23 (4), 2022, 1446-1463
Jurnal Pendidikan MIPA
e-ISSN: 2550-1313 | p-ISSN: 2087-9849
http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Context-Based Chemistry Learning: A Systematic Literature Review

Zelen Surya Minata, Sri Rahayu*, I Wayan Dasna
Department of Chemistry, Universitas Negeri Malang, Indonesia

Abstract: This study aimed to examine the impact of context-based chemistry learning on cognitive, affective, psychomotor, and social aspects of students, integration of context-based learning with chemistry learning models or strategies, and implementation of effective context-based chemistry learning. A total of 34 articles for further analysis were obtained from SCOPUS, ERIC, and Google Scholar database through systematic literature (SLR) method. The result of analysis showed that (1) context-based chemistry learning has a positive effect improving student's cognitive, affective, psychomotor, and social aspects, (2) context-based chemistry learning can be integrated with certain learning models or strategies and presentation of learning context carried out at the beginning of learning, (3) the implementation of effective context-based chemistry learning can be done by considering several aspects including the selection of appropriate and applicable learning contexts, teacher master the concepts of learning materials and students actively participated in each learning syntax that is applied.

Keywords: context-based learning, chemistry learning, systematic literature review.

Abstrak: *Penelitian ini bertujuan untuk mengkaji dampak pembelajaran kimia berbasis konteks terhadap aspek kognitif, afektif, psikomotori, dan social peserta didik, integrase pembelajaran kimia berbasis konteks dengan model atau strategi pembelajaran kimia, dan implementasi pembelajaran kimia berbasis konteks yang efektif. Sebanyak 34 artikel dianalisis lebih lanjut diperoleh dari database SCOPUS, ERIC, dan Google Schoolar melalui metode systematic literature review (SLR). Hasil analisis menunjukkan bahwa (1) pembelajaran kimia berbasis konteks memiliki pengaruh posistif terhadap aspek kognitif, afektif, psikomotor, dan sosial, (2) pembelajaran kimia berbasis konteks dapat diintegrasikan dengan model atau strategi pembelajaran dan penyajian konteks dilakukan pada awal pembelajaran, dan (3) implementasi pembelajaran kimia berbasis konteks yang efektif dapat dilakukan dengan mempertimbangkan beberapa aspek diantaranya adalah pemilihan konteks pembelajaran yang tepat dan aplikatif, guru menguasai konsep pembelajaran, dan peserta didik berpartisipasi aktif dalam setiap sintaks pembelajaran yang diaplikasikan.*

Kata kunci: *Pembelajaran berbasis konteks, pembelajaran kimia, review literature sistematik.*

▪ INTRODUCTION

The current conditions have entered the 21st century era which is marked by the rapid development of science, technology and information in various aspects of global life (Aslamiah et al., 2021). The development of the 21st century has a large positive and negative impact on the world of education, especially chemistry learning. In general, chemistry has triplet representations (macroscopic, submicroscopic, and symbolic) which have an important role in helping to improve understanding of chemical concepts (Talanquer, 2011). Furthermore, chemistry has concepts that are abstract and tiered so that if chemistry learning is not carried out in stages it often creates misconceptions for students (Milenkovic et al., 2014). Based on these facts, assumptions were found from students indicating that studying chemistry does not

Sri Rahayu
*Email: sri.rahayu.fmipa@um.ac.id

DOI: http://dx.doi.org/10.23960/jpmipa/v23i4.pp1446-1463
Received: 23 October 2022
Accepted: 30 November 2022
Published: 05 December 2022

provide significant benefits because it is not relevant to everyday life (Wiyarsi et al., 2017). Therefore, various problems arise in learning chemistry, some of which are students' low understanding of concepts, interest, and learning motivation (Uce & Ceyhan, 2019; Ilhan et al., 2016; Vaino et al., 2012). Therefore, this is a challenge and a demand for teachers to be able to teach chemistry material that is more relevant (Stuckey et al., 2013).

Many studies report that various learning innovations such as approaches, models, strategies, assessment instruments, and learning media that have been developed are of interest to students and are considered to be more effective in their application when compared to conventional learning which tends to focus on the explanations presented by the teacher. One of the new approaches in learning chemistry that is very popular and is considered to be able to increase students' interest and learning motivation is context-based learning (King, 2012). Context-based chemistry learning is a learning that can connect chemical concepts with their applications in the phenomena of everyday life (King & Henderson, 2018). Through context-based learning it is hoped that students will become more motivated in chemistry learning activities.

In general, context-based chemistry learning can facilitate students to become active subjects in learning through applied learning activities (Wei & Long, 2021). Students who are active in learning can build interactive learning so that it can help in constructing a good understanding. The majority, teachers apply inquiry learning models or strategies to connect contexts in learning. Several studies have reported related to the development of learning activities carried out in the classroom using a context-based approach, for example, the research of Majid & Rohaeti (2018) implementing LC-5E learning and Qamariyah et al., (2021) implementing inquiry-based learning.

Context-based learning has positive prospects regarding its impact on chemistry learning, considering that the 21st century demands students to master many fields, one of which is 21st century skills which include critical thinking skills, problem solving, creative thinking, communication, and collaboration. (Redhana, 2019). Many research results explain that context-based learning can facilitate students in improving the quality of chemistry learning. For example, Baydere (2021) explained that context-based learning can facilitate students to increase their understanding of the concepts of the properties of matter, heat, and temperature. Furthermore, research results report that context-based chemistry learning can significantly improve student learning achievement (Majid & Rohaeti, 2018).

So far there have been many research trends that describe the application of context-based learning in science learning (Topcu et al., 2014), but there is still little research that focuses on the application of context-based learning in chemistry topics, especially those that are integrated with certain more relevant learning strategies and models. (Baydere, 2021; Pursitasari et al., 2020). Furthermore, the conditions of a supportive learning environment and the use of appropriate learning strategies or models in context-based chemistry learning can help teachers or researchers to improve learning effectiveness. Therefore, it is necessary to carry out a further review related to the trend of context-based learning in chemistry material in depth. Through this literature review, it is hoped that it will be able to provide information and knowledge to teachers and researchers in the field of chemistry education regarding the importance of involving context in chemistry learning, how to integrate and implement context in chemistry learning strategies or models, trends and context-based chemistry learning research patterns. Some of the problem formulations posed in this systematic literature review are as follows:

1. What is the impact of context-based chemistry learning on the cognitive, affective, psychomotor, and social aspects of students?
2. How is the integration of context-based chemistry learning into the learning model or strategy?
3. How is the implementation of effective context-based chemistry learning?

▪ METHOD

This research implements a systematic literature review method or commonly known as Systematic Literature Review (SLR). SLR is a literature review that follows standard rules to identify and synthesize all relevant research results and provide an assessment of what is known from the topic under study (Xiao & Watson, 2019). Through SLR, many informative summaries and comprehensive research criticisms can be obtained. The SLR in this study was conducted by searching for the results of scientific research publications using an online article database which included SCOPUS, ERIC, and Google Scholar. The keywords applied in the search for articles are "Context-based approach in chemistry", "Context-based learning", "Context-based learning chemistry", "Inquiry", and "Chemistry students".

The search results found 505 articles related to the topic under study after screening based on peer review articles and in English. Of the 505 articles, abstracts were read and then reduced to 49 articles taking into account the suitability of the abstract content and inclusion requirements. Furthermore, 49 articles were read in full (full text) and 34 articles were obtained consisting of (7 articles obtained from the ERIC database, 4 articles from the SCOPUS database, and 23 articles from the Google Scholar database) which type of research is quantitative research with a research design (quasi-experimental or true experiment), mixed method and fulfill all predefined inclusions. Inclusion criteria for searching articles include: (1) articles on context-based chemistry learning issues, (2) publications in the last 10 years between 2012-2021, (3) accredited and published in reputable international journals, (4) full text, journal articles, and accessible. Furthermore, to confirm whether the article fulfills the main purpose of analysis, a writer who is an expert lecturer in the field of chemistry education is entrusted with reviewing, identifying, and selecting individual research articles that focus on context-based chemistry learning with a quantitative research design (experiment). and mixed methods. Furthermore, the inclusion criteria can be seen in Table 1.

Table 1. Selection of articles and journals

Author	Selected Journal	Database
Ilhan et al., (2016)	International Journal of Environmental Science Education (Q4)	ERIC
Wiyarsi et al., (2020)	Journal of Turkish Science Education (Q2)	ERIC
Vogelzang et al., (2021)	Instructional Science (Q1)	ERIC
Karpudewan & Mathanasegaran (2018)	Asia-Pacific Forum on Science Learning and Teaching (Q4)	ERIC

Vaino et al., (2012)	Chemistry Education Research and Practice (Q1)	SCOPUS
Cigdemoglu & Geban, (2015b)	Chemistry Education Research and Practice (Q1)	SCOPUS
Sevian et al., (2018)	International Journal of Science Education (Q1)	SCOPUS
King & Ritchie (2013)	International Journal of Science Education (Q1)	SCOPUS
Baydere (2021)	Chemistry Education Research and Practice (Q1)	SCOPUS
Baran & Sozbilir (2018)	Research in Science Education (Q1)	SCOPUS
Podschuweit & Bernholt (2018)	Research in Science Education (Q1)	SCOPUS
Duay (2017)	International Journal of Emerging Multidisiplinary Research (Q4)	Google Scholar
Bortnik et al., (2021)	Education Science (Q2)	Google Scholar
Giammatteo & Valdivia (2021)	American Journal of Educational Research (Q1)	Google Scholar
Pongchano et al., (2017)	European Journal of Educational Studies (Q4)	Google Scholar
Pursitasari et al., (2020)	Jurnal Pendidikan IPA Indonesia (Q2)	Google Scholar
Edelsztein et al., (2020)	Chemistry Teacher International (Q3)	Google Scholar
Williams & Hin (2017)	New Direction in The Teaching of Physical Science (Q4)	Google Scholar
Slovinsky et al., (2021)	EURASIA Journal of Mathematics, Science and Technology Education (Q2)	Google Scholar
Yuliastini et al., (2018)	Jurnal Pendidikan IPA Indonesia (Q2)	Google Scholar
Pratiwi et al., (2016)	Jurnal Pendidikan IPA Indonesia (Q2)	Google Scholar
Cahyarini et al., (2016)	Jurnal Pendidikan IPA Indonesia (Q2)	Google Scholar
Wiyarsi et al., (2021)	Frontiers in Education (Q2)	Google Scholar
Majid & Rohaeti (2018)	American Journal of Educational Research (Q1)	Google Scholar
Broman et al., (2018)	International Journal of Science Education (Q1)	Google Scholar
Koulougliotis et al., (2021)	International Journal of Science Education (Q1)	Google Scholar
Dori et al., (2018)	International Journal of Science Education (Q1)	Google Scholar
Cigdemoglu & Geban (2015a)	Journal of Baltic Science Education (Q2)	Google Scholar
Ultay (2015)	Journal of Baltic Science Education (Q2)	Google Scholar
Grooms et al., (2014)	International Journal of Science Education (Q1)	Google Scholar
Gulacar et al., (2020)	Sustainable Chemistry and Pharmacy (Q2)	Google Scholar
Solbes et al., (2018)	Asia-Pacific Forum on Science Learning and Teaching (Q4)	Google Scholar
Magwilang (2016)	International Journal of Learning, Teaching, and Educational Research (Q3)	Google Scholar
Altundag (2018)	Journal of Turkish Science Education (Q2)	Google Scholar

Two experienced researchers coded 34 articles based on a coding scheme with a focus on context-based chemistry learning. Prior to coding, a consensus meeting was held to ensure that the coders understood the entire code that had been formulated. The results of the inter-rater coding agreement obtained 80%, this can be interpreted that the coding process is reliable. If the coding is not consistent, then the coder will discuss it again until an agreement is reached. A total of 34 literature article data that have been selected and coded are then analyzed in the July-August 2022 range. Several aspects that have been coded include the impact of context-based chemistry learning on learning outcomes (cognitive, affective, psychomotor, and social), integration of chemistry learning context-based with learning strategies or models, and implementation patterns of effective context-based chemistry learning. The process of searching and screening articles is illustrated by a flowchart as shown in Figure 1 below.

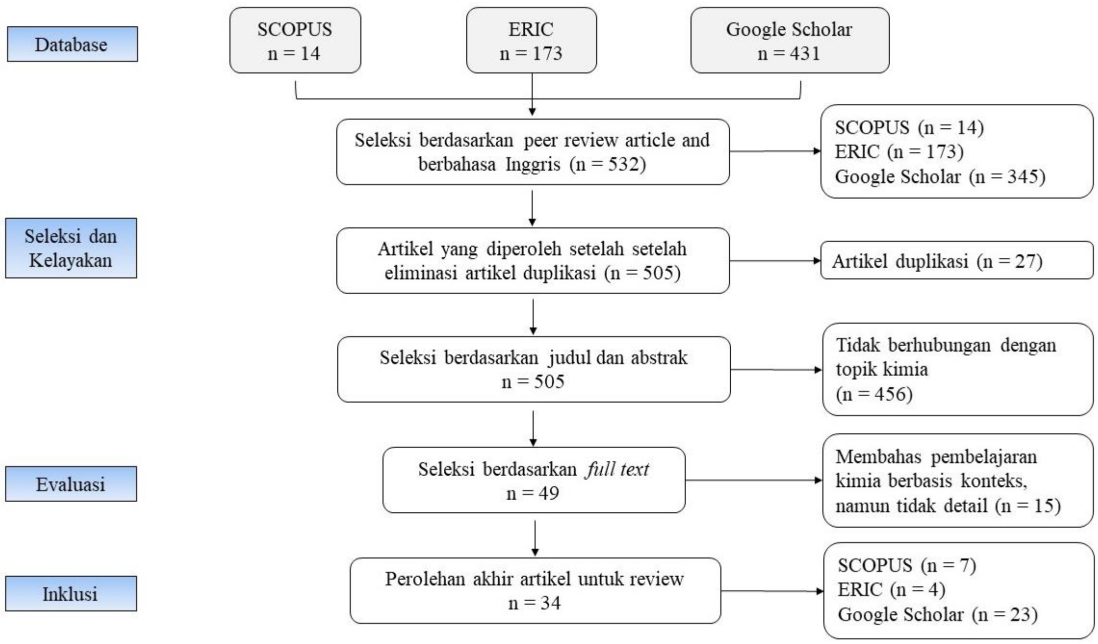

Figure 1. Article review screening flowchart

▪ RESULT AND DISSCUSSION

The Impact of Context-Based Chemistry Learning on Cognitive, Affective, Psychomotor, and Social Aspects

Context-based chemistry learning is a chemistry lesson whose learning activities are student-centered and the teacher's role is as a director and facilitator. Context-based chemistry learning is oriented towards constructivism learning which pays close attention to prior knowledge (prerequisite knowledge) and aims to increase students' understanding of concepts (Ilhan et al., 2016). The implementation of context-based chemistry learning has several positive impacts related to the learning development of students. This can be an alternative learning that can be applied in chemistry learning which is considered better when compared to conventional learning which tends to be centered on the information conveyed by the teacher.

What is discussed in this systematic literature review is the impact of context-based chemistry learning on the aspects of students' cognitive, affective, psychomotor, and social abilities which are presented in Figure 2. Based on the diagram in Figure 2, information is obtained that cognitive aspects are a serious problem. is very popular in context-based chemistry learning because in general learning that is applied in the classroom always emphasizes an increase in student learning outcomes as a measure of cognitive ability. In the article review, N = 18 articles (53%) investigated the impact of context-based chemistry learning on cognitive aspects, followed by affective aspects, N = 14 articles (41%), psychomotor aspects, N = 1 article (3%), and cognitive aspects. social media, N = 1 article (3%). In this context, information is obtained that psychomotor and social aspects are rarely investigated further.

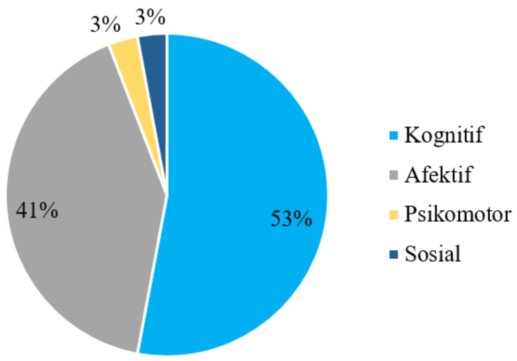

Figure 2. Impact of context-based chemistry learning

The impact of context-based chemistry learning on cognitive, affective, psychomotor, and social aspects is further grouped as presented in Table 1. In general, context-based chemistry learning has a positive effect on improving students' cognitive, affective, psychomotor, and social aspects. This is supported by data on the increase in the average value of students from the pretest to the posttest. The impact of context-based chemistry learning can be presented in Table 1 below.

Table 1. The specific impact of context-based chemistry learning

Aspects	Variable	Authors	Results
Cognitive	Learning outcome	Majid & Rohaeti (2018)	Student learning achievement increases through context-based chemistry learning
		Magwilang (2016)	
		Altundag (2018)	
		Ilhan et al., (2016)	
		Vogelzang et al., (2021)	
		Sevian et al., (2018)	
		King & Ritchie, (2013)	
		Bortnik et al., (2021)	
		Pongchano et al., (2017)	
		Baran & Sozbilir, (2018)	

	Conceptual understanding	Sevian et al., (2018)	Implementation of context-based chemistry learning improve students' conceptual understanding
		King & Ritchie (2013)	
		Baydere (2021)	
		Karpudewan & Mathanasegaran (2018)	
		Duay (2017)	
		Ultay (2015)	
		(Podschuweit & Bernholt, 2018)	
		(Cigdemoglu & Geban, 2015a)	
		(Cigdemoglu & Geban, 2015b)	
		Giammatteo & Valdivia (2021)	
	Metacognitive ability	Altundag (2018)	Context-based chemistry learning improve students' metacognitive abilities
		Vogelzang et al., (2021)	
	Chemical literacy	Wiyarsi et al., (2020)	Context-based chemistry learning improve chemical literacy
		Wiyarsi et al., (2021)	
		Cigdemoglu & Geban (2015b)	
	Argumentation skills	(Grooms et al., 2014)	Context-based chemistry learning can improve students' scientific argumentation skills
	Critical thinking skills	Pursitasari et al., (2020)	Students' critical thinking skills are increased through context-based chemistry learning
		Cahyarini et al., (2016)	
		Pratiwi et al., (2016)	
		Solbes et al., (2018)	
	Habits of scientific thinking	Wiyarsi et al., (2021)	The habit of scientific thinking increases through the implementation of context-based chemistry learning
		Calik & Karatas (2019)	
	Creative thinking ability	Pongchano et al., (2017)	Context-based chemistry learning is able to improve students' creative thinking skills
	Memory ability	Baran & Sozbilir (2018)	Context-based chemistry learning can improve students' memory
	Text comprehension ability	(Dori et al., 2018)	Context-based chemistry learning is able to improve students' scientific understanding skills
Affective	Learning motivation	Magwilang (2016)	Students' learning motivation increases through the implementation of context-
		Ilhan et al., (2016)	
		Vaino et al., (2012)	

		Baran & Sozbilir (2018) Slovinsky et al., (2021) Edelsztein et al., (2020) Gulacar et al., (2020) Yuliastini et al., (2018)	based chemistry learning
	Attitude toward chemistry	Majid & Rohaeti (2018) Magwilang (2016) Baran & Sozbilir (2018)	There is a positive attitude of students towards chemistry through the implementation of context-based chemistry learning
	Perception toward chemistry	Vogelzang et al., (2021) Edelsztein et al., (2020)	There is a positive perception of students towards chemistry through context-based chemistry learning
	Confidence	(Gulacar et al., 2020)	Students' self-confidence increases through context-based chemistry learning
	Awareness of green chemistry	(Koulougliotis et al., 2021)	Students' awareness of green chemistry increases through context-based chemistry learning
Psikomotor	Science process skills	Williams & Hin (2017)	Students' science process skills increase through the implementation of context-based chemistry learning
Sosial	Ability to communicate	Williams & Hin (2017)	Students' communication skills increase through the implementation of context-based chemistry learning
	Ability to work together	Williams & Hin (2017)	The ability to cooperate with students is better with context-based chemistry learning

Cognitive aspects are aspects related to reasoning or thinking processes to be able to solve a particular problem (Johnson et al., 2021). Some of the cognitive aspects investigated include learning achievement, conceptual understanding, metacognitive abilities, chemical literacy, critical thinking skills, argumentative skills, scientific thinking habits, creative thinking skills, memory skills, and understanding of scientific texts. The results of the statistical tests of learning achievement from several articles found information that the average posttest of students was higher when compared to the average pretest. Context-based chemistry learning in relation to cognitive aspects, especially learning achievement, is able to facilitate students in mastering knowledge in connecting the concepts studied with various relevant contexts that exist in everyday life which include three chemical representations (triplet representations) in chemistry learning namely (macroscopic, submicroscopic, and symbolic). Furthermore, it can sharpen cognitive abilities and increase self-confidence (self-efficacy) in solving various problems (Majid & Rohaeti, 2018; Magwilang, 2016; Altundag, 2018; Vogelzang et al., 2019; Sevian et al., 2018; King & Ritchie, 2013; Bortnik et al., 2021; Pongchano et al., 2017; Baran & Sozbilir, 2018).

Context-based chemistry learning can train students to think scientifically (scientific thinking habits) which has several important indicators which include looking at arguments, open thinking, skepticism, rationality, testing beliefs, objectivity, and curiosity (Wiyarsi et al., 2021) . This is in accordance with the characteristics of science which emphasizes the process of learning. The context in everyday life that is studied in learning also supports students to increase understanding of concepts (Sevian et al., 2018; King & Ritchie, 2013; Baydere, 2021; Karpudewan & Mathanasegaran, 2018; Duay, 2017; Giammatteo & Valdivia, 2021). In addition, context-based chemistry learning can also improve students' memory through the relevance of the concepts and contexts learned in learning activities (Baran & Sozbilir, 2018). Students' understanding of concepts can be increased because context-based chemistry learning involves chemical representations in studying the context presented in learning. This is in line with the results of research by Widarti et al., (2019) which showed that the existence of chemical representations can support student learning, one of which is increasing understanding of chemical concepts.

Context-based chemistry learning that is applied involves interconnecting triplet representations that can direct students to think critically, creatively, and can indirectly reflect metacognitive abilities (Pursitasari et al., 2020; Cahyarini et al., 2016; Pratiwi et al., 2016 ; Pongchano et al., 2017). This is in line with the findings of (Thomas, 2017) which explains that the interconnection of triplet representations of the context presented in learning can bring about metacognitive reflections from students. Furthermore, when students are asked to identify the chemical representation of a context presented and explain scientifically it can hone their metacognitive abilities so that they can get used to thinking at a higher level in solving a problem (Altundag, 2018; Vogelzang et al., 2021).

Context-based chemistry learning is one of the lessons that is very suitable to be applied in the 21st century. 21st century learning emphasizes mastery of scientific literacy which also includes chemical literacy which has four assessment aspects including content, knowledge, competence, and attitudes (OECD, 2016). Based on a literature review, context-based chemistry learning can improve students' chemical literacy (Cigdemoglu & Geban, 2015b; Wiyarsi et al., 2020; Wiyarsi et al., 2021). Presentation of the context in learning can help improve aspects of students' chemical literacy competency, one of which is explaining phenomena in life scientifically. In an effort to explain phenomena in life that are presented in learning by involving chemical representations can provide a more scientific and rational explanation. Furthermore, the presentation of the context in learning also facilitates students to argue about data and information that is supported by scientific evidence (Grooms et al., 2014). Therefore, through scientific argumentation, students will be trained to develop 21st century skills. Based on this supporting information, it can be explicitly interpreted that context-based chemistry learning has a positive impact in helping develop students' cognitive aspects.

Context-based chemistry learning also has a positive impact on affective aspects. The affective aspect is related to students' attitudes towards chemical material (Flaherty, 2020). Some of the problems encountered in chemistry learning before the implementation of context-based learning include the low interest and motivation in learning of students (Wiyarsi et al., 2017). Furthermore, the concept of chemistry is abstract in nature so that the perception arises that chemistry does not have applicative benefits in everyday life (Broman & Parchmann, 2014). Through the implementation of context-based chemistry learning, some of the problems that arise can be handled properly. Affective aspects can include motivation and interest in learning, attitudes towards chemistry, and students' perceptions of learning chemistry. Context-based chemistry learning is able to facilitate students to actively participate in learning activities. The existence of the context presented in learning can help students make connections between concepts and contexts through the directions given by the teacher. The context presented in context-based chemistry learning includes chemical phenomena in life and the surrounding environment so that it can attract attention, interest, and motivation to learn from students and make learning more relevant and realistic (Broman & Parchmann, 2014; Ilhan et al., 2016; Magwilang, 2016; Vogelzang et al., 2021; Baran & Sozbilir, 2018; Slovinsky et al., 2021; Yuliastini et al., 2018; Edelsztein et al., 2020). This is very contrary to conventional learning which is often applied today which tends to make students get bored more quickly in learning because learning activities are more inclined to the explanations given by the teacher.

The implementation of context-based learning provides a strong positive perception of students that chemistry has various benefits in life and the surrounding environment. Almost everything in life and the environment around it is composed of chemical elements. Thus, life in the world cannot be separated from chemistry. In addition, phenomena that exist in life and the surrounding environment that cannot be observed with the naked eye can be explained through chemical submicroscopic and symbolic representations so that the benefits of chemistry can be felt more clearly (Enero & Umesh, 2018). Therefore, students can understand the usefulness of chemistry in life and obtain positive perceptions related to the implementation of context-based chemistry learning. Thus, context-based chemistry learning in general can be said to improve students' affective aspects.

The psychomotor aspect is an aspect that relates to student skills arising from an application of learning (Enneking et al., 2019). This psychomotor aspect is an aspect that is rarely investigated in chemistry learning. The psychomotor aspect of students is one of the important things that needs to be reviewed as learning output, especially in chemistry learning. One of the psychomotor aspects in learning chemistry is research skills (laboratory) which is better known as science process skills and includes several indicators, namely skills in operating practicum tools, determining practicum materials correctly, submitting hypotheses, analyzing and interpreting evidence and data scientifically, and develop the design of an experiment (Turiman et al., 2012). Context-based chemistry learning has a positive impact on students' psychomotor aspects. Context-based chemistry learning facilitates students to make connections between concepts and contexts in life and the surrounding environment through designing and analyzing the results of a practicum (Williams & Hin, 2017). Through the implementation of this learning, students' science process skills will be well trained through activities carried out in practicum so that it can be interpreted that context-based chemistry learning can improve students' science process skills.

The social aspect is an aspect of learning related to student behavior or relationships with other students (Enneking et al., 2019). In the 21st century learning, students are directed to be able to master skills including critical thinking skills, creative thinking skills, communication, and collaboration (Rahayu, 2018). The social aspect of learning can be in the form of the ability to communicate and collaborate. Both of these social skills are needed in present and future life because the entry of the 21st century era demands skills that must be mastered by students to prepare for a better future generation or society. Based on article reviews, information was obtained that context-based chemistry learning can improve students' social aspects, especially communication and collaboration skills (Williams & Hin, 2017). Discussion and practicum activities presented in context-based chemistry learning are able to direct students to communicate with each other in constructing understanding and establishing collaboration or cooperation in a discussion group well. The more discussion and practicum activities are carried out in small groups, the more trained students' communication and collaboration skills will be. Therefore, information can be drawn that context-based chemistry learning can improve students' social aspects.

Integration of Context-Based Chemistry Learning with Learning Models or Strategies

Basically context-based chemistry learning focuses on students (student centered) so that in learning activities that are applied students are active subjects in constructing a complete understanding. Indicators of student activity can be seen from their role in learning activities, some of which are actively asking questions, answering questions, and providing responses. Theoretically, context-based chemistry learning can be integrated with certain learning models or strategies. The context that is applied in learning is an approach that functions to make it easier for students to understand material concepts that are more applicable to the phenomena of everyday life and the surrounding environment. The implementation of context-based chemistry learning in several learning models or strategies can be seen in Figure 3 below.

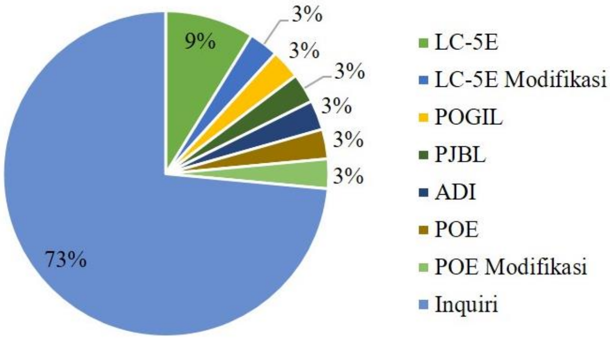

Figure 3. Integration of context-based chemistry learning with learning models or strategies

Based on the diagram in Figure 3, information is obtained that the inquiry learning model is generally a very popular learning in its integration with context-based chemistry learning. Inquiry learning is a form of constructivist learning that directs students as active subjects in exploring and understanding information. In the article review, N = 25 articles (73%) integrated inquiry learning with context-based chemistry learning, followed by N = 3 articles (9%) LC-5E learning model, N = 1 article (3%) POGIL learning model, N = 1 article (3%) modified LC-5E learning model, and N = 1 article (3%) project-based learning model (PJBL), N = 1 (3%) argument driven inquiry (ADI) learning model, N = 1 articles (3%) POE learning strategies, and N = 1 (3%) modified POE learning strategies. Based on the diagram, information is obtained that inquiry learning is generally most integrated with context-based chemistry learning. During the learning process students are directed to construct their understanding from various related contexts and seek relevance to the concept of the topic of the material being studied so that it is more applicable (Magwilang, 2016; Ilhan et al., 2016; Vaino et al., 2012; Broman & Parchmann, 2014; Karpudewan & Mathanasegaran, 2018; Slovinsky et al., 2021; Giammatteo & Valdivia, 2021).

The literature review shows that there are several research results that integrate learning models or strategies in context-based chemistry learning. Some examples of research results that integrate context-based chemistry learning with learning models include Majid & Rohaeti (2018) and Cahyarini et al., (2016) integrating the LC-5E learning model with context-based learning on acid-base material. The learning syntax in the LC-5E learning model includes (1) engagement, the teacher focuses students' attention on a new concept by providing questions and motivation to attract students' curiosity, (2) exploration, students actively dig up as much information as possible to can find solutions to problems that can be done through practical discussion activities, (3) explanation, students convey concepts and information on their findings obtained from discussion and practicum activities, (4) elaboration, students apply new concepts that have been found related to solving problems through discussion activities, (5) evaluation, the teacher and students evaluate the extent to which students' understanding of concepts can be constructed. Based on the integration of context-based chemistry learning with the LC-5E learning model, information is obtained that context is presented in the initial learning syntax, namely at the engagement. (Yuliastini et al., 2018) integrates the POGIL learning model with context-based learning on chemical bonding material. The POGIL learning syntax includes (1) orientation, preparing students to learn by fostering motivation and curiosity, (2) exploration, students responding to a series of questions to complete the tasks assigned to learning, (3) conceptual formation, students are encouraged to finding new concepts in learning, (4) application, students apply concepts to learning contexts, (5) closure, reflecting and evaluating the results of discussions in learning.

Several contexts are presented in varied syntax, some of which are Altundag (2018) integrating the 4EX2 learning model in basic chemistry material. The learning syntax in the 4EX2 learning model includes (1) engaging, (2) exploring, (3) explaining, and (4) extending, teachers and students jointly monitor and evaluate understanding and activities that have been carried out in learning as a whole . Furthermore, Pursitasari et al., (2020) integrates inquiry learning with context-based learning which is better known as Science Context-Based Inquiry Learning (SCOIL) on environmental pollution material. The learning syntax applied includes (1) observation, students make observations and ask questions about the context of phenomena related to everyday life, (2) investigation, students investigate problems posed through group discussions, (3) representation, students provide an explanation of the findings or information obtained from discussion activities, (4) conclusion, students conclude information based on the results of the investigation, (5) communication, students communicate the results of their investigations through presentation activities.

Koulougliotis et al., (2021) integrates project-based learning with context-based learning on chemical reactions and chemical bonds. The syntax for project-based learning includes (1) giving questions or project assignments, students observing in depth questions from the phenomena or context presented, (2) designing project plans, students developing projects that can be carried out through practicum, (3) compiling project schedule, (4) monitor project activities and progress, (5) test results, and (6) evaluate learning experiences. Furthermore, Grooms et al., (2014) integrated the ADI learning model with context-based learning on basic chemistry topics. The syntax of the ADI learning model includes (1) identifying tasks and guiding questions, the teacher presents context and investigative questions to students, (2) designing methods and collecting data, students in several groups develop methods and collect information, (3) analyze data and developing tentative arguments, (4) argumentation sessions, where each group presents its arguments while the audience asks questions and provides criticism, (5) explicit and reflective discussions, (6) writes investigative reports, (7) reviews group reports in pairs.

Baydere, (2021) integrates POE (prediction-observation-explanation) learning strategies with context-based chemistry learning on the topics of material properties, temperature, and heat. The syntax applied to the POE learning strategy is (1) prediction, students make temporary guesses or hypotheses from a context in life and the surrounding environment related to the chemical material being studied, (2) observe, students seek and collect as much information as possible to test their hypotheses through discussion and practicum activities, (3) explain, students provide explanations or communicate the results of investigations that have been carried out accompanied by supporting evidence. Based on the three syntaxes of the applied POE learning strategies, context is presented in all learning syntaxes and the role of the teacher is only as a facilitator and monitors students' activities in learning activities.

In general, the context that is integrated with certain learning models and strategies is presented at the beginning of the learning syntax of each learning model and strategy. Learning activities begin with the presentation of the context in everyday life and the surrounding environment. Furthermore, students are directed to identify or ask questions about related issues and concepts contained in the context presented. Furthermore, learning switches to the syntax of each learning model which is majority oriented towards investigating or investigating problems which can be carried out through discussion and practicum activities until important information or concepts are obtained from the results of the investigation so that students can communicate or exchange information related to each other. his findings. Thus, at the end of learning students can obtain information, complete conceptual understanding, and the relevance of the concepts studied to the related contexts being investigated (Baran & Sozbilir, 2018). Therefore, this can strengthen students' perceptions that chemistry is useful and applicable in various aspects of life and the surrounding environment.

Implementation of Effective Context-Based Chemistry Learning

The context that is applied to chemistry learning can strengthen the understanding of concepts constructed by students (Sevian et al., 2018; King & Ritchie, 2013; Baydere, 2021). Based on a review of the literature, context-based chemistry learning that is purely applied or integrated with certain learning models or strategies is generally proven to be effective in improving the cognitive, affective, psychomotor, and social aspects of students. This is supported by an increase in the average score of students from pretest to posttest. The problem encountered in chemistry learning activities is that the teacher lacks mastery of concepts and is less competent in applying context-based chemistry learning (King, 2007). This information can be the cause of the ineffective implementation of context-based chemistry learning. So far, the context approach to the implementation of chemistry learning is mostly presented in the initial syntax of learning. After that, it is followed by the application of various syntaxes from each particular learning model or strategy which ultimately leads to information discovery. The implementation of this learning can run effectively if students must participate actively in each learning syntax so that indirectly they can be trained in developing concepts through identifying prerequisite knowledge and knowledge that has not been understood for further exploration. In addition, teachers must have good competence in implementing context-based chemistry learning. Therefore, to realize the effective implementation of context-based chemistry learning, a good and mutually supportive role is needed between the teacher and students (Majid & Rohaeti, 2018; Magwilang, 2016; Ilhan et al., 2016).

▪ CONCLUSION

Based on the results and discussion of the article review, several important points can be concluded, namely (1) context-based chemistry learning has a positive effect on improving students' cognitive, affective, psychomotor, and social aspects, (2) context-based chemistry learning can be integrated with certain learning models or strategies where the presentation of the majority context is carried out in the initial syntax of learning, and (3) the implementation of effective context-based chemistry learning can be done by considering several indicators including the selection of an appropriate and applicable learning context, the teacher masters the material concepts along with the learning context, and students actively participate in every learning syntax that is applied.

▪ REFERENCES

Altundag, C. K. (2018). Context-based chemistry teaching within the 4Ex2 model: Its impacts on metacognition, multiple intelligence, and achievement. *Journal of Turkish Science Education*, 15(2), 1–12.

Aslamiah, A., Abbas, E. W., & Mutiani, M. (2021). 21st-century skills and social studies education. *The Innovation of Social Studies Journal*, 2(2), 82.

Baran, M., & Sozbilir, M. (2018). An application of context- and problem-based learning (c-pbl) into teaching thermodynamics. *Research in Science Education*, 48(4), 663–689.

Baydere, F. K. (2021). Effects of a context-based approach with prediction-observation-explanation on conceptual understanding of the states of matter, heat and temperature. *Chemistry Education Research and Practice*, 22(3), 640–652.

Bortnik, B., Stozhko, N., & Pervukhina, I. (2021). Context-based testing as assessment tool in chemistry learning on university level. *Education Sciences,* 11(8).

Broman, K., Bernholt, S., & Parchmann, I. (2018). Using model-based scaffolds to support students solving context-based chemistry problems. *International Journal of Science Education*, 40(10), 1176–1197.

Broman, K., & Parchmann, I. (2014). Students' application of chemical concepts when solving chemistry problems in different contexts. *Chemistry Education Research and Practice*, 15(4), 516–529.

Cahyarini, A., Rahayu, S., & Yahmin, Y. (2016). The effect of 5E learning cycle instructional model using socioscientific issues (SSI) learning context on students' critical thinking. *Jurnal Pendidikan IPA Indonesia,* 5(2), 222–229.

Calik, M., & Karatas, F. O. (2019). Does a "science, technology and social change" course improve scientific habits of mind and attitudes towards socioscientific issues? *Australian Journal of Teacher Education*, 44(6), 34–52.

Cigdemoglu, C., & Geban, O. (2015a). Context-based lessons with 5e model to promote conceptual understanding of chemical reactions and energy concepts. *Journal of Baltic Science Education*, 14, 435–447.

Cigdemoglu, C., & Geban, O. (2015b). Improving students' chemical literacy level on thermochemical and thermodynamics concepts through context-based approach. *Chemistry Education Research and Practice*, 3, 10715–10722.

Dori, Y. J., Avargil, S., Kohen, Z., & Saar, L. (2018). Context-based learning and metacognitive prompts for enhancing scientific text comprehension. *International Journal of Science Education,* 40(10), 1198–1220.

Duay, B. S. (2017). Perceived relevance of chemistry topics to everyday life: inputs to context based enrichment activities in general and inorganic chemistry. 1(September), 73–83.

Edelsztein, V. C., Tarzi, O. I., & Galagovsky, L. (2020). Chemical senses: a context-based approach to chemistry teaching for lower secondary school students. *Chemistry Teacher International*, 0(0), 1–14.

Enneking, K. M., Breitenstein, G. R., Coleman, A. F., Reeves, J. H., Wang, Y., & Grove, N. P. (2019). The evaluation of a hybrid, general chemistry laboratory curriculum: impact on students' cognitive, affective, and psychomotor learning. *Journal of Chemical Education,* 96(6), 1058–1067.

Flaherty, A. A. (2020). A review of affective chemistry education research and its implications for future research. Chemistry Education Research and Practice, 21(3), 698–713.

Giammatteo, L. M. T., & Valdivia, D. A. E. O. (2021). Introducing chemistry of cleaning through context-based learning in a high-school chemistry course. *American Journal of Educational Research*, 9(6), 335–340.

Grooms, J., Sampson, V., & Golden, B. (2014). Comparing the effectiveness of verification and inquiry laboratories in supporting undergraduate science students in constructing arguments around socioscientific issues. *International Journal of Science Education,* 36(9), 1412–1433.

Gulacar, O., Zowada, C., Burke, S., Nabavizadeh, A., Bernardo, A., & Eilks, I. (2020). Integration of a sustainability-oriented socio-scientific issue into the general chemistry curriculum: Examining the effects on student motivation and self-efficacy. *Sustainable Chemistry and Pharmacy,* 15(December 2019), 100232.

Ilhan, N., Yildirim, A., & Yilmaz, S. S. (2016). The effect of context-based chemical equilibrium on grade 11 students' learning, motivation and constructivist learning environment. *International Journal of Environmental and Science Education,* 11(9), 3117–3137.

Johnson, C., Boon, H., & Dinan Thompson, M. (2021). Cognitive demands of the reformed queensland physics, chemistry and biology syllabus: an analysis framed by the new taxonomy of educational objectives. *Research in Science Education*, 0123456789.

Johnson Enero, U., & Umesh, R. (2018). Representations of chemical phenomena in secondary school chemistry textbooks. *Chemistry Education Research and Practice.*

Karpudewan, M., & Mathanasegaran, K. (2018). Exploring the use of context-based green chemistry experiments in understanding the effects of concentration and catalyst on the rate of reaction. *Asia-Pacific Forum on Science Learning and Teaching*, 19(2).

King, D. (2012). New perspectives on context-based chemistry education: using a dialectical sociocultural approach to view teaching and learning. *Studies in Science Education,* 48(1), 51–87.

King, D., & Henderson, S. (2018). Context-based learning in the middle years: achieving resonance between the real-world field and environmental science concepts. *International Journal of Science Education*, 40(10), 1221–1238.

King, Donna T. (2007). Teacher beliefs and constraints in implementing a context-based approach in chemistry. *Journal of Nuclear Cardiology,* 14(4), S97–S97.

King, Donna Therese, & Ritchie, S. M. (2013). Academic success in context-based chemistry: demonstrating fluid transitions between concepts and context. *International Journal of Science Education,* 35(7), 1159–1182.

Koulougliotis, D., Antonoglou, L., & Salta, K. (2021). Probing Greek secondary school students' awareness of green chemistry principles infused in context-based projects related to socio-scientific issues. *International Journal of Science Education,* 43(2), 298–313.

Magwilang, E. (2016). Teaching chemistry in context: its effects on students' motivation, attitudes and achievement in chemistry. International Journal of Learning, *Teaching and Educational Research,* 15(4), 60–68.

Majid, A. N., & Rohaeti, E. (2018). The Effect of context-based chemistry learning on student achievement and attitude. *American Journal of Educational Research,* 6(6), 836–839.

Milenkovic, D. D., Segedinac, M. D., & Hrin, T. N. (2014). Increasing high school students' chemistry performance and reducing cognitive load through an instructional strategy based on the interaction of multiple levels of knowledge representation. *Journal of Chemical Education,* 91(9), 1409–1416.

OECD. (2016). Overview: excellence and equity in education: Vol. I.

Podschuweit, S., & Bernholt, S. (2018). Composition-effects of context-based learning opportunities on students' understanding of energy. *Research in Science Education,* 48(4), 717–752.

Pongchano, P., Jansawang, N., & Chomchid, P. (2017). A study of context-based learning activity model on chemical reaction issue for secondary students at the 10th level. *European Journal of Education Studies*, 3(5), 629–647.

Pratiwi, Y. N., Rahayu, S., & Fajaroh, F. (2016). Socioscientific issues (SSI) in reaction rates topic and its effect on the critical thinking skills of high school students. *Jurnal Pendidikan IPA Indonesia*, 5(2), 164–170.

Pursitasari, I. D., Suhardi, E., Putra, A. P., & Rachman, I. (2020). Enhancement of student's critical thinking skill through science context-based inquiry learning. *Jurnal Pendidikan IPA Indonesia*, 9(1), 97–105.

Qamariyah, S. N., Rahayu, S., Fajaroh, F., & Alsulami, N. M. (2021). The effect of implementation of inquiry-based learning with socio-scientific issues on students' higher-order thinking skills. *Journal of Science Learning*, 4(3), 210–218.

Rahayu, S. (2018). Promoting the 21 st century scientific literacy skills through innovative chemistry instrwuction promoting the 21 st century scientific literacy skills through innovative chemistry instruction. 020025(December 2017), 0–8.

Redhana, I. W. (2019). Mengembangkan keterampilan abad ke-21 dalam pembelajaran kimia. *Jurnal Inovasi Pendidikan Kimia*, 13(1).

Sevian, H., Hugi-Cleary, D., Ngai, C., Wanjiku, F., & Baldoria, J. M. (2018). Comparison of learning in two context-based university chemistry classes. *International Journal of Science Education*, 40(10), 1239–1262.

Slovinsky, E., Kapanadze, M., & Bolte, C. (2021). The effect of a socio-scientific context-based science teaching program on motivational aspects of the learning environment. *Eurasia Journal of Mathematics, Science and Technology Education*, 17(8), 1–16.

Solbes, J., Torres, N., & Traver, M. (2018). Use of socio-scientific issues in order to improve critical thinking competences. *Asia-Pacific Forum on Science Learning and Teaching*, 19(1).

Stuckey, M., Hofstein, A., Mamlok-Naaman, R., & Eilks, I. (2013). The meaning of "relevance" in science education and its implications for the science curriculum. *Studies in Science Education*, 49(1), 1–34.

Talanquer, V. (2011). Macro, submicro, and symbolic: The many faces of the chemistry "triplet*." International Journal of Science Education*, 33(2), 179–195.

Thomas, G. P. (2017). "Triangulation:" an expression for stimulating metacognitive reflection regarding the use of "triplet" representations for chemistry learning. *Chemistry Education Research and Practice*, 18(4), 533–548.

Topcu, M. S., Mugaloglu, E. Z., & Guven, D. (2014). Socioscientific issues in science education: The case of Turkey. *Kuram ve Uygulamada Egitim Bilimleri*, 14(6), 2340–2348.

Turiman, P., Omar, J., Daud, A. M., & Osman, K. (2012). Fostering the 21st century skills through scientific literacy and science process skills. Procedia - Social and Behavioral Sciences, 59, 110–116.

Uce, M., & Ceyhan, İ. (2019). Misconception in chemistry education and practices to eliminate them: literature analysis. *Journal of Education and Training Studies*, 7(3), 202.

Ultay, N. (2015). The effect of concept cartoons embedded within context-based chemistry: Chemical Bonding. *Journal of Baltic Science Education*, 14(1), 96–

108.

Vaino, K., Holbrook, J., & Rannikmäe, M. (2012). Stimulating students' intrinsic motivation for learning chemistry through the use of context-based learning modules. *Chemistry Education Research and Practice*, 13(4), 410–419.

Vogelzang, J., Admiraal, W. F., & van Driel, J. H. (2019). Scrum methodology as an effective scaffold to promote students' learning and motivation in context-based secondary chemistry education. *Eurasia Journal of Mathematics, Science and Technology Education*, 15(12).

Vogelzang, J., Admiraal, W. F., & van Driel, J. H. (2021). Scrum methodology in context-based secondary chemistry classes: effects on students' achievement and on students' perceptions of affective and metacognitive dimensions of their learning. Instructional Science.

Wei, B., & Long, F. (2021). Teaching chemistry in context: what we know from teachers' lesson plans. *International Journal of Science Education*, 43(8), 1208–1227.

Widarti, H. R., Marfu'ah, S., & Parlan. (2019). The effects of using multiple representations on prospective teachers' conceptual understanding of intermolecular forces. *Journal of Physics: Conference Series*, 1227(1).

Williams, D. P., & Hin, S. L. F. (2017). Measuring the impact of context and problem based learning approaches on students' perceived levels of importance of transferable & workplace skills. *New Directions in the Teaching of Physical Sciences*, 12(12), 1–8.

Wiyarsi, A., Pratomo, H., & Priyambodo, E. (2017). Chemistry learning: perception and interest of vocational high school student of automotive engineering program. *International Seminar on Science Education*, 3(October), 359–365.

Wiyarsi, A., Pratomo, H., & Priyambodo, E. (2020). Vocational high school students' chemical literacy on context-based learning: A case of petroleum topic. *Journal of Turkish Science Education*, 17(1), 147–161.

Wiyarsi, A., Prodjosantoso, A. K., & Nugraheni, A. R. E. (2021). Promoting students' scientific habits of mind and chemical literacy using the context of socio-scientific issues on the inquiry learning. Frontiers in Education, 6(May), 1–12.

Xiao, Y., & Watson, M. (2019). Guidance on conducting a systematic literature review. *Journal of Planning Education and Research*, 39(1), 93–112.

Yuliastini, I. B., Rahayu, S., Fajaroh, F., & Mansour, N. (2018). Effectiveness of pogil with ssi context on vocational high school students' chemistry learning motivation. *Jurnal Pendidikan IPA Indonesia*, 7(1), 85–95.