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SYSTEMATIC LITERATURE REVIEW: THE IMPLEMENTATION OF CASE-BASED LEARNING (CBL) IN CHEMISTRY EDUCATION

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Abstract
This study aims to analyze research trends, variations in the application of syntax, as well as the effectiveness and limitations of Case-Based Learning (CBL) in chemistry education. The method used is a Systematic Literature Review (SLR) guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Of the 30 articles selected, 17 met the criteria and were analyzed further. The articles analyzed were published in the period 2010–2025. The reviewed articles show that the implementation of CBL has developed since 2010, with the highest number of publications in Turkey and samples predominantly at the university level. The topics covered vary, including reaction rates, solution equilibrium, acids and bases, and green chemistry. The commonly used syntax includes case orientation, analysis and discussion, literature review, presentation of results, and concept clarification. In general, CBL has been proven to improve cognitive aspects (concept understanding, achievement, retention) and process aspects (motivation, attitude, and critical thinking skills). However, CBL also has limitations, such as small sample sizes, lack of integration of modern chemistry topics, limited implementation at the high school level, and the time consuming nature of its application.

Keywords: case-based learning (CBL), chemistry, contextual learning

1. Introduction

Chemistry learning is considered highly important due to its abstract nature. This abstractness requires students to understand the relationship between theoretical concepts and their real life applications, which can lead to misconceptions and short-term understanding (Arsyad et al., 2024). The use of conventional teaching methods dominated by teacher lectures tends to worsen this issue, as it does not provide students with active and contextual learning opportunities to understand complex chemistry concepts and relate them to real-world phenomena (Arsyad et al., 2024). Conventional methods that focus on teacher-centered instruction create learning environments where students struggle to connect symbolic representations or abstract concepts with real phenomena, making chemistry often perceived as difficult (Sari et al., 2023; Yıldıran Sönmez, 2015).

Moreover, the complexity of chemistry topics such as acid-base reactions, stoichiometry, and chemical kinetics can cause a high cognitive load if not combined with contextual approaches. This, in turn, leads to low student motivation and engagement in learning (Arsyad et al., 2024). Even when students learn complex materials, they still struggle to apply that knowledge to solve real-world problems or think creatively because they lack contextual learning experiences (Arsyad et al., 2024). The gap between theory and application not only results in poor learning outcomes but also decreases students' confidence in solving scientific problems, thereby reducing their motivation and participation in chemistry learning (Sari et al., 2023; Yıldıran Sönmez, 2015).

Therefore, there is a need for innovative, student-centered, and contextual learning models. One approach that can address this need is Case-Based Learning (CBL). CBL is considered a promising learning strategy because it embeds abstract chemistry concepts into real world phenomena (Çam & Geban, 2016; Dewi et al., 2022). This model is defined as an approach where students are presented with cases that reflect real life situations in industrial, environmental, and research contexts (Dewi et al., 2022). These designed cases encourage students to engage in critical inquiry, collaboration, and problem solving (Dewi et al., 2022). The approach bridges theoretical knowledge with practical application and helps students grasp chemistry concepts that are often perceived as difficult (Dewi et al., 2022).

CBL is a student centered learning method that emphasizes discussion and collaboration among students. Each student is encouraged to use prior knowledge, analyze data, integrate theory with practice, and draw conclusions based on evidence (Dewi & Rahayu, 2024). In general, CBL includes the following learning stages: case orientation, exploration and discussion, and analysis and reflection (Dewi & Rahayu, 2024). CBL emphasizes real life contexts to enhance student motivation, as students are more likely to understand chemistry material that relates to their personal experiences and future careers (Günter et al., 2018; Uy Jr. & Tan, 2025). Therefore, the implementation of Case Based Learning (CBL) serves as an effective solution to longstanding problems in chemistry education, such as abstract content, fragmented concept perception, and student misconceptions (Uy Jr. & Tan, 2025; Magwilang, 2022).

In various efforts to improve the teaching and learning process, case-based learning has been utilized in educational literature over the past 25 years (Belford & Herreid, 2013). Quantitative and qualitative analyses from various studies have shown that CBL has a positive impact on both cognitive and affective learning outcomes. Students often report increased learning motivation, satisfaction, and willingness to independently explore complex chemistry concepts (Magwilang, 2022).

However, despite various studies reporting these positive impacts, to date, there has been no study that systematically summarizes and maps trends in CBL implementation in chemistry education. These studies are still limited to individual case studies and do not provide a comprehensive picture of CBL implementation in chemistry education, thus indicating a lack of clear mapping and unclear patterns of CBL implementation in chemistry learning. Furthermore, differences in case design and implementation strategies make it difficult to conclude the characteristics of CBL in chemistry learning.

This condition is an important problem due to the lack of a comprehensive picture of the application of CBL in chemistry learning, which has the potential to hinder educators in designing learning and research. Therefore, a literature review of previous studies on CBL is needed to clarify the trend of CBL application from year to year in chemistry learning. This article aims to: (1) describe the trend of Case-Based Learning application based on year, country, and sample in chemistry learning; (2) analyze the similarities and differences in the application of Case-Based Learning syntax in chemistry learning; (3) identify the effectiveness and limitations of Case-Based Learning in chemistry learning. The results of this study are expected to provide an overview of the application of CBL in the field of chemistry that can be used as a basis for further research.

2. Methods

2.1 Study Design

This study employed the Systematic Literature Review (SLR) method to examine and synthesize research findings related to the implementation of Case-Based Learning (CBL) in chemistry education. The systematization of the literature was conducted following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher, 2009). The PRISMA framework was chosen to ensure transparency in article selection and to enhance the accuracy of the obtained results.This study used the Systematic Literature Review (SLR) method with qualitative synthesis. Meta-analysis was not performed because the characteristics of the articles analyzed showed diverse research designs and outcome variables, so the synthesis was conducted descriptively.

2.2 Literature Search

Data were collected from four main databases: Education Resources Information Center (ERIC), Google Scholar, ScienceDirect, and Wiley Online Library. In September 2025, an initial search was conducted across these four databases. The keywords used in the article search included: “Case-Based Learning” AND “Chemistry”; “Case-Based Learning” AND “Chemistry Education”; “CBL” AND “Chemistry”; “Case Study Learning” AND “Chemistry”; and “Case-Based Instruction” AND “Chemistry.” Articles published between 2010 and 2025 were included. The initial search results were then screened based on the following inclusion and exclusion criteria:

Table 1.
Inclusion and Exclusion Criteria of Articles

Inclusion Criteria	Exclusion Criteria
1. Articles that discuss the implementation of Case Based Learning (CBL) in chemistry education.	1. Articles that discuss CBL outside of chemistry education (e.g., medicine, nursing, or non-chemistry fields).
2. Articles that are either empirical studies or conceptual/pedagogical papers relevant to CBL.	2. Articles that only mention CBL briefly without in depth discussion.
3. Articles published in national or international journals.	3. Articles that are opinion pieces, editorials, or non scientific publications.
4. Articles available in full text format.	4. Articles not available in full text or only available as abstracts.

Inclusion and exclusion criteria were established to ensure that the articles analyzed align with the research objectives. Selected articles must specifically address the implementation of Case-Based Learning (CBL) in chemistry education, ensuring that the data analyzed is relevant to the intended research focus. The articles used included both empirical research and conceptual studies to obtain a clear picture of the impact of CBL implementation, both from a practical perspective and a theoretical framework.

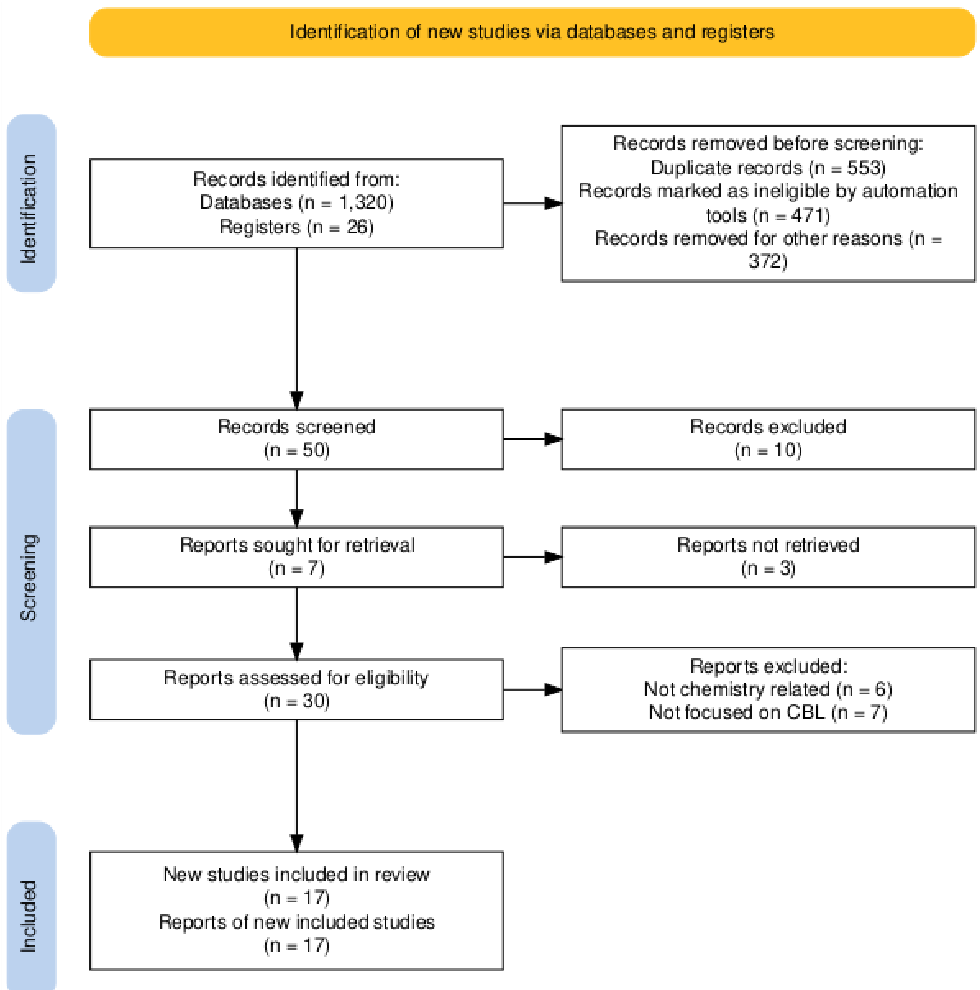
Articles were limited to national and international journals to ensure that sources came from credible scientific publications. Furthermore, only articles with full text were included to allow for in-depth analysis. Conversely, articles excluded from the analysis were those that discussed topics outside of chemistry education, only briefly mentioned CBL without discussing its implementation, were opinion pieces or non-scientific publications, and articles with incomplete text.

2.3 Study Selection Process

The identification process began with a literature search in the ERIC, Google Scholar, ScienceDirect, and Wiley Online Library databases using keywords such as “Case-Based Learning” and “Chemistry.” This search initially yielded 1,346 records. Of these, 553 records were identified as duplicates and removed from the analysis. In addition, 471 records were deemed ineligible, and 372 records were excluded for other reasons unrelated to the research criteria. At the initial screening stage, 50 articles remained. From this set, screening was conducted with a specific focus on the implementation of Case-Based Learning in educational settings, both at the school and university levels. Based on this screening, 30 articles were found to meet the inclusion criteria. These 30 articles were then assessed in more depth regarding their discussion of CBL.

Upon further screening, 6 articles were excluded because they discussed CBL in non-chemistry fields such as medicine, nursing, or other unrelated disciplines. Additionally, 7 articles were excluded for only mentioning CBL briefly without an in-depth discussion. As a result, a total of 17 articles were selected for comprehensive analysis. This selection process is illustrated in the PRISMA flow diagram, which visually represents each step of identification, screening, and inclusion of research articles. The diagram shows the progression from the initial number of articles to the final number included in the analysis. The PRISMA diagram for this study is presented in Figure 1.

Figure 1.
PRISMA Flow Diagram



2.4 Data Extraction and Coding Process

A total of 17 articles that met the inclusion criteria were extracted using the PICOC framework (Population, Intervention, Comparison, Outcome, Context) to obtain detailed information. The analysis of each study was conducted as follows:

- Population: The type of sample or population involved (e.g., high school students, university students, or chemistry teachers).
- Intervention: The implementation of Case-Based Learning (CBL) in chemistry education.
- Comparison: The comparison of CBL with other teaching methods (e.g., conventional, Problem-Based Learning, or other instructional models).
- Outcome: The research results, such as improvement in conceptual understanding, learning motivation, and other related outcomes.
- Context: The learning environment used in the study (e.g., high school, university, online class, etc.).

3. Result and Discussion

Discussion

3.1 Trends and Characteristics of CBL Research in Chemistry Education

A total of 17 articles were analyzed to identify the characteristics of Case Based Learning (CBL) research in chemistry education. These characteristics were classified into four categories: year of publication, country, sample level, and subject matter. The summary of these classifications is presented in Table 2. Based on Table 2, the publication distribution is as follows: 2010 (2 studies), 2011 (1 study), 2012 (2 studies), 2014 (1 study), 2015 (3 studies), 2017 (3 studies), 2019 (2 studies), 2020 (1 study), 2021 (1 study), and 2025 (1 study). This pattern indicates that the application of CBL began to attract attention starting from the 2010s. This aligns with the rise of innovative learning approaches that emphasize student-centered learning and higher-order thinking skills (Dewi & Rahayu, 2024).

The research themes highlighted during each period are as follows:

- **2010–2015:** 9 publications with themes such as *reaction rate, solution equilibrium, petroleum, and gas laws.*
- **2016–2020:** 6 publications with themes such as *acids and bases, acid-base titration, BOD (Biochemical Oxygen Demand), and chemical weapons.*
- **2021–2025:** 2 publications with the theme of *green chemistry.*

Table 2.
Characteristics of CBL Research in Chemistry Education

Author	Country	Sample	Subject Matter
Çam & Geban (2017)	Turkey	Pre-service elementary school teachers	Acids and Bases

Author	Country	Sample	Subject Matter
Yalçınkaya et al. (2012)	Turkey	11th-grade high school students	Reaction Rate
Çam & Geban (2010)	Turkey	11th-grade high school students	Solution Equilibrium
Ballard & Mooring (2021)	United States	High school students	Green Chemistry
Dewi & Hamid (2015)	Indonesia	10th-grade high school students	Petroleum
Günter et al. (2019)	Turkey	University students	Acid-Base Titration
Günter & Alpat (2017)	Turkey	University students	Biological Oxygen Demand (BOD)
Hartfield (2010)	Australia	University students	—
Kulak et al. (2017)	Canada	University students	—
Sümen & Şendur (2015)	Turkey	11th-grade high school students	Reaction Rate
Kulak & Newton (2014)	Canada	—	—
Adesoji & Idika (2015)	Nigeria	High school students	—
Şendur (2012)	Turkey	University students	Gas Laws
Thibaut & Schroeder (2020)	United States	University students	—
Alpat et al. (2011)	Turkey	University students	—
Uy & Tan (2025)	Philippines	9th-grade students	—
Williams (2019)	United States	University students	Chemical Weapons

During the 2010–2015 period, the topics explored were dominated by fundamental chemistry concepts, including reaction rates, solution equilibrium, petroleum, and gas laws. Initially, the case-based approach was implemented to address common misconceptions students had regarding basic chemistry topics prevalent in the early 2010s. One study found that case based learning improved students' understanding of solubility equilibrium compared to traditional methods and was effective in correcting misconceptions (Çam & Geban, 2013).

Then, during the 2016–2020 period, there was a transition toward topics integrating laboratory practices, such as acids and bases, biochemical oxygen demand (BOD), and chemical weapons. These topics were used to bridge theoretical concepts with experimental applications in chemistry learning. In the following period, 2021–2025, the focus shifted to *green chemistry*. Recent research during this time reflects a growing commitment to sustainability and environmental awareness in chemistry education (Mellyzar et al., 2025). Bibliometric analyses revealed a significant increase in publications related to green chemistry education, particularly from countries such as the United States, Canada, and the United Kingdom (Irfani, 2024).

The description in Table 2 also shows that two articles addressed the topic of reaction rates. The main difference between these studies lies in the types of cases used. Yalçınkaya et al. (2012) employed simple and conceptual cases such as "Why do our eyes sting when cutting onions?" and "Why does temperature affect the reaction rate?", which are microscopic and conceptual in nature. In contrast, Sümen & Şendur (2015) utilized more complex and contextual cases drawn from real-world phenomena, such as "coal mine explosions," "catalytic converters in vehicles," and "glow sticks," linking reaction rate concepts with environmental, technological, and safety issues.

Beyond the material aspect, the number of publications per country also shows interesting trends. Turkey has the highest number of publications (8 studies), followed by the United States (3 studies), Indonesia (1 study), Australia (1 study), Canada (2 studies), Nigeria (1 study), and the Philippines (1 study). The dominance of Turkey indicates the country's strong emphasis on contextual and case-based learning in the field of chemistry. The next analysis focuses on the educational level of the samples. Case-Based Learning (CBL) has been applied across various levels of education, from schools to universities. At the university level, there are 9 studies involving undergraduate students and 7 studies conducted with secondary school students (grades IX, X, and XI), while 1 study was a pedagogical article without direct samples. This shows that CBL research is predominantly conducted at the university level, as university students are expected to develop critical thinking, problem solving, and collaborative skills all of which are central to the CBL approach (Günter et al., 2019).

3.2 Variations in CBL Syntax and Its Relation to the Characteristics of Chemistry Content

Based on the analysis of 17 articles, the implementation of Case-Based Learning (CBL) in chemistry demonstrates a generally similar syntactical pattern, though differences exist in the way materials are applied, cases are presented, and learning activities are conducted. Although the basic stages are relatively consistent beginning with case presentation, case analysis, group discussion, and presentation each study adapts or applies these stages differently according to the chemistry topic and the sample level (students or university students). Most studies employ the following core learning stages:

1. **Case Orientation:** Students are introduced to a case (a contextual problem) or a real-world phenomenon.
2. **Analysis and Discussion:** Students are divided into groups and discuss the given case under the teacher's guidance.
3. **Literature Review:** In small groups, students solve the case by consulting relevant scientific literature and chemistry concepts.

4. **Presentation and Concept Clarification:** Each group presents the results of their case analysis, followed by a Q&A session between groups. This activity reinforces the link between theory and the phenomenon under study.

The similarities among these syntaxes indicate that CBL implementation always begins with the introduction of a case. The learning process is student centered, with the teacher acting solely as a facilitator and moderator guiding small and large group discussions and moderating question and answer sessions. However, variations occur in how these stages are executed, depending on the characteristics of the content and the students' academic level.

Differences Based on Sample Level

Differences in educational levels affect how CBL is applied, mainly due to variations in learning autonomy between university students and secondary school students.

At the university level, CBL is often implemented through scientific inquiry combined with laboratory practice. The case analysis stage is typically integrated with hands-on laboratory work or mini research projects. For instance, Williams (2019) applied CBL in teaching chemical weapons, consisting of two stages:

- In the first stage (proficiency testing), students act as chemical analysts tasked with identifying unknown compounds using various spectroscopic instruments.
- In the second stage (assessment of chemical weapon risk), students determine the compound's structure from given data and evaluate its potential misuse as a chemical weapon based on OPCW documentation.

Through this activity, students connect chemical analysis with social and ethical issues regarding the use of chemicals. Another example is provided by Günter et al. (2019), who implemented CBL in acid-base titration. The stages included case analysis, case presentation, and experimental design, which was then carried out in the laboratory under the teacher's supervision. Similarly, Alpat et al. (2011) applied CBL through three main phases—case analysis, research and discussion, and evaluation via laboratory experiments. Students solved a case about mislabeled weak acid solutions by researching related concepts and testing them directly in the lab.

At the high school level, case-solving activities tend to rely more on literature-based discussions rather than laboratory work. Here, the teacher's role is crucial in directing case analysis and preventing misconceptions. For example, Dewi & Hamid (2015) divided students into small groups of five and assigned a case related to petroleum. After small-group discussions, the entire class engaged in a larger group Q&A session. Case resolution was achieved through literature-based discussions rather than laboratory experiments. Thus, the difference in syntax between university and high school students lies not in the sequence of stages but in the activities conducted within each stage. University students integrate laboratory practice into case-solving, whereas high school students primarily rely on literature review using credible learning resources.

Differences in Cases Based on Material Characteristics

The nature of the subject matter is a key factor determining the type of cases used and the depth of CBL application. The following outlines the characteristics of the materials used in CBL implementation:

1. **Abstract and Conceptual Material**
   Dewi & Hamid (2015) explored petroleum as a topic. This material is abstract since the visible form of petroleum does not reveal its underlying formation process or chemical composition, which cannot be observed directly. Thus, a contextual approach is necessary to make the concept more comprehensible to students.
   Sendur (2012) implemented gas laws with students, a conceptual topic rich in theoretical frameworks. The study introduced cases such as:
   - *Hyperbaric fish traps and ear pain* (Boyle-Mariotte's Law),
   - *Nitrogen-filled tires and perfume bottle explosions* (Amonton's Law),
   - *Golf courses in Turkey* (Avogadro's Law), and
   - *Lifeboats* (Charles' Law and the Ideal Gas Law).
     For example, in the "perfume bottle explosion" case, students read about an incident where someone accidentally threw a perfume bottle into a fire, causing it to explode and injure bystanders. Students were asked to explain the explosion using gas laws, specifically Amonton's Law (the relationship between gas pressure and temperature). Through this case, students linked the concepts of pressure and temperature to real-world events and formulated equations describing the explosion mechanism.

2. **Material Involving Direct Experimentation**
   Examples include acid-base reactions, BOD, and titration topics. These subjects encourage integration between CBL and laboratory activities. The case analysis phase becomes data-driven exploration, while the reflection stage connects experimental findings to theoretical chemistry principles.

Differences in Case Presentation Formats

Variations in CBL implementation in chemistry are not only determined by subject matter and educational level but also by the way cases are presented during the case orientation stage. Based on the synthesis, three main case presentation patterns were identified:

1. **Image-Based or Animated Cases**
   Alpat et al. (2011) demonstrated the use of illustrated animation in case presentation. Students first viewed an animation depicting a real laboratory scenario about mislabeled weak acid solutions and their impact on experimental results. The animation not only captured attention and motivated learners but also visually contextualized the problem and prompted critical thinking about possible errors and solutions. In terms of syntax, using animations enhances the case orientation phase by providing visual context before analysis, making exploration more meaningful as students already have a mental model of the situation.

2. **Contextual Narratives from Everyday Life**
   The second type commonly used involves real-life narratives derived from daily phenomena. Çam & Geban (2017) discussed a case about the failure of olive trees to grow properly due to soil acidity differences. Students analyzed the problem by revisiting concepts of acids, bases, and soil pH. In another study, Çam & Geban (2010) used a case about washing machine damage caused by hard water. Students acted as small research teams to identify the cause and propose chemical solutions based on solubility equilibrium concepts.
3. **Research-Based Real Cases**
   These cases stem from authentic scientific or biochemical research, as shown in studies by Kulak et al. (2017) and Hartfield (2010). In Kulak et al. (2017), the case involved Avery, a 22-year-old fitness trainer who suffered acute liver failure after consuming a fat-burning supplement containing usnic acid. Students answered data driven biochemical questions involving ATP levels, NAD^+/NADH ratios, and H_2O_2 concentrations. Similarly, Hartfield (2010) used actual biochemical research papers containing data on enzyme activity, metabolism, and molecular mechanisms. Students analyzed and solved problems based on real research findings rather than instructor-generated cases.

Overall, these three case presentation formats do not alter the sequence of stages in the CBL syntax but influence the depth of material analysis, types of activities, and levels of student engagement at each stage of learning.

3.3 Analysis of the Effectiveness Variables and Limitations of CBL Implementation in Chemistry

Based on the 17 analyzed articles, the next discussion focuses on the impact of Case-Based Learning (CBL) on chemistry education. The effects are categorized into two main variables: cognitive variables and process variables, as presented in Table 3.

Table 3.
Effectiveness of CBL Based on Variables

No	Cognitive Variables	Process Variables
1	Conceptual Understanding (Yalçınkaya et al., 2012; Ballard & Mooring, 2021; Dewi & Hamid, 2015; Sümmen & Şendur, 2015)	Chemistry Motivation (Çam & Geban, 2017; Williams, 2019)
2	Generic Science Skills (Dewi & Hamid, 2015)	Attitude Toward Chemistry (Çam & Geban, 2017; Çam & Geban, 2010; Alpat et al., 2011; Adesoji & Idika, 2015)
3	Academic Achievement (Günter et al., 2019; Günter & Alpat, 2017; Adesoji & Idika, 2015; Sendur, 2012)	Epistemological Beliefs (Çam & Geban, 2010)

No	Cognitive Variables	Process Variables
4	Chemistry Retention (Kulak et al., 2017; Uy & Tan, 2025)	Problem-Solving, Teamwork, Communication, and Data Analysis Skills (Hartfield, 2010)

Based on Table 3, it can be seen that the implementation of CBL generally improves all variables in both cognitive and process aspects, with the exception of motivation. In the cognitive aspect, CBL has been proven effective in enhancing conceptual understanding, generic science skills, academic achievement, and chemistry retention. This is because students are trained to connect theory with real life cases, leading to deeper and more lasting understanding. In the process aspect, CBL can improve students' attitudes toward chemistry, epistemological beliefs, problem solving, teamwork, communication, and data analysis skills. However, there are differing results regarding the motivation variable. The study by Çam & Geban (2017) revealed that CBL was not yet effective in improving chemistry motivation due to limited time; ideally, motivation enhancement should occur gradually. In contrast, Williams (2019) found that CBL increased chemistry motivation among university students.

In addition to its advantages, several limitations in CBL implementation have been identified. Studies by Günter & Alpat (2017) and Sendur (2012) reported that small sample sizes caused minimal differences between control and experimental groups. Moreover, Günter et al. (2019) found that CBL requires significantly more time than traditional laboratory practices, as students must read cases, explore related subtopics, and design experiments before conducting practical work. Furthermore, most studies have been conducted at the university level, while implementation at the high school level remains relatively rare. In fact, applying CBL in high schools is highly beneficial, given that chemistry at this level involves many abstract concepts and misconceptions. Additionally, the topics used are still limited to traditional chemistry and have not yet covered modern chemistry themes (e.g., renewable energy, nanochemistry, or environmental chemistry), which have strong potential to be developed into case studies. Therefore, based on the analysis of these limitations, there is room for further development in chemistry education. Future research should involve larger sample sizes, expand the application of CBL in high school settings, and incorporate modern chemistry topics. With these improvements, it is expected that CBL implementation can further enhance both cognitive and process skills in chemistry learning.

3.4 Identification of Case-Based Learning Characteristics in Chemistry Education

Based on the results of the synthesis of the articles described, Case-Based Learning (CBL) in chemistry learning is not applied in a uniform form, but can show consistent main characteristics even though it is carried out with different learning designs (Çam & Geban, 2011). In general, the application of CBL begins with the use of contextual cases sourced from everyday life phenomena related to the chemistry concepts that have been learned (Yalçınkaya et al., 2012). These cases are used to encourage students to analyze problems, connect chemistry concepts with real life, and develop scientific reasoning through discussion (Çam & Geban, 2011). Although the cases used are different, there are similarities in the learning stages, the articles described show that CBL positions students as active learners in building conceptual understanding through case-based problem solving (Yalçınkaya et al., 2012; Çam & Geban, 2011). Thus, CBL in chemistry learning is defined as a learning approach that has the characteristics of real-context communication, discussion and analysis, even though it is applied in a variety of learning frameworks.

4. Conclusion

Based on the synthesis of 17 articles on Case-Based Learning (CBL) in chemistry education, it can be concluded that the application of CBL has shown significant development from 2010 to the present. The majority of studies were conducted in Turkey and primarily implemented at the university level. Most of these studies employed a similar instructional sequence, consisting of case orientation, analysis and discussion, literature review, presentation of results, and concept clarification. Nonetheless, variations were observed depending on the educational level of participants, which influenced the nature of case solving activities, case presentation methods, and the topics explored. Overall, CBL has proven effective in enhancing both cognitive aspects such as conceptual understanding, academic achievement, and retention and process skills, including attitude, motivation, and critical thinking. However, the improvement in motivation was not consistently observed across all studies. Despite its advantages, several limitations were identified, including small sample sizes, limited integration of modern chemistry topics, minimal implementation at the high school level, and the relatively long duration required for effective application of the CBL approach.

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