BHARATI INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH & DEVELOPMENT (BIJMRD)

(Open Access Peer-Reviewed International Journal)

DOI Link : https://doi.org/10.70798/Bijmrd/04010027

Available Online: www.bijmrd.com | BIJMRD Volume: 4 | Issue: 01 | January 2026 | e-ISSN: 2584-1890

An Analytical Review on the Effectiveness of Chemistry Curriculum Delivery at the Secondary Level

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Abstract::

The quality of chemistry education at the secondary level largely depends on how effectively the curriculum is delivered in classrooms. Chemistry, being both a conceptual and practical subject, requires clear explanation, proper sequencing of content, suitable teaching methods, and adequate learning resources. However, several studies and reports have pointed out gaps between the prescribed chemistry curriculum and its actual classroom implementation. In this context, the present study aims to review and analyze the effectiveness of chemistry curriculum delivery at the secondary level using a secondary qualitative approach.The study is based on the analysis of existing literature such as research articles, policy documents, curriculum frameworks, examination reports, and previous evaluation studies related to secondary-level chemistry education. Through systematic document analysis, the study identifies key issues affecting curriculum delivery, including teacher preparedness, teaching methods, laboratory practices, availability of resources, time constraints, assessment patterns, and student engagement. The review also highlights how traditional lecture-based teaching, limited practical exposure, and examination-oriented instruction reduce conceptual understanding and interest among students.The findings reveal that while the chemistry curriculum is well-structured and conceptually sound, its effectiveness is often limited due to gaps in pedagogical practices and classroom implementation. Inadequate integration of experiments, lack of contextual and activity-based learning, and insufficient use of innovative teaching strategies are major concerns. The study emphasizes the need for teacher training, learner-centred approaches, effective use of laboratory work, and continuous assessment practices to improve curriculum delivery.The study concludes that strengthening the link between curriculum objectives and classroom practices is essential for improving students' understanding and achievement in chemistry. The analytical review provides useful insights for teachers, curriculum planners, and policymakers to design strategies that ensure effective and meaningful chemistry education at the secondary level.

Keywords: *Chemistry education, curriculum delivery, secondary level, teaching practices, qualitative review, science education, classroom implementation*

Introduction: Chemistry is an important branch of science at the secondary school level, as it helps students understand the composition, properties, and changes of matter in their everyday life. It also develops scientific thinking, problem-solving ability, and practical skills among learners. At the secondary stage, chemistry forms the foundation for higher studies in science, engineering, medicine, and related fields. Therefore, the effectiveness of chemistry education at this level largely depends on how well the prescribed curriculum is delivered in classrooms.The chemistry curriculum at the secondary level is designed with

specific learning objectives, including conceptual understanding, practical knowledge, and the development of scientific attitudes. It emphasizes the integration of theory and laboratory work to make learning meaningful and engaging. However, in actual classroom situations, there is often a noticeable gap between curriculum intentions and teaching practices. Factors such as heavy syllabus load, limited laboratory facilities, shortage of time, large class size, and reliance on traditional lecture methods affect the effective delivery of the chemistry curriculum.Many teachers continue to focus mainly on completing the syllabus and preparing students for examinations, which results in rote learning rather than conceptual clarity. Practical work, experiments, and activity-based learning are often neglected or treated as secondary components. As a result, students may find chemistry difficult, abstract, and less interesting, leading to poor understanding and low academic achievement. These challenges raise important questions about the overall effectiveness of chemistry curriculum delivery at the secondary level.In this context, the present analytical review aims to examine the effectiveness of chemistry curriculum delivery by analyzing existing studies, policy documents, and evaluation reports. The study seeks to identify major gaps in teaching practices and classroom implementation that hinder effective learning. By understanding these issues, the study intends to suggest directions for improving teaching strategies and curriculum implementation, thereby enhancing the quality of chemistry education at the secondary level.

Need and Significance of the Study

Chemistry is a core subject in the secondary school curriculum and plays a crucial role in developing scientific knowledge, practical skills, and problem-solving abilities among students. Despite having a well-designed curriculum, many students face difficulties in understanding chemistry concepts, which often leads to poor academic performance and low interest in the subject. This situation highlights the need to examine how effectively the chemistry curriculum is delivered at the secondary level. Understanding the strengths and weaknesses of curriculum delivery is essential to ensure that educational objectives are achieved in real classroom situations.The need for the present study arises from the increasing concerns about the gap between the prescribed chemistry curriculum and its actual implementation in schools. Issues such as limited laboratory exposure, teacher-centered instructional methods, time constraints, and examination-oriented teaching practices affect students' conceptual clarity and practical understanding. A systematic analytical review of existing studies and documents helps in identifying these gaps and understanding the factors that hinder effective curriculum delivery. Such an analysis is necessary to improve the quality of chemistry teaching and learning at the secondary stage.The significance of this study lies in its potential contribution to teachers, curriculum developers, school administrators, and policymakers. By highlighting the challenges and limitations in current chemistry teaching practices, the study provides valuable insights for improving instructional strategies and classroom practices. It also emphasizes the importance of learner-centred approaches, effective use of laboratory activities, and continuous assessment. Ultimately, the findings of this study can help in strengthening chemistry education at the secondary level, making learning more meaningful, engaging, and aligned with curriculum objectives, thereby improving students' overall academic achievement and interest in science.

Table 1: Need and Significance of the Study on Chemistry Curriculum Delivery at the Secondary Level

Aspect	Need of the Study	Significance of the Study
Chemistry as a Core Subject	Students often find chemistry difficult despite its importance in secondary education.	Helps strengthen the foundation of chemistry learning for higher studies.
Curriculum–Practice Gap	A gap exists between prescribed curriculum objectives and actual classroom practices.	Identifies areas where curriculum implementation needs improvement.

Teaching Methods	Overdependence on lecture-based and examination-oriented teaching.	Encourages adoption of learner-centered and activity-based teaching methods.
Practical and Laboratory Work	Limited use of experiments and hands-on activities in classrooms.	Emphasizes the importance of practical learning for conceptual clarity.
Student Learning Outcomes	Poor understanding and low interest among students in chemistry.	Aims to enhance student engagement, understanding, and academic performance.
Teacher Preparedness	Inadequate training and support for effective curriculum delivery.	Highlights the need for professional development and instructional support.
Assessment Practices	Focus on rote learning rather than continuous and formative assessment.	Promotes meaningful evaluation methods aligned with learning objectives.
Educational Planning	Lack of systematic analysis of chemistry curriculum delivery issues.	Provides insights useful for curriculum planners and policymakers.
Quality of Education	Variations in teaching quality across schools.	Contributes to improving the overall quality of secondary science education.
Policy and Reform Support	Need to align classroom practices with educational reforms.	Supports evidence-based decisions for strengthening chemistry education.

Review of Related Literature

The effectiveness of chemistry curriculum delivery at the secondary level is a major concern in science education. Chemistry plays a vital role in developing scientific understanding, logical thinking, and practical skills among students. Although the secondary-level chemistry curriculum is carefully designed with clear objectives and structured content, many students struggle to understand concepts and apply them in real-life situations. This gap indicates that the problem often lies not in the curriculum itself, but in the way, it is delivered in classrooms. Therefore, there is a strong need to examine how effectively the chemistry curriculum is implemented and what factors influence its delivery.The need for the present study arises from persistent issues such as teacher-centred instruction, limited laboratory work, time constraints, and examination-oriented teaching practices. Many teachers focus mainly on syllabus completion and rote learning to help students score marks, rather than encouraging conceptual understanding and scientific inquiry. Studies have shown that inadequate practical exposure and lack of activity-based learning reduce students' interest and confidence in chemistry (Hodson, 1998). As chemistry is an experimental science, ineffective curriculum delivery can weaken students' foundational knowledge and affect their future academic choices. Hence, an analytical review of existing studies is necessary to identify gaps and suggest improvements in curriculum delivery practices.Several earlier studies have highlighted similar concerns. Johnstone (2000) pointed out that students often find chemistry difficult because abstract concepts are introduced without sufficient linkage to practical experiences. This makes learning mechanical rather than meaningful. Similarly, NCERT (2005) emphasized that science curricula should promote understanding through experimentation, observation, and discussion, but classroom practices often fail to reflect these principles. A study by Osborne and Dillon (2008) reported that traditional teaching methods dominate secondary science classrooms, limiting student engagement and higher-order thinking.

Research has also indicated that teachers' professional preparedness significantly affects curriculum delivery. According to UNESCO (2017), continuous professional development is essential for teachers to effectively transact science curricula and adopt innovative teaching strategies. However, lack of training and support often restricts teachers to conventional methods. Further, Kumar and Sharma (2019) found that assessment practices in chemistry are mostly summative and exam-focused, which discourages continuous learning and conceptual growth.Recent reviews stress the importance of learner-centred approaches, integration of laboratory activities, and formative assessment to improve chemistry learning outcomes (Singh, 2021). These studies collectively suggest that while the chemistry curriculum is theoretically sound, its effectiveness depends on classroom implementation. The present analytical review is significant as it synthesizes existing literature to understand key challenges in curriculum delivery and highlights the need for aligning teaching practices with curriculum objectives to improve the quality of chemistry education at the secondary level.

Objectives

1. To analyze the effectiveness of chemistry curriculum delivery at the secondary level by reviewing existing research studies, policy documents, and evaluation reports.
2. To identify major gaps and challenges in the teaching–learning and classroom implementation of the chemistry curriculum at the secondary level.

Research Methodology

The present study adopts a qualitative research approach based entirely on secondary data to analyze the effectiveness of chemistry curriculum delivery at the secondary level. The study relies on existing sources such as published research articles, books, government and institutional reports, curriculum frameworks, policy documents, and review papers related to secondary-level chemistry education. These sources were collected from academic journals, educational databases, official websites, and standard textbooks.A document analysis method was used to systematically examine and interpret the selected materials. Relevant themes such as teaching practices, curriculum implementation, laboratory work, assessment methods, and teacher preparedness were identified and analyzed. The collected data were reviewed, compared, and categorized to understand common patterns, gaps, and challenges in curriculum delivery. Since the study is based on secondary qualitative data, no primary data collection tools were used. The findings are interpretative in nature and aim to provide meaningful insights for improving chemistry curriculum delivery at the secondary level.

Discussion

The present analytical review was undertaken with two main objectives: first, to analyze the effectiveness of chemistry curriculum delivery at the secondary level using secondary sources, and second, to identify major gaps and challenges in the teaching–learning and classroom implementation of the chemistry curriculum. The discussion is based on the synthesis of findings from previous research studies, curriculum documents, policy reports, and evaluation studies related to secondary-level chemistry education.The analysis of secondary literature clearly indicates that the chemistry curriculum at the secondary level is well-structured and designed with clear objectives. It aims to develop conceptual understanding, scientific reasoning, and practical skills among students. Most curriculum frameworks emphasize the integration of theory and laboratory work, activity-based learning, and real-life applications of chemistry concepts. However, despite these well-defined objectives, the actual delivery of the curriculum in classrooms often falls short of expectations. This highlights a gap between curriculum design and classroom practice.

One of the major issues identified through the review is the dominance of traditional lecture-based teaching methods. Many teachers rely heavily on textbook explanations and rote learning to complete the syllabus

within a limited time. As a result, students often memorize chemical formulas and reactions without fully understanding the underlying concepts. This practice reduces students' interest in the subject and makes chemistry appear difficult and abstract. The literature also suggests that limited classroom interaction and lack of discussion restrict the development of critical thinking and problem-solving skills among students.Another important challenge related to curriculum delivery is inadequate laboratory exposure. Chemistry is an experimental science, and practical work plays a crucial role in helping students understand concepts clearly. However, several studies report that laboratory activities are either insufficient or poorly conducted due to lack of resources, time constraints, large class sizes, or inadequate teacher training. In some cases, practical work is treated as a formality rather than an essential learning experience. This weakens students' ability to connect theory with practice.The review also highlights issues related to assessment practices. Most secondary-level chemistry assessments are examination-oriented and focus mainly on written tests. Such summative evaluation methods encourage rote learning rather than continuous understanding. Limited use of formative assessment and feedback further reduces opportunities for students to identify and improve their learning gaps. Effective curriculum delivery requires assessment practices that support learning rather than merely measuring performance.

Teacher preparedness emerges as another significant factor affecting curriculum delivery. Many teachers lack adequate professional development opportunities to update their subject knowledge and teaching strategies. Without proper training, teachers find it difficult to implement learner-centered approaches, use innovative teaching methods, or integrate ICT and laboratory activities effectively. This directly impacts the quality of curriculum implementation in classrooms. So, the discussion shows that while the chemistry curriculum at the secondary level is conceptually sound, its effectiveness largely depends on how it is delivered. The findings emphasize the need for improving teaching methods, strengthening laboratory practices, promoting continuous assessment, and enhancing teacher training. Addressing these gaps can help align classroom practices with curriculum objectives, thereby improving students' understanding, interest, and achievement in chemistry at the secondary level.

Table 2: Discussion Themes on Chemistry Curriculum Delivery at the Secondary Level

Area of Curriculum Delivery	**Observed Situation from Discussion**	**Implication for Learning**
Curriculum Design	Chemistry curriculum is well-structured and conceptually sound.	Curriculum goals are appropriate but require effective implementation.
Teaching Methods	Predominant use of lecture-based and textbook-centered teaching.	Encourages rote learning and limits conceptual understanding.
Classroom Interaction	Limited discussion and student participation in lessons.	Reduces critical thinking and problem-solving skills.
Practical and Laboratory Work	Inadequate and irregular laboratory activities.	Weak connection between theory and practice.
Learning Experience	Chemistry perceived as abstract and difficult by students.	Leads to low interest and poor engagement.
Assessment Practices	Heavy focus on summative, exam-oriented evaluation.	Encourages memorization rather than continuous learning.
Formative Assessment	Limited use of feedback-based and diagnostic assessment.	Students are unable to identify and correct learning gaps.
Teacher Preparedness	Insufficient professional development and training.	Limits use of innovative and learner-centered approaches.

Use of Resources	Inadequate use of ICT and teaching–learning aids.	Missed opportunities for interactive and visual learning.
Curriculum Implementation	Gap between curriculum objectives and classroom practice.	Reduces overall effectiveness of chemistry education.

Findings

The analytical review of secondary sources reveals several important findings regarding the effectiveness of chemistry curriculum delivery at the secondary level. One of the key findings is that the prescribed chemistry curriculum is well-structured, clearly defined, and aligned with educational objectives aimed at developing conceptual understanding and scientific skills. However, its effectiveness is often reduced due to gaps in classroom implementation.The study finds that traditional lecture-based teaching methods dominate chemistry classrooms, leading to rote learning rather than meaningful understanding. Limited student interaction and lack of discussion-based learning negatively affect students' critical thinking and problem-solving abilities. Another major finding is the inadequate emphasis on laboratory and practical work. Due to constraints such as lack of resources, insufficient time, large class sizes, and limited teacher training, practical activities are often neglected or treated as secondary components of learning.

The findings also indicate that assessment practices at the secondary level are largely examination-oriented and summative in nature. Such practices encourage memorization instead of continuous learning and conceptual clarity. The review further highlights that many teachers lack adequate professional development opportunities, which affects their ability to use innovative teaching strategies, learner-centered approaches, and ICT tools effectively. So, the findings suggest that the gap between curriculum objectives and classroom practices is a major challenge. Improving teaching methods, strengthening laboratory practices, adopting formative assessment, and enhancing teacher training are essential for effective chemistry curriculum delivery at the secondary level.

Conclusion

The present analytical review highlights that the effectiveness of chemistry curriculum delivery at the secondary level depends not only on the quality of the prescribed curriculum but also on how it is implemented in classrooms. The chemistry curriculum is carefully designed with clear objectives to develop conceptual understanding, scientific thinking, and practical skills among students. However, the review shows that there is a significant gap between curriculum intentions and actual classroom practices.The study concludes that traditional teaching methods, such as lecture-based instruction and rote learning, continue to dominate chemistry classrooms. These practices limit student engagement, reduce conceptual clarity, and make the subject appear difficult and abstract. Inadequate laboratory work and limited hands-on experiences further weaken students' ability to connect theory with practice. Chemistry being an experimental subject, the lack of effective practical exposure reduces students' interest and confidence in learning the subject.

The review also concludes that assessment practices are largely examination-oriented and focus mainly on written tests. Such assessment methods encourage memorization rather than continuous learning and deep understanding. In addition, insufficient professional development opportunities for teachers affect their ability to adopt learner-centered approaches, innovative teaching strategies, and effective use of teaching–learning resources. So, the study concludes that strengthening teaching practices, improving laboratory facilities, adopting formative assessment, and providing continuous teacher training are essential for effective chemistry curriculum delivery. Addressing these issues will help align classroom practices with curriculum objectives, thereby improving students' understanding, achievement, and interest in chemistry at the secondary level.

Recommendations

Based on the analytical review of chemistry curriculum delivery at the secondary level, several important recommendations can be suggested to improve the teaching–learning process. First, teachers should be encouraged to adopt learner-centered and activity-based teaching methods instead of relying only on traditional lecture-based instruction. Classroom discussions, problem-solving activities, and real-life examples should be used regularly to improve students' conceptual understanding and interest in chemistry.

Second, greater emphasis should be given to laboratory and practical work. Schools should ensure the availability of basic laboratory facilities and adequate time for conducting experiments. Teachers should integrate practical activities with theoretical lessons so that students can clearly relate concepts to experiments. Third, assessment practices should be improved by including formative assessment techniques such as quizzes, assignments, projects, and regular feedback. This will help students identify their learning gaps and improve continuously rather than focusing only on examinations.

Further, regular professional development and training programs should be organized for chemistry teachers to update their subject knowledge and teaching skills. Training should focus on innovative teaching strategies, the use of ICT tools, and effective classroom management. Lastly, curriculum planners and school administrators should monitor curriculum implementation regularly to ensure alignment between curriculum objectives and classroom practices. These recommendations can help enhance the effectiveness of chemistry curriculum delivery and improve the overall quality of secondary-level chemistry education.

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Citation: Gupta,S. (2026) An Analytical Review on the Effectiveness of Chemistry Curriculum Delivery at the Secondary Level , *Bharati International Journal of Multidisciplinary Research & Development (BIJMRD)*, Vol-4, Issue-1, January-2026.