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Efforts to Develop Students' Critical Thinking Skills in Chemistry Learning: Systematic Literature Review

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Abstract: This article examines the efforts that can be made to develop students' critical thinking (CT) skills through chemistry learning. The method used in this study is the systematic literature review method, which consists of three stages: planning, conducting, and reporting. The planning stage is the stage of determining the topic, formulating the problem, and determining the criteria for the article to be used as a reference source. The conducting stage is the implementation stage of the systematic literature review and the reporting stage is the stage of writing systematic literature review articles. Based on the results of studies that have been conducted on 24 articles, it can be concluded that the learning model most widely used to develop students' CT skills in chemistry learning is project-based learning (PjBL). Other efforts made include implementing problem-based learning (PBL) models, guided inquiry, inquiry, predict observe explain (POE), REACT, the local culture-based 7E learning cycle, the ethnoscience-based chemistry learning model (MPKBE), and creative problem solving (CPS). The study's results also found that the characteristics of learning to develop students' CT skills in chemistry learning were using problems in everyday life (contextual) as motivation or stimulus and applying local wisdom-oriented learning.

Keywords: Chemistry learning; Critical thinking skills; Systematic literature review

Introduction

Education in the 21st century is education that integrates knowledge, skills, and attitudes as well as mastery of information and communication technology (ICT). Based on this, there are four 21st century skills that students need to have, namely CT and problem-solving, creativity and innovation, communication, and collaboration. According to Frima et al (2020; Fuad et al (2017) the dominant thinking skills that are needed in the 21st century are CT skills.

CT is an important high-level skill for solving complex and sharp problems that require in-depth analysis (Wardani et al., 2019). In learning chemistry, students not only memorize theories, formulas, and chemical reactions, but students need to understand chemical concepts correctly. In addition, learning chemistry has goals and functions including cultivating a scientific attitude which includes a critical attitude towards scientific statements, namely not easily believing without the support of observations, understanding chemical concepts, and their application to solving problems in everyday life. Thus, CT skills are important to develop in chemistry learning (Fernanda et al., 2019).

The importance of CT skills is apparently not accompanied by optimal achievement of these skills. This is evidenced by several previous research results. (Khoirunnisa & Widhia Sabekti, 2020), discovered that students in Tanjungpinang City had relatively low CT skills in chemical bonding material. Meanwhile, in other chemical material, namely buffer solutions, Fernanda et al (2019), found that students in the high group still had difficulty making inductions. Medium-sized group students still have difficulty considering observation reports, making inductions, making decisions, and identifying assumptions. Low-group students still have difficulty considering the credibility of sources, observing, making inductions, making decisions, and identifying assumptions. While the indicator that was

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most successful was the indicator of asking and answering, the indicator that was least successful was the indicator of making inductions.

Students' low CT skills are caused by learning models that teach CT skills that are not used properly in every classroom lesson (Pasaribu et al., 2020). CT can develop if in each learning step, you can practice periodically (Susilowati et al., 2017). Teachers who act as mediators and facilitators should design and implement certain methods, models, or strategies that can train and develop students' CT skills (Ijirana et al., 2022).

Based on the description above, students' CT skills in chemistry learning still need to be developed. so that researchers conduct a systematic literature review to obtain information about learning models that can be applied to develop students' CT skills and what learning characteristics can develop students' CT skills in chemistry learning.

Method

This study uses a systematic literature review method. A systematic literature review is a review method that follows standard rules for identifying and synthesizing relevant research articles (Xiao & Watson, 2019). A systematic literature review consists of three stages: planning, conducting, and reporting.

Planning Stage

At the planning stage, the researcher determines the research topic, namely efforts to develop students' CT skills. At this stage, the criteria for the articles to be used are also determined. These criteria are described in Table ***1***.

Table 1. Article Criteria

Criteria	Description
Inclusion	The article discusses the learning model applied to develop CT skills in chemistry learning.
	The articles used are those published between 2016 and 2023.
	Scopus and Sinta-indexed articles (minimum Sinta 3).
Exclusion	Articles that do not discuss learning models that are applied to develop CT skills in chemistry learning.
	Literature review articles are not included.

Conducting Stage

This stage is carried out by collecting articles that match the predetermined criteria. Article searches were carried out on databases such as ERIC and Google Scholar. The keywords used in the search are “critical thinking skills in chemistry learning”. Based on the screening search results for article titles, 201 articles were obtained from the ERIC database and 103 from the Google Scholar database. The articles are reviewed in stages by reading the abstracts. If the abstract is in accordance with the research topic, it is continued by reading the contents of the article.

After reviewing the articles that meet the criteria, there are 24 articles that can be used in a systematic literature review, as listed in

Table **2** The next step after getting the desired article is extracting data and synthesizing the various things in the selected.

Reporting Stage

The final stage is writing the results of a systematic literature review.

Table 2. Articles Used in Systematic Literature Review

Author	Article Titles	Journal
Prasetyowati & Suyatno, 2016	Peningkatan Penguasaan Konsep dan Keterampilan Berpikir Kritis Siswa Melalui Implementasi Model Pembelajaran Inkuiri pada Materi Pokok Larutan Penyangga	Jurnal Kimia dan Pendidikan Kimia (S2)
Arfianarfiawati et al., 2016	Model Pembelajaran Kimia Berbasis Etnosains untuk Meningkatkan Keterampilan Berpikir Kritis Siswa	Jurnal Pengajaran MIPA (JPMIPA) (S2)
Jufrina & Utami, 2016	Pembelajaran Berbasis Masalah untuk Meningkatkan Keterampilan Berpikir Kritis Siswa pada Materi Reaksi Redoks	Jurnal Tadris Kimiya (S2)
Hikmah et al., 2016	Pengaruh Strategi Project Based Learning (PjBL) terhadap Keterampilan Berpikir Kritis Siswa Kelas XI IPA pada Materi Koloid	Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan (S2)
Seranica et al., 2018	Influence of Guided Inquiry Learning Model to Critical Thinking Skills	Journal of research & method in education (Q1)

Author	Article Titles	Journal
Suardana et al., 2018	Students' critical thinking Skills in Chemistry Learning Using Local Culture-Based 7E Learning Cycle Model	International Journal of Instruction (Q2)
Sari et al., 2018	The Correlation of Guided Inquiry Model with Sets Approach on Students' Critical Thinking Skills	Edusains (S2)
Dakabesi & Luoise, 2019	The Effect of Problem Based Learning Model on Critical Thinking Skills in the Context of Chemical Reaction Rate	Journal of Education and Learning (EduLearn) (S2)
Mahanani et al., 2019	Pengaruh Pembelajaran Inkuiri Berkonteks Socioscientific-Issues Terhadap Keterampilan Berpikir Kritis Dan Scientific Explanation	Jurnal Kependidikan: Penelitian Inovasi Pembelajaran (S2)
Fernanda et al., 2019	Analisis Keterampilan Berpikir Kritis Siswa Kelas XI pada Materi Larutan Penyangga Dengan Model Pembelajaran Predict Observe Explain	Jurnal Inovasi Pendidikan Kimia (S3)
Ariyatun & Octavianelis, 2020	Pengaruh Model Problem Based Learning Terintegrasi STEM terhadap Kemampuan Berpikir Kritis Siswa	Journal of Educational Chemistry (S3)
Sumarni & Kadarwati, 2020	Ethno-stem Project-Based Learning: Its Impact To Critical and Creative Thinking Skills	Jurnal Pendidikan IPA Indonesia (Q2)
Zahroh, 2020	Pengaruh Model Pembelajaran Project Based Learning terhadap Keterampilan Berpikir Kritis Siswa pada Materi Elektrokimia	Phenomenon (S3)
Ihsani et al., 2020	Penerapan Model Pembelajaran REACT terhadap Keterampilan Berpikir Kritis Siswa pada Konsep Kelarutan dan Hasil Kali Kelarutan	Jurnal Inovasi Pendidikan Kimia (S3)
Kasmiati et al., 2020	Effect of Problem Based Learning Model on the Chemical Reaction Rate toward Critical Thinking Ability of Students	Jurnal Akademika Kimia (S3)
Sutiani et al., 2021	Implementation of an Inquiry Learning Model with Science Literacy to Improve Student critical thinking Skills	International Journal of Instruction (Q2)
Santyasa et al., 2021	Project Based E-Learning and Academic Procrastination of Students in Learning Chemistry	International Journal of Instruction (Q2)
Saekawati & Nasrudin, 2021	Effectiveness of Guided Inquiry-Based on Blended Learning in Improving Critical Thinking Skills	Jurnal Penelitian Ilmu Pendidikan (S3)
Wahyudiati, 2022	Critical Thinking Skills and Scientific Attitudes of Pre-Service Chemistry Teachers Through the Implementation of Problem-Based Learning Model	Jurnal Pendidikan IPA Indonesia (Q2)
Desiana et al., 2022	Application of Project-Based Learning (PjBL) to Improve Critical Thinking Skills and Students' Learning Independence on the Making of Colloids in Dispersion	Jurnal Tadris Kimiya (S2)
Mitarlis et al (2020)	The Effectiveness of New Inquiry-Based Learning (NIBL) for Improving Multiple Higher-Order Thinking Skills (M-HOTS) of Prospective Chemistry Teachers	European Journal of Educational Research (Q3)
Anjarwati & Nasrudin, 2022	Implementation of Guided Inquiry Based on Contextual Approach to Improve Students Critical Thinking Skills on Reaction Rate Material	Journal of Science Education Research (S3)
Ijirana et al., 2022	Critical Thinking Skills of Chemistry Education Students In Team Project-Based STEM-Metacognitive Skills Learning During The Covid-19 Pandemic	Journal of Technology and Science Education (Q2)
Muzaimah et al (2022)	Implementation of Creative Problem Solving Model to Improve Students' Critical Thinking Skills in Chemistry Lessons	Jurnal Tadris Kimiya (S2)

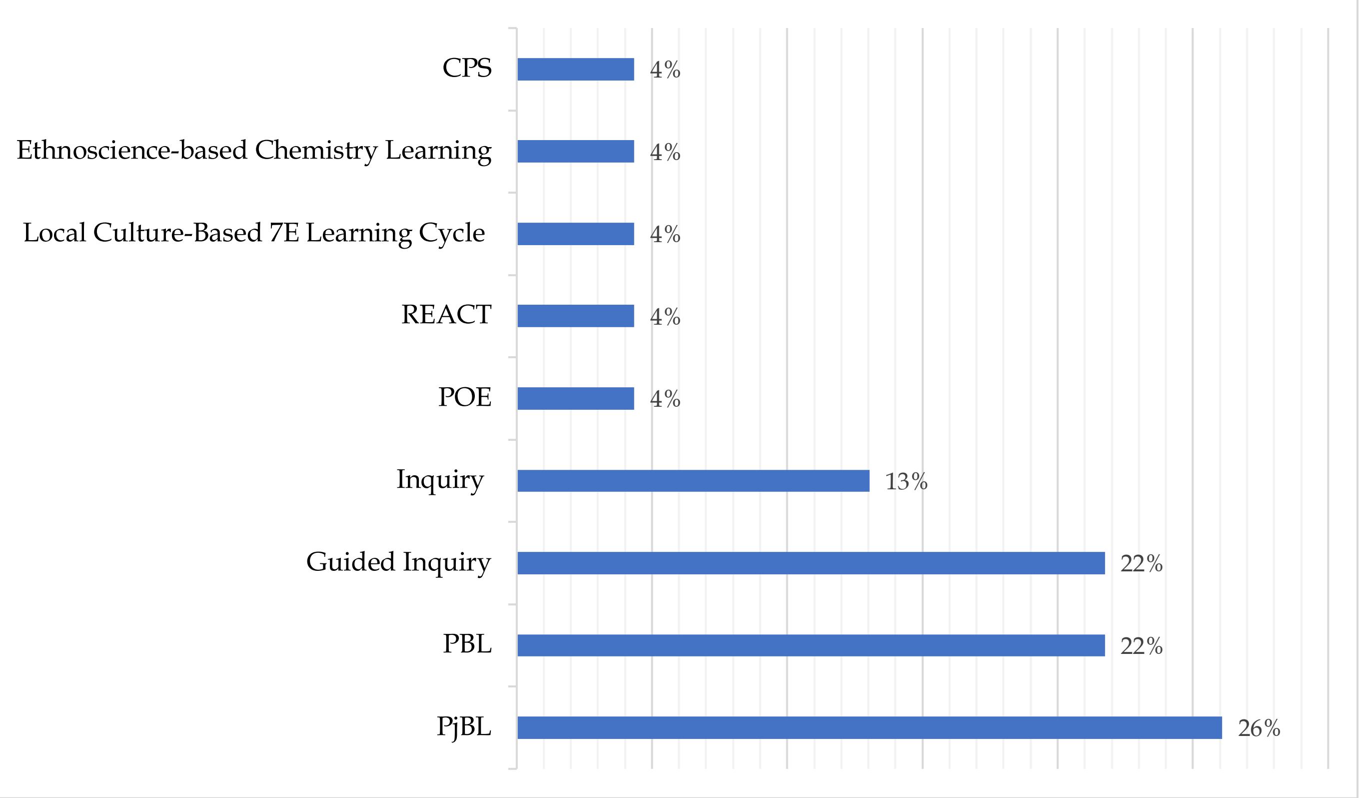

Figure 1. Various Learning Models to Develop Students' CT Skills

Result and Discussion

Learning Model Applied to Develop CT Skills in Chemistry Learning

The use of learning models can affect students' CT skills (Wartono et al., 2018). Therefore, teachers need to determine the learning model that will be used to develop students' CT skills. Based on the analysis of 24 articles, there have been several attempts made to develop students' CT skills by applying a learning model, as can be seen in Figure 1.

Based on Figure 1, the project-based learning model has the highest percentage, namely 26%. This shows that the application of project-based learning is the most widely used effort to develop CT skills in chemistry learning based on the 24 articles reviewed. In addition, there are problem-based learning models, guided inquiry, inquiry, POE, REACT, the local culture-based 7E learning cycle, ethnoscience-based chemistry learning models (MPKBE), and Creative Problem Solving (CPS) whose syntax can be seen in

Table 3. The following is an explanation of each learning model.

Project-Based Learning

The most widely used effort is to apply the project-based learning model. Based on the articles reviewed, the implementation of the PjBL model can improve students' CT skills in chemistry learning (Desiana et al., 2022; Hikmah et al., 2016; Ijirana et al., 2022; Santyasa et al., 2021; Sumarni & Kadarwati, 2020; Zahroh, 2020). Of the six articles, one article applies the project-based e-learning (PjBeL) model (Santyasa et al., 2021). PjBeL is a learning model that combines PjBL with e-learning strategies. One other article applies project-based learning, which is integrated with the ethno-STEM approach so that it can be called ethno-STEM PBL. This model involves project-based learning that is integrated with the four STEM fields that are based on local culture to develop critical, creative, innovative, and collaborative thinking skills (Sumarni & Kadarwati, 2020). Another project-based learning was carried out by Ijirana et al (2022), in their research applying team project-based stem-metacognitive skills learning. The learning is project-oriented which is carried out in groups where metacognitive skills are used and integrated in STEM.

Based on a study of the six articles, PjBL, PjBeL, ethno-STEM PBL, and team project-based stem-metacognitive skills learning can develop students' CT skills because learning with this model focuses on the concepts and principles of the material being taught, involves students in solving problems and completing meaningful tasks, gives students opportunities to work independently in building their own knowledge through real experience, and produces products that are of value and realistic (Effendi, 2017; Hikmah et al., 2016; Iskandar & Mulyati, 2019). In addition, each stage of the

PjBL model has enormous potential to train students' thinking processes that lead to CT skills (Panjaitan et al., 2020).

At the stage of determining fundamental questions, students will be trained in the skills of focusing questions. The second stage is to design a plan for the project, students will be trained to determine an action to be taken to answer basic questions, interact with others in discussion activities, and consider whether the sources obtained for planning projects can be trusted or not. The third stage is to create a schedule. At this stage, students will be trained to determine actions and interact with others in order to arrange schedules so that projects will be carried out properly.

The fourth stage is monitoring project implementation, students will be trained in the skills of observing and considering observations, evaluating, giving arguments, and interacting with others. In the fifth stage, assessing the outcome, students will be trained in defining terms, considering definitions, evaluating, and giving arguments. In the last stage, namely the evaluation of experience, students will be trained to make and determine the value of consideration, evaluation, and argumentation (Santyasa et al., 2021; Zahroh, 2020).

Problem-Based Learning

Another effort is to use a problem-based learning model (Ariyatun & Octavianelis, 2020; Dakabesi & Luoise, 2019; Jufrina & Utami, 2016; Kasmiati et al., 2020; Wahyudiati, 2022). Based on a review of five articles, there is one article that applies a PBL model that is integrated with the STEM approach (PBL-STEM). The PBL model can develop students' CT skills because PBL model is based on complex problem situations which will increase students' curiosity so that students are involved in investigations (Dakabesi & Luoise, 2019). Another factor is the principle of the PBL model which places more emphasis on improving learning methods. It aims to strengthen concepts in real situations, develop high-order thinking skills and improve problem-solving skills, train students to participate actively, develop decision-making skills, explore information, increase students' self-confidence, responsibility, cooperation, and communication (Supiandi & Hendrikus, 2016). The PBL model that is integrated with the STEM approach (PBL-STEM) causes students to become motivated so students become more active and supports the achievement of indicators of students' CT skills (Adiwiguna et al., 2019).

At the stage of problem-based learning, problem orientation activities are carried out by conveying various phenomena or problems originating from everyday life. This activity can train students to be actively involved in analyzing, predicting a problem that comes from everyday experiences, which can enable students to find and design problem-solving both individually and in groups. This activity can positively impact students' scientific attitudes and CT skills (Dakabesi & Luoise, 2019; Wahyudiati, 2022).

At the problem identification and investigation stages, it can attract students' curiosity and improve identification skills, as well as students' logical and CT in identifying problems to determine a solution to be carried out. The fourth stage is discussion activities that allow students to actively exchange thoughts and opinions and construct knowledge, attitudes, and skills. The last stage is evaluation, at this stage, reflection is carried out on the constraints and benefits of each learning process (Wahyudiati, 2022). The stages of problem-based learning are not designed to help teachers provide as much information as possible to students but to help students develop thinking skills, problem-solving skills, and intellectual thinking (Kasmiati et al., 2020).

Guided Inquiry

Another effort in developing thinking skills in chemistry learning is by applying the guided inquiry learning model. Based on studies that have carried out the application of face-to-face guided inquiry and effective blended learning to improve students' CT skills (Anjarwati & Nasrudin, 2022; Mahanani et al., 2019; Saekawati & Nasrudin, 2021; Sari et al., 2018; Seranica et al., 2018). The guided inquiry learning model can develop CT skills because this model emphasizes students in the process of seeking and finding answers to the formulated problems themselves, through this learning model, students can solve problems both in learning and everyday life with their CT (Cahyani & Azizah, 2019; Sari et al., 2018; Seranica et al., 2018).

The application of the guided inquiry model to develop CT skills can be integrated with approaches such as the contextual approach and the SETS (Science, Environment, Technology, and Society) approach (Anjarwati & Nasrudin, 2022; Sari et al., 2018). Through the application of guided inquiry based on a contextual approach, students' curiosity will increase and it will be easier for them to understand the material. This is due to the use of everyday phenomena as modeling material to build student understanding (Anjarwati & Nasrudin, 2022). The application of the guided inquiry model based on the SETS approach can connect chemical concepts with phenomena in everyday life and is able to create an active atmosphere that involves thinking processes to support students' CT skills (Astyana & Saadi, 2017; Sari et al., 2018).

Other research applies the guided inquiry model by integrating the SSI context to make learning more interesting for students so that students are more actively involved in building concepts and making decisions related to socioscientific issues (Mahanani et al., 2019).

Inquiry

Another effort to develop thinking skills is applying the inquiry model (Mitarlis et al., 2020; Prasetyowati & Suyatno, 2016; Sutiani et al., 2021). Based on the results of the study, inquiry learning, inquiry with scientific literacy and New Inquiry-Based Learning (NIBL) can develop students' CT skills in chemistry learning because it facilitates active learning, which has an impact on improving students' CT skills (Kahlke & Eva, 2018; Mitarlis et al., 2020; Prasetyowati & Suyatno, 2016; Sutiani et al., 2021). This is supported by the statement of Sahoo & Mohammed (2018) which state that inquiry learning provides opportunities for students to actively participate in the inquiry process and train CT skills in solving scientific problems.

Predict-Observe-Explain (POE)

The application of the POE model is an attempt to develop students' CT in chemistry learning (Fernanda et al., 2019). Based on the studies that have been carried out, at the predict stage students are trained to make simple explanations. At the observe stage, students are trained to develop basic skills in conducting experiments, observing experiments, and collecting data. In addition, students are also trained to be able to provide conclusions based on observational data. At the explain stage, there is a question and answer session that can train students to focus on questions and provide further explanations as well as set strategies and tactics (Fitrianingsih et al., 2021).

Relating, Experiencing, Applying, Cooperating, Transferring (REACT)

Applying the REACT learning model is one way to develop students' CT skills (Ihsani et al., 2020). The effectiveness of applying REACT learning to students' CT skills is because the REACT model has a gradual understanding strategy. The applying stage leads to basic understanding, and the transferring stage leads to deep understanding. This gradual strategy can maximize students' thinking skills and overcome difficulties in learning chemistry. In addition, REACT learning helps students connect the material being studied with real-life applications (Junedi et al., 2018).

Local Culture-Based 7E Learning Cycle Model

The application of the local culture-based 7E learning cycle model is one way to develop students' CT skills (Suardana et al., 2018). The application of the local culture-based 7E learning cycle model effectively improves students' CT skills because each stage of the local culture-based 7E learning cycle directs students to carry out thinking activities from easy to more complex stages in the material being taught so that students can practice skills. CT gradually (Rahmayani et al., 2016). In addition, the use of local cultural phenomena as a stimulus can motivate and assist students in understanding chemical material (Suardana et al., 2018).

Ethnoscience-based Chemistry Learning Model (MPKBE)

Another effort that can be made to develop students' CT skills in chemistry learning is to apply ethnoscience-based chemistry learning (Arfianawati et al., 2016). The application of the ethnoscience-based chemistry learning model is effective in improving students' CT skills because MPKBE is related to everyday life so it can help students understand chemistry material. The application of MPKBE can be done by giving observation assignments to students regarding habits that exist in society (Arfianawati et al., 2016). This can help students develop CT skills because students are trained to organize strategies and tactics to determine actions during observation. Furthermore, there is an interaction between students and the community to train students in determining whether or not sources can be trusted. After observation, students are trained to draw conclusions regarding the observations that have been made. Such learning will provide opportunities for students to find learning experiences so that they will further assist students in mastering concepts (Darling-Hammond et al., 2020).

Creative Problem Solving (CPS)

The CPS model can be applied to develop students' CT in chemistry learning (Muzaimah et al., 2022). The CPS model used has four learning steps, namely: clarifying problems, expressing ideas, evaluating and selecting, and implementing. With these learning steps, the CPS model emphasizes CT skills in solving problems, providing opportunities for students to choose solutions and develop problem-solving ideas.

The first step is the classification of the problem. Students are trained to observe and find problems in worksheets by focusing on questions related to these problems. At the stage of expressing ideas, students are given the freedom to express their opinions about how to solve problems. This spurred students to better understand the concept, thus helping students to develop CT skills. At the evaluation and selection stage, students re-discuss the ideas that have been submitted and then choose one by one the truth of the ideas that have been found so that students can find the most appropriate solution. Through the third stage, students are trained to choose strategies and tactics in problem solving. The fourth stage is implementing the right solution as a problem solving (Maharani et al., 2021).

Table 3. Learning Models and Syntak Used

Learning Models	The Learning Syntax Used		Authors
PjBL	1. Start with essential question 2. Design a plan for the project 3. Create a schedule	4. Monitoring 5. Assess the outcome 6. Evaluate the experience	(Desiana et al., 2022; Hikmah et al., 2016; Santyasa et al., 2021; Sumarni & Kadarwati, 2020; Zahroh, 2020)
	1. Reflection 2. Research 3. Discovery	4. Application and communication 5. Evaluation	(Ijirana et al., 2022)
PBL	1. Stage orientation learners on the problem 2. Stage of organizing learners in learning 3. Stage guiding individual and group investigations	1. Stage of developing and presenting the work 2. Phase analyze and evaluate problem solving process	(Dakabesi & Luoise, 2019; Jufrina & Utami, 2016; Kasmiati et al., 2020)
	1. Problem orientation 2. Problem identification 3. Group investigation	4. Class discussion 5. Evaluation and consensus	(Wahyudiati, 2022)
Guided Inquiry	1. Orientation 2. Exploration 3. Conceptual formation	4. Application 5. Closure	(Mahanani et al., 2019; Sari et al., 2018)
	1. Focusing the attention of students' and explaining the inquiry process 2. Presenting an inquiry problems or phenomena 3. Encouraging students to formulate hypotheses to explain problems or phenomena	4. Collecting data to test hypotheses 5. Formulating explanations and conclusions 6. Reflecting on problem situations thought processes	(Anjarwati & Nasrudin, 2022)
	1. Confrontation with problems 2. Data collection and verification 3. Experimental data collection	4. Organizing and formulating explanations 5. Inquiry process analysis	(Saekawati & Nasrudin, 2021)
Inquiry	1. Finding the problem 2. Develop hypotheses 3. Designing the experiment	4. Carry out an experiment 5. Analyze data 6. Make conclusions	(Prasetyowati & Suyatno, 2016)
	1. Orientation 2. Conceptualization 4. Investigation	3. Conclusion 4. Performance	(Mitarlis et al., 2020)
	1. Observation of the chemical phenomena 2. Focus of the questions 3. Investigation planning 4. Conducting investigations 5. Data analysis	6. Formation of the new knowledge 7. Epistemic of the knowledge 8. Presenting the new concepts 9. Implementation of the new concepts	(Sutiani et al., 2021)
POE	1. Predict 2. Observe	3. Explain	(Fernanda et al., 2019)
REACT	1. Relating 2. Experiencing 3. Applying	4. Cooperating 5. Transferring	(Ihsani et al., 2020)
Local Culture-Based 7E Learning Cycle Model	1. Elicitation 2. Engagement 3. Exploration 4. Explanation	5. Elaboration 6. Evalution 7. Extension	(Suardana et al., 2018)
CPS	1. Clarification of problem 2. Brainstorming	3. Evaluation and selection 4. Implementation	(Muzaimah et al., 2022)

Characteristics of Learning to Develop Students' CT Skills

One effort to train students' CT skills is to provide contextual learning (Pratiwi et al., 2016). Based on the studies that have been conducted, there are six articles that start learning by discussing problems regarding various phenomena in everyday life related to the material to be studied (Anjarwati & Nasrudin, 2022; Dakabesi & Luoise, 2019; Hikmah et al., 2016; Saekawati

& Nasrudin, 2021; Sutiani et al., 2021; Wahyudiati, 2022). In addition, two articles use controversial issues (Mahanani et al., 2019; Sari et al., 2018). One other article uses local cultural phenomena to start the learning process (Suardana et al., 2018). Another article assigns students to carry out direct observation activities related to habits that exist in society (Arfianawati et al., 2016).

Problem orientation related to everyday life can train students to actively participate in analyzing and predicting a problem that comes from experiences close to students and can positively influence students' CT skills (Villafañe & Lewis, 2016; Wahyudiati, 2022). The application of local wisdom-oriented learning can also help students understand chemistry material and develop students' CT skills (Arfianawati et al., 2016). This can be done by making wisdom a project activity in chemistry learning. Project activities that can be carried out include making tofu, grass jelly, and antor crackers which are able to train students' CT skills (Hikmah et al., 2016; Sumarni & Kadarwati, 2020). Project activities can also utilize materials found in the surrounding environment. For example, using bamboo shoots (*Dendrocalamus asper*) to make liquid organic fertilizer through a fermentation process with the help of bacteria. This fermentation can be a very interesting theme in learning about reaction rates (Sumarna et al., 2022).

Based on the study results, there are similarities in the articles studied, namely the application of contextual learning. The use of context can bridge the gap between abstract concepts and the realities of everyday life (Mahanani et al., 2019). Thus, it is essential to integrate chemistry learning with contextual learning to increase learning motivation and train CT skills in solving problems (Sagita et al., 2021; Yunita et al., 2018).

Conclusion

Based on the studies that have been carried out, there are several learning models that can be applied to develop students' CT skills in chemistry learning, including project-based learning (PjBL), problem-based learning (PBL), guided inquiry, inquiry, POE, REACT, local culture-based 7E learning cycle, and ethnoscience-based chemistry learning model (MPKBE), and creative problem solving (CPS). The results of this study also show that the characteristics of learning that can develop CT skills are using contextual learning, such as using problems in everyday life as motivation and stimulus, and applying local wisdom-oriented learning. Recommendations for future researchers need to prepare phenomena of daily life, controversial issues, or phenomena of local wisdom that are appropriate to learning materials as a stimulus or motivation for learning.

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