taught only through abstract theory, students lose interest and fail to appreciate its practical significance. Contextual learning engages students more deeply and makes learning more meaningful (Johnson, 2008).

2. Disparities in Facilities and Technology Access

   Unequal access to laboratories, digital tools, and teacher training contributes to varied educational outcomes. Inadequate infrastructure in many schools limits the effective teaching of science, especially when special equipment is required. In remote areas, poor technological access further hinders creativity and access to teaching resources (Permatasari, 2024). Experiments—central to science

education—often become difficult without proper tools, requiring teachers to be resourceful and creative (Manullang et al., 2021).

3. Low Scientific Literacy

   Scientific literacy is defined as the ability to apply scientific knowledge in identifying questions, acquiring new knowledge, explaining phenomena, and drawing conclusions based on evidence (Fuadi et al., 2020). According to the OECD's PISA 2018 results, Indonesian students scored low in scientific literacy compared to their global peers (OECD, 2019). Poor literacy is closely linked to weak critical thinking and is often caused by the same factors mentioned earlier.

4. Misinformation and Erosion of Trust in Science

   While digital technology enhances access to information, it also fuels the spread of misinformation, especially among students exposed to conspiracy theories and unverified content on social media. This blurs the lines between facts and opinions, undermining trust in science (Scheufele & Krause, 2019). Scientific topics such as climate change, vaccination, and genetic engineering are frequently misrepresented in public discourse.

Proposed Solutions

Technological advancements and innovative pedagogical approaches offer promising solutions. Methods such as inquiry-based learning, project-based learning, and integrating global issues into science lessons can enhance relevance and engagement. For instance, students can explore climate change through satellite data or study pandemics with molecular biology tools. Such contextual learning helps students see science as a tool to understand and solve real-world problems.

Global issues also promote the development of global competence—understanding multiple perspectives, thinking critically, and acting ethically in a global context. These are essential 21st-century skills that should be central to modern science education.

In addition, collaboration among teachers, educational institutions, and stakeholders is essential. Joint efforts can help provide the necessary facilities to support an optimal

learning environment. Continuous teacher training, the use of online learning platforms, and the development of adaptive curricula that respond to global issues are crucial for preparing students not just academically, but also as future agents of change.

CONCLUSION

Science education must address the challenges of the times through innovative, reflective, and context-based approaches. Transformative efforts through curriculum reform, teacher development, and learning strategies that connect science to global realities are necessary. This will result in graduates who are not only academically competent but also capable of contributing meaningfully to solving the complexities of today's world.

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