

A Critical Review of Literature on Scientific Attitude, Scientific Interest, and Problem-Solving Ability among Secondary School Students

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Abstract

At the secondary school level, the development of a scientific attitude to life, an interest in science and skills for problem solving are all considered as vital outcomes of science education. This critical assessment of the literature focuses on the interconnected concepts of scientific attitude, science interest and problem-solving skills among secondary school learners, drawing on national and international research findings over the last 20 years. The review is centred on the main theoretical viewpoints, empirical investigations and instructional methodologies that have influenced the development of these notions in traditional educational contexts. It also analyses the impact of cognitive, affective and contextual factors such as curriculum design, teaching approaches, socio-economic background, gender and school context on students' attitude toward science and their problem-solving skills. The review also examined the role of inquiry-based education, STEM programs, and experiential learning in fostering higher-order thinking and scientific attitude. It reveals the shortcomings of the research especially when contrasted with integrated studies that show a complete link between the three variables. The results demonstrate to the need of a holistic approach to scientific education that cultivates both academic success and critical thinking, curiosity and habits of lifetime learning. This assessment calls for future research and pedagogical initiatives for the comprehensive development of secondary students as scientifically literate persons.

Keywords: Science, Scientific Attitude, Science Interest, Problem-Solving Ability

Introduction

In this age of tremendous advances in the realms of science and technology, the training of human beings with a suitable scientific education has become the premier educational priority all over the world. The goal of modern scientific education is to develop a way of thinking and a set of skills that enable students to think critically, to solve problems relevant to the real world and to be active in the world beyond the mere transfer of factual information. These three features are the basic pillars of successful science learning, i.e. scientific mentality, curiosity in science and problem solving. These are three of the many ingredients needed for that growth. These abilities affect greatly the way pupils in secondary school comprehend, interpret and use scientific information, both within and outside the classroom.

Numerous educational programs and curricular frameworks, both nationally and internationally, emphasise the significance of having these components. For example, India's National Curriculum Framework (2005) and the National Education Policy (2020) emphasise the importance of inquiry-based learning and developing students' critical thinking skills.

Despite the existence of these frameworks, research continues to reveal that there are considerable gaps between expected outcomes and actual student success in a number of different disciplines. Many students, especially those in secondary school, exhibit evidence of declining interest in science, difficulties in addressing problems, or a lack of the scientific mindset required for logical scientific thinking. A scientific mentality is the individual's tendency to think critically and logically, to be objective and open-minded, and to respect the outcomes of scientific research. It affects the pupil's passion toward the scientific issue and the wish to question, test their knowledge and reevaluate what they have learnt. Science enthusiasm also generates engagement, continuous participation and a sense of personal importance within science education. Students who take part in science are more likely to be interested in scientific-related activities and to pursue jobs in STEM and other similar subjects. One of the most important results of a successful science education is the development of the ability to solve issues. In contrast, problem-solving ability is described as the ability to use knowledge and cognitive processes in a practical way to assess situations, solve problems, and draw useful conclusions. To bridge the gap between the aim and the reality, a comprehensive examination of the literature accessible on these three important attributes is required. A large number of studies have been undertaken independently on scientific attitude, scientific interest and problem-solving skills. But seldom are the results of different enquiries merged or synthesised into one body of knowledge. Other important contextual factors such as gender, culture, socioeconomic background and instructional processes, tend not to be discussed in full in the research. This study aims to review, analyse and synthesise the research literature on the development, determinants and links of scientific attitude, science curiosity and problem-solving skills among secondary school pupils. The objective of this study is to address the identified knowledge gap. The review makes an attempt at an in-depth analysis of both the known and the unknown in an effort to build the framework for future research and for the establishment of more effective instructional approaches.

Definition of Key Constructs

Science is the intellectual and practical activity including the systematic study of the structure and behaviour of the physical and natural world via observation and experiment Oxford Dictionary (2020) According to National Science Teachers Association (NSTA, 2018) "Science is a body of knowledge and a process. It is a technique of finding out what is in the universe and how those things work, today, in the past, and how they are likely to work in the future". Leading scholars and educators have characterised science in different ways. J. A. Zahorik (1975) thought of science as a body of knowledge obtained through methods based on observation. Zahorik (1975) stated that science is developed by methodical and continuous observation of natural phenomena. S. K. Kochhar (1986) has defined science as a methodical and systematic body of knowledge based upon facts, observation and experimentation, thus emphasising its empirical and logical aspect. Similarly, R. C. Sharma (2006) describes science as a systematised body of knowledge gained through observation and experimentation and aimed at discovering general facts about the natural world. In this sense, science is characterised to aim at discovering universal principles through objective investigation.

A scientific attitude is a combination of mental traits that represent an empirical, reasonable way of looking at the world. Its features are curiosity, objectivity, open-mindedness, critical thinking and respect for the evidence. Yadav (2005) describes a scientific mentality as "a tendency to approach problems logically, to seek empirical validation, and to be willing to

revise beliefs in light of new information”. Students with a strong scientific mindset are more likely to engage in scientific discourse, inquiry-based learning, and logically and scientifically approach challenges in the real world.

Science interest as an affective-motivational concept combines a learner’s emotional involvement and cognitive propensity toward science-related topics and activities. According to Krapp (2002), “interest in science is not only the desire to explore, understand and apply scientific knowledge but also enjoyment.” Interest often leads to deeper learning and long-term involvement with science.” Students with a high interest in science tend to be more focused, persistent and self-directed learners when they are engaged in science. This is a dynamic, context-sensitive concept influenced by teaching tactics, individual relevance and past experiences.

Problem solving competency refers to the ability to identify, analyse and create solutions for complex or unexpected issues using imagination, logic and previous knowledge. Within the framework of science education this involves an understanding of the nature of scientific issues, idea generation, designing experiments, evaluating data and assessing possible solutions. In his problem-solving analysis, Mayer (2008) distinguishes between two different categories: well-structured tasks and ill-structured tasks. Both kinds of jobs require higher-order cognitive skills and adaptability. If students are able to solve issues, then they will be more able to apply the theoretical knowledge they are learning in secondary school in real-world contexts and to their future academic or professional ambitions.

These basic aforementioned key constructs are quite a relevant conceptual basis for comprehending the significance of these basic constructions in science education. Science is not simply a body of organised information, it is a dynamic activity, a dynamic process of observation, experimentation, inquiry and evidence-based reasoning. A scientific way of thinking allows learners to explore scientific facts and problems in everyday life in an objective, analytical and logical manner, and they are receptive to new information and ideas. Scientific curiosity is likely to lead to active, persistent and meaningful engagement in scientific issues and activities on the part of learners. The learner’s emotional and motivational component stimulates learning. In contrast, problem-solving competence refers to the learner’s capacity to use scientific knowledge, reasoning, creativity and logical thinking to detect, evaluate and solve problems that arise in both academic and social contexts. These constructs are interconnected and successfully lead to the development of learners’ scientific understanding and higher order thinking abilities. These can be effectively developed through the combination of these constructs. A scientific mindset is described by reasonable and evidence-based reasoning. Interest is characterised by sustained involvement in learning. Problem-solving ability is characterised by the application of information to novel, real-world problems. Science is the knowledge and the method that helps us understand the natural world. A good understanding of these types of constructs is important for promoting meaningful science learning and developing learners who are inquisitive, rational, reflective and able to use scientific information effectively in their academic and everyday lives.

Research Objectives

1. To critically examine the existing corpus of literature on the development of a scientific mindset in secondary school children.

2. To examine the key characteristics identified in prior studies that affect the engagement of secondary students in science.
3. To analyse and evaluate research on how secondary scientific education enhances students' problem-solving ability.
4. To explore the relationship between scientific mindset, scientific interest and problem-solving skills reflected in the corpus of empirical and theoretical literature.

Need and Significance of the Study

In the continuously changing sectors of science and technology, the formation of scientific attitudes, scientific interests and problem-solving abilities of students of secondary schools has become important. Students today need to study the basics of science and also develop curiosity, critical thinking, and the ability to apply concepts to real-life circumstances. Many students still have inadequate analytical abilities, a passive learning orientation and a low enthusiasm in science, even with national and international education changes that emphasise inquiry-based and student-centered learning. It is important to note the interaction of these three notions: scientific attitude, science interest, and problem-solving skills, and how these three concepts contribute to the entire science learning. Previous research has looked at these characteristics in isolation, and there are few thorough literature reviews that bring together data from diverse fields. This study aims to fill this vacuum by systematically reviewing empirical evidence and identifying patterns, contradictions and consequences for educational practice and policy. This evaluation provides important information to the researchers, educators and curriculum designers within the framework of National Education Policy (2020) which stresses upon competency-based learning and scientific temper. The ultimate goal is to influence teaching practices to reinforce the scientific grounding of secondary education, to give students a feeling of purpose and to enable them to address issues in innovative and independent ways.

Methodology

A qualitative research design in the form of a critical literature review has been used in this study to analyse and synthesise prior studies on scientific attitudes, scientific interests and problem-solving skills of secondary school pupils. Secondary data was collected from peer-reviewed journal articles, dissertations, academic publications, research reports, and policy papers published from 2000 to 2024 using databases including ERIC, JSTOR, Scopus, ScienceDirect, and Google Scholar. The inclusion criteria were mostly based on English language studies that mentioned at least one of the three target conceptions and involved secondary school students in Indian and overseas contexts.

Delimitation of the Study

This study is limited to a qualitative analysis of the literature on secondary school students and their scientific attitudes, scientific interests, and problem-solving skills. The research included is published in English between 2021 and 2024 and is gathered from scholarly books, academic dissertations, peer-reviewed journals and policy documents available from reliable sources. Studies that were limited to primary or tertiary education, non-academic sources and studies not connected to the selected aspects were excluded. The study seeks a critical synthesis using thematic analysis, not primary data collection or statistical meta-analysis.

Review of Related Literature

1. A study by Wulandari, Syukri, and Murniati (2021) titled “Effect of Problem-Based Learning on Scientific Attitudes of Senior High School Students in Indonesia” This study was a quasi-experimental study involving three hundred Indonesian high school students. Attitudes toward science were measured by a series of pre and after tests. The results revealed that project-based learning significantly affected the students' scientific attitudes toward their level of curiosity, engagement and participation in scientific study.
2. Hadi, Juandi, and Rusdiana (2023) conducted a systematic review entitled “A Systematic Review of Secondary School Students’ Problem-Solving Abilities (1999–2022)”. This review examined more than fifty research on the development of problem-solving skills of secondary school students. Results showed that active learning strategies were very useful in improving problem-solving skills and also that teacher support and student motivation were important aspects that contributed to the success.
3. Jaleel and Philip (2023) conducted a study titled “Scientific Attitude and Achievement in Physics Among Secondary School Students”. The quantitative study was conducted with a total of five hundred students, and it used surveys and achievement tests to explore the association between scientific mindset and academic achievement in the subject of physics. The results showed that there was a favourable relationship between students’ scientific attitudes and their achievement in physics. This implies that the development of scientific attitudes will result in a rise in the general level of science achievement.
4. Mondal (2023) published an article in 2023 titled “Challenges and Prospects of Science Education and Secondary Education in India”. The present qualitative research was conducted through in-depth interviews with thirty science teachers and fifty students from various secondary schools in India. The research results show an urgent need to change the educational program in an effort to develop favourable attitudes toward science and to motivate students to pursue scientific issues, especially through practical learning.
5. An investigation entitled “Development and Validation of the Attitude Toward Science Literacy Scale for Secondary School Students” was performed by Çelik and Doğru (2024). This study used a quantitative approach to develop and validate the scale for measuring the attitudes of students toward science literacy. The statistics were collected from 500 pupils in secondary schools in Turkey. The findings showed that pupils who had a positive attitude toward science literacy also got superior results in numerous science related topics.
6. Hanifah, Mutmainah, and Kartika did research in 2024 titled “Impact of Problem-Based Learning on Junior High School Students’ Mathematical Problem-Solving Abilities”. This systematic review was intended to evaluate the impact of Problem-Based Learning (PBL) on students’ problem-solving abilities in learning mathematics. Articles from 2010 to 2023 were reviewed for the study. The study results showed that problem-based learning (PBL) considerably improved students’ problem-solving skills by promoting the development of critical thinking and improving their numerical comprehension.
7. In 2024, Tuveri, Steri and Fadda performed a research project called “Teaching Gravitational Waves through Storytelling and Theatrical Techniques for High School Students in Italy”. The research project employed a mixed-method approach to evaluate the impact of storytelling and theatrical techniques in students’ understanding of gravitational waves, using qualitative interviews and quantitative surveys. According to the findings of the study, it was established that these strategies had a substantial effect on the level of interest and conceptual comprehension that students had on the subject matter.
8. Sharma, S., & Bora, A. (2024) investigated upon the relationship between the metacognitive

skills and problem-solving capacity of secondary school students in India. Research design was correlation design. The present investigation was conducted on 200 pupils. The instruments used were problem solving exam and metacognitive awareness questionnaire. The findings demonstrated that a favourable relationship existed between metacognitive abilities and problem-solving skills. Students with more metacognitive awareness had better performance at problem-solving activities.

9. Gupta, C. & Chakravarti, A. (2024) carried out a study titled “Scientific Attitudes of Upper Primary School Students in Ahmedabad, India”. The study was survey type and data were obtained from 500 kids of urban and rural schools of Ahmedabad. The results showed that the scientific attitude of urban students was significantly greater than that of rural students, which highlighted the impact of environmental variables and availability of resources.
10. Himmawan, Kusumah, Suhendra (2024) conducted a study entitled “Systematic Review of Students’ Problem-Solving Ability in Mathematics Education”. The systematic review focused on problem solving ability of secondary school pupils in mathematics. Researchers showed that students’ ability to solve complicated mathematical problems rose dramatically after attending seminars on collaboration and problem-solving.
11. Nguyen, T., & Kim, H. (2024) researched on “Interactive Science Labs: A Case Study on Enhancing Problem Solving and Scientific Attitudes in Vietnamese Secondary Schools”. The study was conducted with 250 students from several secondary schools in Vietnam via interactive, practical science laboratory activities. Results demonstrated considerable increase in problem solving skills and attitudes toward science of the students. Students were more excited about learning science and more able to apply scientific techniques to real-world situations.
12. Gasparini et al. (2024) undertook an investigation upon “Cosmological and General Relativity for Upper Secondary Students: Motivation and Learning Outcomes”. A mixed-methods study was carried out in Italy with 150 high school pupils attending a special course on cosmology and general relativity. Results showed that there was considerable increase of the students’ learning result and motivation to take a job related to science after the course.
13. Tuveri, M., & Fanti, A. (2025) carried out a research study on “A Teaching-Learning Sequence for High School Students: Understanding Physics of Gravity”. The study was experimental and involved 100 students who were subjected to a teaching-learning sequence on gravitational physics. Results indicated that the sequence considerably boosted students’ understanding and heightened their interest in physics and related topics in science.
14. Kolomuç A., Demir Sağlam M. (2025) did a research on “Science Attitude Scale for Middle School Students with Special Needs”. The present study established and validated a measure of attitudes toward science for middle school pupils with exceptional needs. Data were gathered on 300 kids in inclusive education settings. The scale was shown to be quite reliable and valid to measure the scientific attitudes of the students in different courses. The results indicated that youngsters within the inclusive educational context were able to demonstrate varied and measurable attitudes toward science when utilising an appropriately adapted instrument.

Research Gaps

The review of existing literature shows that scientific attitude, scientific interest and problem-solving skills are significant elements of effective science learning among secondary school pupils. However, the existing studies have mostly studied these constructs individually or have focused on specific correlations between two variables. A large number of studies have also focused on the effectiveness of particular instructional approaches, such as, problem-based learning, interactive laboratory activities, storytelling and specialised teaching-learning

sequences, rather than critically synthesising the broader evidence concerning scientific attitude, scientific interest and problem-solving ability. Prior studies have indicated positive correlations between scientific attitude and science achievement and between metacognitive skills or active learning approaches and problem-solving ability, but relatively little attention has been paid to the understanding of how the scientific attitude, scientific interest and problem-solving ability are represented together in the existing literature. The review also points out a geographical disparity in that many studies have been conducted in countries such as Indonesia, Vietnam, Turkey, and Italy, but relatively fewer studies have studied similar variables in the Indian secondary-school context. Existing Indian studies have often been limited to specific variables, places, or groups of students, therefore offering a narrow scope for a thorough comprehension of the three elements. In addition, variables relating to students' educational context, locality, learning environment and access to resources have not been regularly explored in the literature. Individual findings are also difficult to generalise to broader contexts because to methodological discrepancies across existing studies, such as variances in research design, sample characteristics, measurement tools, and instructional situations. Hence, there is a need for a critical synthesis of the existing literature to point out the major trends, relationships, methodological patterns, inconsistencies and under-researched areas related to scientific attitude, scientific interest and problem-solving ability among secondary school students. This critical review seeks to fill this gap by synthesising the existing research on these three constructs and highlighting topics for further inquiry in secondary science education.

Major Findings of the Study

1. Relationship of Scientific Attitude to Science Achievement: The research studied reveal that students' attitude toward science is substantially associated to their academic accomplishment in science related areas. According to Jaleel and Philip (2023) and Çelik and Doğru (2024), pupils with higher levels of interest, objectivity and willingness to participate in scientific activities are likely to have superior academic accomplishment. Hence, a favourable scientific disposition has the potential to increase students' interest and persistence and their engagement in learning of scientific concepts.
2. Interest Matters in Learning Science: One of the important ingredients to keep students involved in science is interest. Gasparini et al., (2024) and related research has shown that students with a real interest in scientific topics are more likely to study concepts, participate in learning activities and have deeper understanding of the field. Interest in science is therefore recognised as a key motivational factor for meaningful and sustained involvement in science study.
3. Effect of Active Learning on Problem Solving Ability: Active and learner-centred strategies in the development of problem-solving abilities are well supported by literature. Problem-based learning and interactive practical exercises have demonstrated advances in students' ability to appraise situations, apply information, and devise acceptable solutions (Hanifah et al., 2024; Nguyen & Kim, 2024; Wulandari et al., 2021). These results suggest that providing students opportunity to work on real problems and learn actively may enhance their ability to apply scientific knowledge in contexts other than the typical classroom exercise.
4. Higher Order Thinking and Problem Solving: Several studies underlined the importance of

higher-order cognitive processes in the development of problem-solving talent. According to Hadi et al. (2023) and Himmawan et al. (2024), learning experiences that encompass reasoning, research, analysis, and reflection, can assist students in coping with complex situations. Such skills are especially important in science education, where students are expected not merely to learn content but to interpret evidence, evaluate options and create reasoned answers.

5. Importance of the Instruments Used for Measurement: The studied literature also indicates to the requirement of using adequate and scientifically elaborated instruments for assessing educational ideas. For example, Kolomuç and Demir Sağlam (2025) emphasised the requirement for validity and reliability of tools measuring students' attitudes toward science. When research involves numerous groups of learners, accurate assessment methodologies are of particular importance since they serve to ensure that the findings are representative of the construct being examined.

6. Education and culture. The impact of education and culture: The results in several countries suggest that the pupils' scientific attitude, passion and learning capacities cannot be considered independently from their educational environment. The curriculum, teacher help, classroom practices, the availability of learning tools and broader educational contexts can all make a difference to students' experiences of studying science. Thus, the evidence from the research in India and other countries shows the need to include contextual variables in understanding students' scientific attitudes, interests and problem-solving skills.

7. The Need for Appropriate Educational Support: The literature reviewed points to the need of providing learning experiences that actively foster scientific thinking, interest and problem solving. More opportunities to develop these talents may be offered to students by practical activities, inquiry orientated learning, issue-based projects and supportive school environments. Thus, the findings underscore the need for science education methodologies and curriculum provisions that go beyond the transfer of factual knowledge and provide students with the chance to enquire, question, reason and apply scientific ideas to important situations.

Implications of the Study

1. Curriculum development: The study states that integrating scientific learning with real-life situations and question-based methods is essential to developing a scientific mind-set and excitement.

2. Pedagogical Practices: Pedagogical practices that are more problem-based, interactive and student-centered can generate interest among students to study and empower them to develop answers for real-world problems.

3. Assessment Practices: The study stresses the importance of designing and giving validated tests to accurately assess students' knowledge, attitudes, and skills in the science domain.

4. Educator Preparation Programs: Educator preparation programs should contain new pedagogical techniques that arouse students' enthusiasm in science and develop their critical thinking skills.

5. Policy Relevant: The findings are policy relevant as they can be used to drive the design of strategies and solicitation of financing for programs that give high school students with

opportunity to engage in hands-on science learning.

6. Equity and inclusiveness: The study stresses the importance of creating science lessons that are inclusive of students with different interests, talents and backgrounds, and that offer differentiated training to each student.

7. Future Research: The findings open the door for research into the factors affecting academic achievement using experimental and longitudinal studies.

Conclusion

The present study was aimed at investigating the scientific attitude, scientific interest and problem-solving ability of secondary school pupils. The relationships among these three key conceptions pertaining to science education were examined in this study. The existing literature and empirical evidence thoroughly review that students' strong interest in science and their positive scientific perspective considerably contribute to their ability to deal with and solve scientific issues. The research demonstrates that students with an open mind, curiosity and a good attitude to scientific research are more likely to actively participate in the learning process, especially if their interest in the subject is actively developed. In addition, the study highlighted the significance of science interest not simply as an emotional element but as a mediating variable to bridge the gap between attitude and application. It noted that student enthusiasm in science heavily influences instructional methodologies, contextual relevance and opportunities for active engagement. Such features may contribute to or inhibit student participation in higher cognitive functions. The findings also pointed out the necessity of curriculum designs and educational interventions that promote inquiry-based, problem-solving activities that move beyond rote memorisation in an attempt to relate science training to real-world situations. The study identified considerable gaps in the existing literature, mainly the lack of integrated analysis of the three constituent elements, the inadequate use of established methods and the limited contextual application to secondary education in India. The gaps served to frame the analysis and underscore the importance of the investigation underway. Curriculum designers may produce more interactive science modules; teachers can revisit their teaching methods depending on the outcomes and governments can drive systematic reforms in assessment and pedagogy. Finally, the report suggests that future research investigate these variables by demographic variables (e.g., gender, grade level, and socioeconomic position) and consider the long-term implications for academic and career trajectories.

Finally, this study contributes significantly to the burgeoning field of science education by demonstrating that the development of scientific attitudes and interests is not a choice but a need for those who want to generate competent, enquiring and critical-thinking pupils. In addition to scientific education, it advocates for a shift toward inquiry-based, student-centered pedagogy that nurtures secondary school students' critical thinking, questioning and problem-solving skills that are crucial in today's knowledge-driven world.

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