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Trends in Science Curriculum Development in Education: A Systematic Literature Analysis

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Abstract: The aim of this research is to investigate and analyze current trends in science curriculum development. This study adopts a qualitative research approach utilizing the Systematic Literature Review method, exploring literature sources from Scopus, DOAJ, and Google Scholar, focusing on publications between 2013 and 2024. Research findings indicate that the evolution of the science curriculum is a response to contemporary advancements in science and technology. Emphasizing STEM (Science, Technology, Engineering, and Mathematics), the development of teaching methods, and technology integration are considered pivotal measures to enhance students' skills and knowledge in alignment with the demands of the era. The incorporation of technology into the science curriculum empowers students to understand and effectively apply technology in scientific problem-solving. Specialized teaching approaches, such as post-colonial and decolonial teaching, inquiry-based methods, and student-centered interventions, signify efforts to decolonize science education and achieve a more inclusive learning environment. Despite successfully enhancing students' understanding and skills, challenges arise in integrating indigenous knowledge with Western science. While the evolution of the science curriculum demonstrates significant progress, there exists a gap in comprehending and effectively integrating various teaching methods, particularly in addressing social and cultural diversity.

Keywords: Science Curriculum; Curriculum Development; Education Trends.

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A. INTRODUCTION

The science curriculum serves as a fundamental educational foundation across various levels of instruction, spanning from elementary to advanced levels. This curriculum concept is crafted to guide students in comprehending and cultivating skills in the realm of scientific knowledge. At the elementary level, the science curriculum provides a robust foundation for understanding the fundamental principles of the natural sciences Moon & Blackman (2014), while at the middle level, its focus evolves towards a deeper comprehension of more complex concepts. At the advanced level, the science curriculum encompasses aspects of research and scientific applications, preparing students for increased involvement in the exploration of scientific knowledge (Lederman et al., 2013). The pivotal role of the curriculum in shaping

students' understanding and skills lies in its emphasis on a skill-based approach, wherein students not only grasp scientific facts but also apply their knowledge in practical contexts. Consequently, the science curriculum functions as a comprehensive guide in shaping a generation of students capable of critical thinking, fostering curiosity, and possessing relevant skills to confront future scientific challenges.

The evolution of the science curriculum has undergone a protracted journey throughout the history of education, manifested through various changes that mirror the dynamics of scientific development and societal needs. In its development, factors influencing changes in the science curriculum involve the dynamics of social, economic, and technological dimensions (Otto et al., 2020). In tandem with the advancements in science and technology, the science curriculum tends to undergo transformations to ensure that instructional materials reflect the latest understanding of the natural sciences. Additionally, responses to the demands of the job market and societal requirements for specific skills are also key factors in the evolution of the science curriculum. In some cases, global issues such as climate change and environmental crises further motivate the alignment of the science curriculum with contemporary challenges (Reid, 2019). The evolution of the science curriculum not only reflects changes in educational paradigms but also responds to social and environmental changes encompassing the development of science and technology (Barth & Michelsen, 2013).

Contemporary challenges in developing the science curriculum encompass the intricacies of the evolving dynamics of science and technology (Bernstein, 2015). The rapid advancements in scientific research and technological development necessitate that the science curriculum remains relevant and up-to-date. Moreover, environmental changes and societal needs are pivotal factors influencing the science curriculum (Carleton & Hsiang, 2016). Climate change, environmental crises, and socio-economic transformations require curriculum adaptations to reflect a deeper understanding of the human impact on the environment. The continuously shifting demands of the job market also pose challenges in aligning the science curriculum with the skills and knowledge required by modern industries and society. Therefore, in developing the science curriculum, considerations must extend beyond its scientific aspects to encompass social and environmental contexts, ensuring its relevance in addressing the complex challenges faced by contemporary society and our planet.

Current trends in the evolution of science curricula worldwide involve a concentration on STEM education, interdisciplinary methodologies, and the fusion of science with technology and engineering (Tairab & Belbase, 2023); (Sapozhnikov, 2022); (Hamdan, 2020). Numerous nations have instituted progressive reforms to advance STEM education, incorporating science, education, and production to mobilize resources for pragmatic problem-solving (Nandwani et al., 2021). Instances of inventive approaches adopted by educational systems internationally encompass the fostering of teacher self-efficacy in integrated STEM education Zhan et al. (2022), the establishment of national hubs for high-performance computing and data processing, and the refinement of science curricula to address contemporary challenges. These initiatives aim to enhance science teaching techniques, advance science education technology, and assess the efficacy of science instruction. In essence, there is an escalating emphasis on

interdisciplinary cooperation, pedagogical methodologies, and educational fairness within the realm of STEM education.

An adaptive science curriculum that keeps pace with advancements in science and technology is imperative for students to grasp scientific concepts fully and realize their potential in the twenty-first century (Abdurrahman, 2022). Sustainable learning emerges as a contemporary educational philosophy seeking to formulate curricula and methodologies that cultivate skills and mindsets conducive to thriving in intricate and ever-evolving environments (Hays & Reinders, 2020). This approach underscores the importance of systems thinking, ecological awareness, and self-reliance as both means and objectives in sustainable education (Debarger et al., 2017). The adjustment of curricula can contribute to the reform of science teaching and learning by aligning educators' practices with the vision outlined in science education frameworks (Fleacă et al., 2023). Education assumes a pivotal role in nurturing sustainability skills and equipping students as responsible agents of change for a secure and prosperous future (Aceska, 2015). The integration of natural sciences into educational processes is vital for advancing sustainable development and fostering critical thinking among students. Additionally, information and communication technology (ICT) stands as a valuable tool for elevating the quality of teaching and learning in science education.

Numerous research papers have explored the correlation between the science curriculum and students' learning experiences, specifically focusing on how it contributes to an enhanced comprehension of scientific concepts applicable in daily life. One investigation indicated that science teaching grounded in real-world contexts, showcasing the personal and societal relevance of scientific knowledge and practices, has the potential to heighten students' motivation for learning science (Kostøl & Remmen, 2022). Another study found that curriculum materials supplemented with teacher supports, such as information regarding students' ideas and recommended instructional strategies, yielded positive outcomes for both students and teachers (Roblin et al., 2018). Moreover, students expressing favorable encounters with school science exhibited a greater likelihood of pursuing science in their advanced studies, underscoring the influential role of curriculum content and teaching practices (Shirazi, 2017). Additionally, a research effort demonstrated that students can establish connections between science learning processes and their everyday experiences through embodied explorations, humor, and narrative representation, fostering a more profound and emotionally resonant understanding of scientific concepts (Hill et al., 2020).

The aim of this research is to investigate and analyze current trends in science curriculum development. Delving into these trends, the research aims to provide a deeper understanding of the changes and innovations occurring in science teaching approaches. Furthermore, the study emphasizes the significance of gaining further insight into these trends to enhance the quality of science education. By identifying and comprehending the current trends, it is anticipated that this research will contribute to policymakers, educational decision-makers, and practitioners in designing and implementing more relevant and effective science curricula. The goal is not only to document trends but also to offer valuable insights to improve science education practices and meet the demands of advancements in science and technology in the contemporary era.

B. METHOD

This study aims to investigate and analyze current trends in the development of science curriculum within the educational context. The research employs a qualitative approach utilizing Systematic Literature Review as the chosen methodology. Inclusion criteria encompass Contemporary Approaches, Global Perspective, and Empirical Evidence, aiming to provide profound insights into the recent developments in science curriculum. Exclusion criteria involve avoiding literature classified as Outdated Information, excessively Localized or Specific, and exhibiting Conceptual Ambiguity. The data sources include reputable databases such as Scopus, DOAJ, and Google Scholar, with search keywords covering "Science Curriculum," "Curriculum Development," and "Education Trends." The chosen publication timeline spans from 2013 to 2024 to ensure the incorporation of recent literature. The research stages involve identifying literature based on inclusion and exclusion criteria, collecting data from relevant sources, analyzing data to identify major trends in science curriculum development, and ultimately drafting an article with a focus on significant findings and contributions to the understanding of current trends in science education.

C. RESULTS AND DISCUSSION

From the outcomes of the search, we have identified numerous pertinent research findings that can shed light on the focus and objectives of this study. We have outlined various aspects that require detailed descriptions., including: (1) Evolution of Science Curriculum Development in Educational Literature; (2) The Main Issues Emerging in The Literature are Related to the Development of Science Curricula at Various Levels of Education; (3) Trends in Science Curriculum Development; and (4) Patterns or Differences in Science Teaching Approaches. In broad terms, an overview can be observed in Table 1.

Table 1. Focus and insight into research results according to eligibility criteria

No	Focus Area	Authors	Insights or Research Variables
1	Evolution of Science Education Curricula	Zasiekina (2023), Capstick et al. (2015), E. Childs (2015)	Shifts from content-centric and prescribed activities to inquiry-based learning and societal dimensions of science. The integration of scientific facts, understanding nature and processes of science, and practical applications in societal contexts. Recognition of the need for more effective teaching of evolutionary theory.
2	Objectives of Science Education Transformation	Tairab & Belbase (2023), Lubis et al. (2022)	A shift towards fostering scientific and technological literacy, evident in increased enthusiasm for research in STEM fields. Formulation of curricula focusing on interconnected concepts related to nature, humanity, and technology, tailored to students' needs. Refinement geared towards enhancing previous iterations.
3	Issues in	Hamdan (2020),	Imperatives for reforms in teaching and

	Science Curriculum Development	Booi & Khuzwayo (2019), Kennedy (2023)	learning, recognition and integration of contemporary scientific fields, effective teaching methods, technology integration, assessment of scienceteaching, and training of science educators. Diverse studies addressing challenges and opportunities in curriculum research and science teaching methodologies.
4	Challenges in Science Curriculum Development at Different Levels	Margot & Kettler (2019), Paraniti & Suma (2022), Romana Bano (2022)	Length issues, lack of time and resources, including inadequate laboratory facilities, insufficient practicum resources, and the importance ofprofessional development for teachers. Debate on whether science curricula should focus on processes or content. The involvement of all stakeholders is crucial. Social and cultural changesmust be addressed.
5	Integration of Science and Technology in theCurriculum	Ablakulov (2023), Liston et al. (2022), Mafa & Govender (2022)	Incorporation of technological tools such as computer technology, the internet, and communication into science materials. Development of skills in using science and technology applications to generate and analyze data. Emphasis on cultivating critical competencies and programming skills.
6	Innovative Science Teaching Methodologies	Rüschenpöhler (2023), Constantinouet al. (2018), Deehanet al. (2024)	Focus on postcolonial and decolonial science teaching, inquiry-based approaches, and student-centered interventions. Integration of Indigenous knowledge, advocacy for a more expansive perspective on science education, beyond traditional content-centric methods.
7	Scientific and STEM Approaches in Science Teaching	Diep et al. (2023), Basiran et al. (2023), Septaria & Rismayanti (2022)	Emphasis on developing students' process skills, problem-solving abilities, and scientific attitudes through scientific and STEM approaches. Strengthening students' ability to solve real-world problems. Influence on fostering critical, creative, and innovative thinking.

Table 1 provides a comprehensive overview of diverse research findings, emphasizing various aspects of science education, including curriculum development, challenges, integration of technology, and innovative teaching methodologies. A detailed explanation of each aspect will be elaborated in the following discussion:

1. Evolution of Science Curriculum Development in Educational Literature

In recent times, there have been notable transformations in science education curricula, moving away from an emphasis on content and prescribed practical activities towards a greater focus on inquiry-based learning and the societal dimensions of science (Zasiekina, 2023). These shifts have been influenced by global trends in education and the exchange of best practices among researchers across the globe (Capstick et al., 2015). The development of school science curricula has witnessed various paradigms, encompassing an emphasis on scientific facts and concepts, the understanding of the nature and processes of science, and the practical applications of science in societal contexts (E. Childs, 2015). Contemporary curricula aspire to integrate these three dimensions, aiming to meet the educational needs of both future science professionals and informed citizens (Steketee et al., 2013). Nevertheless, there is a recognized need for more effective teaching of evolutionary theory, as current biology textbooks often present it in a fragmented and unclear manner, contributing to misconceptions among students (Soysal, 2022). In summary, science curricula have evolved to embrace inquiry-based learning, the societal dimensions of science, and a more holistic approach to science instruction.

The transformation of the science curriculum in recent times has been influenced by the evolving objectives of science education, placing greater importance on fostering scientific and technological literacy (Tairab & Belbase, 2023). This change is evident in the growing enthusiasm for engaging in research within STEM fields (Lubis et al., 2022). The formulation of science curricula has also centered around the incorporation of interconnected concepts involving nature, humanity, and technology, with a specific emphasis on their pertinence to students' requirements and encounters (Kozoll & Ower, 2023). Furthermore, the refinement and alterations in the curriculum are geared towards enhancing previous iterations.

The findings indicate that changes in science curricula are influenced by global trends in education and the exchange of best practices among researchers worldwide. The new focus places greater emphasis on inquiry and the social dimensions of science, signaling efforts to create a holistic approach to science learning. This reflects the need to prepare students as future science professionals and informed citizens. The shift towards an emphasis on inquiry and the social dimensions of science is viewed positively as it aligns with the requirements of contemporary society. However, the awareness of the need to teach evolutionary theory more effectively suggests room for improvement in learning approaches, particularly in the context of biology. This assessment provides an overview of the challenges faced by current science curricula.

2. The Main Issues Emerging in The Literature are Related to the Development of Science Curricula at Various Levels of Education

Issues concerning the development of the science curriculum across educational levels are widely discussed in the literature. These include: (1) the imperative for reforms in science teaching and learning; (2) the recognition and integration of contemporary scientific fields and their branches; (3) the implementation of effective teaching methods and strategies for science education; (4) the integration of technology in science education; (5) the assessment of science

teaching; and (6) the training of science educators. Various studies both domestic and international, including research in Arab and foreign contexts, have delved into these issues, shedding light on the challenges and opportunities within curriculum research and science teaching methodologies (Hamdan, 2020) (Booi & Khuzwayo, 2019) (Kennedy, 2023).

The development of the science curriculum at different levels of education faces several important issues. The length of the curriculum can be problematic as it is not possible to cover all topics, which can hinder understanding (Margot & Kettler, 2019). Lack of time and resources, such as inadequate laboratory facilities and insufficient resources for practicums, can also impact the development of science curricula (Paraniti & Suma, 2022). The lack of professional development for teachers is a limitation in the successful implementation of the science curriculum. There is a debate about whether science curricula should focus on science processes or science content. The involvement of all stakeholders, including teachers, parents, school administrators, and university and college employees, is critical to the successful development of science curricula (Romana Bano, 2022). Science curricula must keep pace with social and cultural changes to remain relevant and effective. Integration of interdisciplinary topics is necessary for a comprehensive understanding of science concepts. The development of process abilities, such as seeing, classifying, communicating, and processing data, is essential in science curricula (Jang, 2016). Teachers need to be trained to teach process skills. Science curricula should address social questions, such as the impact of science on society and the environment.

These issues reflect the complexity and diversity of challenges faced in the development of science curricula across various educational levels. This diversity encompasses the need to adapt to recent scientific and technological advancements, acknowledge contemporary scientific coverage, and create effective and relevant teaching methods. The integration of technology and teaching evaluation emerges as key aspects in efforts to enhance the quality of science education. The diversity of these issues highlights the complexity and variety of challenges encountered in the development of science curricula. The evaluation of the inability to cover all topics in the curriculum, resource limitations, and the need for professional training for teachers indicates a requirement for holistic and sustainable solutions in improving science curricula.

3. Trends in Science Curriculum Development

The evolution of science curricula is closely tied to the dynamic landscape of scientific and technological advancements. Numerous reform initiatives have emerged to advocate for an integrated STEM approach in teaching and learning, placing a strong emphasis on reshaping STEM education to enhance teacher self-efficacy and empower students through problem-solving skills (Tairab & Belbase, 2023). A review of the literature reveals that current global trends in curriculum research and science teaching methods encompass various reform movements in the teaching and learning of science, the exploration of modern scientific fields and their branches, the development of methods and strategies for teaching science, the integration of science education technology, the evaluation of science teaching, and the preparation of science teachers (Hamdan, 2020). The field of science education has witnessed a focus on teaching practices and methods, with articles reflecting the ongoing developments

in research within the discipline (Karampelas, 2021). Over the past decade, there has been a notable increase in studies related to science instruction and information and communication technology (ICT), reflecting the evolving demands and advancements in science teaching and technology (Yiğit et al., 2022). The trajectory of school science curricula has shifted towards inquiry-based science education, emphasizing the integration of scientific facts and concepts, the understanding of the nature and processes of science, and the practical applications of science in society (Childs, 2015).

Incorporating the latest advancements in science and technology into the science curriculum enables students to comprehend and effectively utilize technology in solving scientific problems (Ablakulov, 2023). This entails integrating technological tools such as computer technology, the internet, and communication into science materials (Liston et al., 2022). Moreover, it involves cultivating skills in using science and technology applications to generate and analyze data. Critical competencies are also cultivated, encompassing the understanding and utilization of technology, along with identifying its positive and negative impacts (Mafa & Govender, 2022). Furthermore, programming competencies are acquired, including fundamental programming skills and the utilization of programming tools. By embracing these recent developments, students acquire the capability to apply technology effectively in understanding and resolving scientific problems.

The trends in science curriculum development reflect an adaptation to the recent scientific and technological advancements. Reform initiatives, the emphasis on STEM, and the integration of technology serve as responses to the necessity of cultivating students' skills and knowledge in alignment with contemporary demands. The incorporation of technology into science curricula provides students with the ability to understand and effectively apply technology in scientific problem-solving. The enhancement of critical competencies and programming skills signifies efforts to equip students with relevant skills in the digital era.

4. Patterns or Differences in Science Teaching Approaches

Various science teaching methodologies highlighted in the literature include postcolonial and decolonial science teaching, inquiry-based approaches, and student-centered interventions. Postcolonial and decolonial science teaching seek to integrate Indigenous knowledge systems with Western science in classrooms, aiming to decolonize science education (Rüschenpöhler, 2023). Inquiry-based approaches stress the importance of evidence and scientific reasoning, often recommended in science teacher education curricula (Constantinou et al., 2018). Student-centered interventions have demonstrated significant enhancements in science content knowledge, skills, and attitudes in primary science education (Deehan et al., 2024). These methodologies contribute to reshaping science curricula by advocating for a more expansive perspective on science education, moving beyond traditional content-centric methods. They emphasize the incorporation of Indigenous knowledge, inquiry-based learning, and student-centered approaches in science teaching (Urdanivia Alarcon et al., 2023) (Hamdan, 2020).

Scientific and STM approaches in science teaching focus on developing students' process skills, problem-solving abilities, and scientific attitudes (Diep et al., 2023). These approaches

aim to enhance students' understanding and use of science and technology to solve relevant problems in society (Basiran et al., 2023). By integrating these approaches into the science curriculum, students can effectively develop their scientific process skills (Septaria & Rismayanti, 2022). The STM approach specifically strengthens students' ability to solve problems in society. Both scientific and STM approaches also influence students' scientific attitudes, fostering critical, creative, and innovative thinking in understanding and solving science problems. Therefore, incorporating these approaches in the science curriculum enables students to understand and apply science and technology effectively in addressing real-world science problems.

The highlighted science teaching approaches in the literature reflect a desire to decolonize science education, emphasizing inquiry and student-centered learning as a robust foundation. This indicates an effort to move beyond traditional methods and introduce a broader and more inclusive perspective. Inquiry-based approaches and student-centered interventions demonstrate a significant improvement in students' understanding and science skills, showcasing the success of these methods in achieving science education goals. However, it is noteworthy that challenges may arise in integrating indigenous knowledge with Western science.

D. CONCLUSION

Through the evaluation of literature on the development of science curriculum, a significant shift in the approach to science education becomes apparent. The current focus is on inquiry-based learning and the social dimensions of scientific knowledge. There is a recognized need to enhance the teaching of evolutionary theory, particularly in the context of biology, to address common misconceptions among students. This reflects a commitment to improving science and technology literacy. Various issues in the literature concerning the development of science curriculum include challenges in reforming science teaching and learning, acknowledgment of contemporary scientific fields, effective implementation of teaching methods, technology integration, assessment of science teaching, and teacher training. The integration of technology and the evaluation of teaching are considered crucial elements in the effort to enhance the quality of science education. A holistic and sustainable solution is required to address challenges such as time and resource constraints, insufficient professional development for teachers, and debates regarding the emphasis on scientific processes or content.

The evolution of the science curriculum appears to be a response to recent developments in science and technology. Emphasizing STEM, the development of teaching methods, and technology integration are considered steps towards enhancing students' skills and knowledge in line with contemporary demands. The integration of technology into the science curriculum provides students with the ability to understand and effectively apply technology in scientific problem-solving. Specialized approaches to science teaching, such as post-colonial and decolonial teaching, inquiry-based methods, and student-centered interventions, demonstrate efforts to decolonize science education and achieve more inclusive learning. Despite successfully improving students' understanding and skills, challenges arise in integrating indigenous knowledge with Western scientific perspectives.

Although the evolution of the science curriculum has made significant progress, there remains a gap in the effective understanding and integration of various teaching methods, especially in addressing social and cultural diversity. Further research is needed to delve into strategies for integrating indigenous knowledge with Western science that can create an inclusive learning environment. Additionally, solutions to issues such as the lack of resources and professional development for teachers, as well as addressing critical questions about the curriculum's focus on scientific processes or content, need to be identified. Future research should be more focused on evaluating the impact of technology integration in enhancing the quality of science education. In line with the dynamics of current science and technology, urgent research should be directed towards exploring the potential integration of STEM concepts and the latest technologies into the science curriculum. Such research can pave the way for the development of innovative strategies to respond to contemporary challenges.

REFERENCE

Abdurrahman, A. (2022). *Integrated Science Curriculum in the Unpredictable World*. https://doi.org/10.1007/978-3-031-15963-3_11

Ablakulov, K. (2023). Extensive Use Of Additional Products In The Development Of Science And Technology, As Well As Innovative Factor. *Economics and Education*. https://doi.org/10.55439/eced/vol24_iss1/a12

Aceska, N. (2015). New Science Curriculum Based on Inquiry Based Learning - A Model of Modern Educational System in Republic of Macedonia. *Journal of Education in Science, Environment and Health*. https://doi.org/10.21891/jeseh.47175

Atabek Yiğit, E., Balkan Kiyici, F., & Kiyici, M. (2022). Information and Communication Technologies in Science Instruction: Systematic Review of Publications in Last Decade. *International Journal of Technology in Education and Science*. https://doi.org/10.46328/ijtes.313

Azwar Lubis, M. S., Fatmawati, E., Yunita Rahma Pratiwi, E., Sabtohadi, J., & Damayanto, A. (2022). Understanding Curriculum Transformation Towards Educational Innovation in The Era of All-Digital Technology. *Nazhruna: Jurnal Pendidikan Islam*. https://doi.org/10.31538/nzh.v5i2.2110

Barth, M., & Michelsen, G. (2013). Learning for change: An educational contribution to sustainability science. *Sustainability Science*. https://doi.org/10.1007/s11625-012-0181-5

Basiran, B., & Siswadi, S. (2023). Science Learning Strategies in Madrasah Ibtidaiyah Using the Stm Approach Model. *International Journal Of Multidisciplinary Research And Analysis*. https://doi.org/10.47191/ijmra/v6-i6-41

Bernstein, J. H. (2015). Transdisciplinarity: A review of its origins, development, and current issues. In *Journal of Research Practice*.

Booi, K., & Khuzwayo, M. E. (2019). Difficulties in developing a curriculum for pre-service science teachers. *South African Journal of Education*. https://doi.org/10.15700/saje.v39n3a1517

Capstick, S., Whitmarsh, L., Poortinga, W., Pidgeon, N., & Upham, P. (2015). International trends in public perceptions of climate change over the past quarter century. *Wiley Interdisciplinary Reviews: Climate Change*. https://doi.org/10.1002/wcc.321

Carleton, T. A., & Hsiang, S. M. (2016). Social and economic impacts of climate. In *Science*. https://doi.org/10.1126/science.aad9837

Constantinou, C. P., Tsivitanidou, O. E., & Rybska, E. (2018). What Is Inquiry-Based Science

Teaching and Learning? In *Contributions from Science Education Research*. https://doi.org/10.1007/978-3-319-91406-0_1

Debarger, A. H., Penuel, W. R., Moorthy, S., Beauvineau, Y., Kennedy, C. A., & Boscardin, C. K. (2017). Investigating Purposeful Science Curriculum Adaptation as a Strategy to Improve Teaching and Learning. *Science Education*. https://doi.org/10.1002/sce.21249

Deehan, J., MacDonald, A., & Morris, C. (2024). A scoping review of interventions in primary science education. In *Studies in Science Education*. https://doi.org/10.1080/03057267.2022.2154997

Diep, N. H., Thuy, H. T. P., Lai, D. T. B., Viet, V. Van, & Chung, N. T. K. (2023). A comparison of three stem approaches to the teaching and learning of science topics: Students' knowledge and scientific creativity. *International Journal of Education and Practice*. https://doi.org/10.18488/61.v11i2.3336

E. Childs, P. (2015). Curriculum development in science - past, present and future. *Lumat: International Journal of Math, Science and Technology Education*. https://doi.org/10.31129/lumat.v3i3.1036

Fleacă, B., Fleacă, E., & Maiduc, S. (2023). Fostering Skills for Sustainability – Lessons Learnt from Curriculum Design and Learning Outcomes. *European Journal of Sustainable Development*. https://doi.org/10.14207/ejsd.2023.v12n1p69

Hamdan, A. (2020). Recent Trends In Curriculum And Teaching Methods In Science Education. *Gamtamokslinis Ugdymas / Natural Science Education*. https://doi.org/10.48127/gu-nse/20.17.24

Hays, J., & Reinders, H. (2020). Sustainable learning and education: A curriculum for the future. *International Review of Education*. https://doi.org/10.1007/s11159-020-09820-7

Hill, M. A., Overton, T. L., & Thompson, C. D. (2020). Evaluating the impact of reflecting on curriculum-embedded skill development: the experience of science undergraduates. *Higher Education Research and Development*. https://doi.org/10.1080/07294360.2019.1690432

Jang, H. (2016). Identifying 21st Century STEM Competencies Using Workplace Data. *Journal of Science Education and Technology*. https://doi.org/10.1007/s10956-015-9593-1

Karampelas, K. (2021). Trends on science education research topics in education journals. *European Journal of Science and Mathematics Education*. https://doi.org/10.30935/scimath/9556

Kennedy, D. (2023). Curriculum Design in Science and Technology Education at International Level. In *Contemporary Trends and Issues in Science Education*. https://doi.org/10.1007/978-3-031-24259-5_5

Kostøl, K. B., & Remmen, K. B. (2022). A qualitative study of teachers' and students' experiences with a context-based curriculum unit designed in collaboration with STEM professionals and science educators. *Disciplinary and Interdisciplinary Science Education Research*. https://doi.org/10.1186/s43031-022-00066-x

Kozoll, R. H., & Ower, P. S. (2023). Transitioning Between Reform-Based Curricula: A Middle School Teacher's Construction of a Science Teaching Identity. *Science Education International*. https://doi.org/10.33828/sei.v34.i1.5

Lederman, N. G., Lederman, J. S., & Antink, A. (2013). Nature of Science and Scientific Inquiry as Contexts for the Learning of Science and Achievement of Scientific Literacy. *International Journal of Education in Mathematics Science and Technology (IJEMST) International Journal of Education in Mathematics Science and Technology International Journal of Education in Mathematics Science and Technology*.

Liston, M., Morrin, A. M., Furlong, T., & Griffin, L. (2022). Integrating Data Science and the Internet of Things Into Science, Technology, Engineering, Arts, and Mathematics

Education Through the Use of New and Emerging Technologies. *Frontiers in Education*. https://doi.org/10.3389/feduc.2022.757866

Mafa, R. K., & Govender, D. W. (2022). In-Service Science Teacher's Perceptions Towards the Use of Information Communication Technology Tools in Teaching and Learning in a COVID-19 Environment. *E-Journal of Humanities, Arts and Social Sciences*. https://doi.org/10.38159/ehass.2022383

Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration and education: a systematic literature review. In *International Journal of STEM Education*. https://doi.org/10.1186/s40594-018-0151-2

Moon, K., & Blackman, D. (2014). A Guide to Understanding Social Science Research for Natural Scientists. In *Conservation Biology*. https://doi.org/10.1111/cobi.12326

Nandwani, S., Rind, A. A., & Dool, M. A. (2021). Science Curriculum Implementation in Educational Settings: A Case of Public Secondary Schools of Sukkur, Sindh. *Global Regional Review*. https://doi.org/10.31703/grr.2021(vi-i).18

Otto, I. M., Donges, J. F., Cremades, R., Bhowmik, A., Hewitt, R. J., Lucht, W., Rockström, J., Allerberger, F., McCaffrey, M., Doe, S. S. P., Lenferna, A., Morán, N., van Vuuren, D. P., & Schellnhuber, H. J. (2020). Social tipping dynamics for stabilizing Earth's climate by 2050. *Proceedings of the National Academy of Sciences of the United States of America*. https://doi.org/10.1073/pnas.1900577117

Paraniti, A. A. I., & Suma, K. (2022). Science Teachers Competencies and Problem in Implementing 2013 Curriculum at Primary and Secondary School in Bali. *Jurnal Pendidikan Dan Pengajaran*. https://doi.org/10.23887/jpp.v55i3.46366

Reid, A. (2019). Climate change education and research: possibilities and potentials versus problems and perils? In *Environmental Education Research*. https://doi.org/10.1080/13504622.2019.1664075

Roblin, N. P., Schunn, C., & McKenney, S. (2018). What are critical features of science curriculum materials that impact student and teacher outcomes? *Science Education*. https://doi.org/10.1002/sce.21328

Romana Bano. (2022). Examine the importance of teachers' participation in curriculum development. *Voyage Journal of Educational Studies*. https://doi.org/10.58622/vjes.v2i1.9

Rüschenpöhler, L. (2023). A review of postcolonial and decolonial science teaching approaches for secondary school from a European perspective. *International Journal of Science Education*. https://doi.org/10.1080/09500693.2023.2207748

Sapozhnikov, G. A. (2022). Current development of professional education and science based on traditions and innovations. *Actual Problems of Education*. https://doi.org/10.33764/2618-8031-2022-1-148-151

Septaria, K., & Rismayanti, R. (2022). The Effect of Scientific Approach on Junior High School Students' Scientific Creativity and Cognitive Learning Outcomes. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*. https://doi.org/10.36312/esaintika.v6i3.955

Shirazi, S. (2017). Student experience of school science. *International Journal of Science Education*. https://doi.org/10.1080/09500693.2017.1356943

Soysal, Y. (2022). Science Curriculum Objectives' Intellectual Demands: A Thematic Analysis. *Journal of Science Learning*. https://doi.org/10.17509/jsl.v5i1.35439

Steketee, C., Lee, A., Moran, M., & Rogers, G. (2013). Towards a theoretical framework for curriculum development in health professional education. *University of Notre Dame Australia ResearchOnline@ND Health Sciences Papers and Journal Articles School of Health Sciences Focus on Health Professional Education*.

Tairab, H. H., & Belbase, S. (2023). *Current Trends in Science Curriculum Reforms in Response to*

STEM Education: International Trends, Policies and Challenges. https://doi.org/10.1007/978-3-031-27334-6_16

Urdanivia Alarcon, D. A., Talavera-Mendoza, F., Rucano Paucar, F. H., Cayani Caceres, K. S., & Machaca Viza, R. (2023). Science and inquiry-based teaching and learning: a systematic review. In *Frontiers in Education*. https://doi.org/10.3389/feduc.2023.1170487

Zasiekina, T. (2023). Development and evaluation of educational literature: the curriculum of the discipline – 011 Educational, pedagogical sciences. In *Development and evaluation of educational literature: the curriculum of the discipline – 011 Educational, pedagogical sciences*. https://doi.org/10.32405/978-966-644-686-5-2022-12

Zhan, Z., Shen, W., Xu, Z., Niu, S., & You, G. (2022). A bibliometric analysis of the global landscape on STEM education (2004-2021): towards global distribution, subject integration, and research trends. *Asia Pacific Journal of Innovation and Entrepreneurship*. https://doi.org/10.1108/apjie-08-2022-0090