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## Culturally Responsive Chemistry Teaching (CRCT) of College Students as A Novice Teacher: Does It Matter?

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### Abstract

Culture is an essential part of human life; cultural involvement in learning can train students to find the meaning of life, including the contribution of chemistry in the cultural context of society. Teachers reported that they struggle to meet students' needs relevant to differences in culture and ability. The study aimed to investigate college students' understanding of chemistry by involving their culture with various methods, including transformative teaching and problem-solving. The research method used a descriptive with a qualitative approach. The data collection techniques were projects, interviews, observation, and questionnaires. The findings revealed that the learning process involving cultural aspects could show the contribution of chemical elements in society, especially the formation of scientific cognition. Culturally responsive chemistry teaching is an innovative learning approach to training college students' understanding (novice teachers). The research concludes that a good chemistry teacher can understand the needs of students, especially knowing their cultural background. To effectively teach from diverse backgrounds, schools need teachers who understand the impact of students' home and community cultures on their educational experience. This research can also develop an instructional design, train novice chemistry teachers' teaching skills, and develop curriculum.

Keywords: chemistry teaching; culturally responsive teaching; novice teachers

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### 1. Introduction

According to Gilbert & Treagust (2009), chemistry is a science closely related to human life, including the universe, nuclear energy, technology, the environment, and even humans themselves. In learning chemistry, the experts Barke et al. (2012); Gilbert and Treagust, (2009) provide a theory of chemical representation as a fundamental basis for understanding chemistry. In his study, chemical representation is a theory that studies a context by looking at three aspects, which are macroscopic, submicroscopic or particulate level, and symbolic (Barke et al., 2009; Gilbert & Treagust, 2009). This theory

Indirectly shows that chemistry is the basis for studying human life, so every human being needs to understand the function of science holistically (Barke et al., 2009). In the context of teaching, according to Barke et al. (2009), teachers still have difficulties in guiding students to understand a scientific context even though chemistry is an inseparable part of human activity, especially the formation of thinking skills for students in the classroom (Barke et al., 2012). The construction of student understanding certainly requires teachers who understand the essence of learning, including being responsive to the cultural background and life experiences of students (Siwatu, 2007; Taylor & Sobel, 2011).

Studies Taylor and Sobel (2011) reveal that many professional education organizations globally have adopted a certain standard for preparing and retaining high-quality teachers. The purpose of this adoption is to produce teachers who can work effectively with students with differences in the teaching process carried out, such as family background, gender, experience, cognition, language, learning style, and of course, culture (Barke et al., 2012; Rahayu et al., 2020; Rahmawati & Ridwan, 2017; Taylor & Sobel, 2011). Good teaching is not just transferring knowledge in the classroom but how the teacher presents a learning process that meets the learning needs of students. This difference in conditions significantly affects the academic achievement of students, including the mindset and the way students understand a context (Taylor & Sobel, 2011). This difference is referred to as diversity, especially culture, where culture dramatically influences the students' perspective on something so that students gain meaning from what they learn (Lee, 2001; Taylor & Sobel, 2011).

The teachers who are sensitive and responsive to cultural differences in learning are needed in a school environment. The teacher's self-awareness (in context, perspective, and belief) on cultural presence can significantly influence the planned teaching presentation. This awareness is caused because some students understand that the culture at home and school differs. These differences motivate teachers to present learning relevant to the diversity element that occurs in the classroom (Taylor & Sobel, 2011). However, several studies reveal that novice teachers do not yet have mature readiness for individuals from diverse cultural, linguistic, and racial/ethnic backgrounds (Taylor & Sobel, 2011). College students are novice teachers who must be considered and prepared for quality education in the future (Alles et al., 2019). Furthermore, Tinkler et al. (2019) added that the quality of students in the classroom is primarily determined by the quality of the teacher and, in particular, how the teacher treats them at the school. The novice teachers are very vital part of education, so it is crucial to prepare

teacher candidates who are resilient, creative, and innovative (Tinkler et al., 2019).

Research Tinkler et al. (2019) shows that learning offerings that integrate phenomena, including cultural contexts, can improve critical thinking skills and train students' reasoning power. The statement aims to show that novice teachers have cognitive abilities and concrete teaching skills, especially in society (Damianakis et al., 2020; Durmaz, 2018; Tinkler et al., 2019). The presentation of learning in a cultural context is relevant to studies Barke et al. (2012); Cheng and Gilbert (2009) that chemistry is present in aspects of human life so that elements of culture and science become one unit. The presence of culture in learning science can enrich students' knowledge as future novice teachers. This statement is relevant to the findings Cheng and Gilbert (2009) chemistry has a relationship with all aspects, such as the universe, technology, and society. In the teaching aspect, the mission of chemistry learning is to construct a central meaning between chemistry knowledge and student life (Taylor & Sobel, 2011). The main goal is that students are aware of their responsibility for environmental conservation, educating science in society, and integrating chemical knowledge into people's lives, including culture (Barke et al., 2011; Taylor & Sobel, 2011; Toom et al., 2019). Cultural aspects affect one's cognition, motivation, and perspective in viewing a problem. That is, teachers have to have an awareness of cultural integration. That culture affects student's way of thinking, beliefs, and behavior; then teachers need to understand that the presence of culture has an impact on the design of the designed learning, including chemistry learning (Barke et al., 2012; Cheng & Gilbert, 2009; Damianakis et al., 2020; Taylor & Sobel, 2011).

Indonesia has more than 17000 islands and more than 300 ethnicities or cultures, so the cultural context in Indonesia is very much needed to be integrated with teaching, especially in understanding chemistry culturally (Rahmawati et al., 2019). Research from Rahmawati & Ridwan (2017) shows that instruction that integrates culture into science

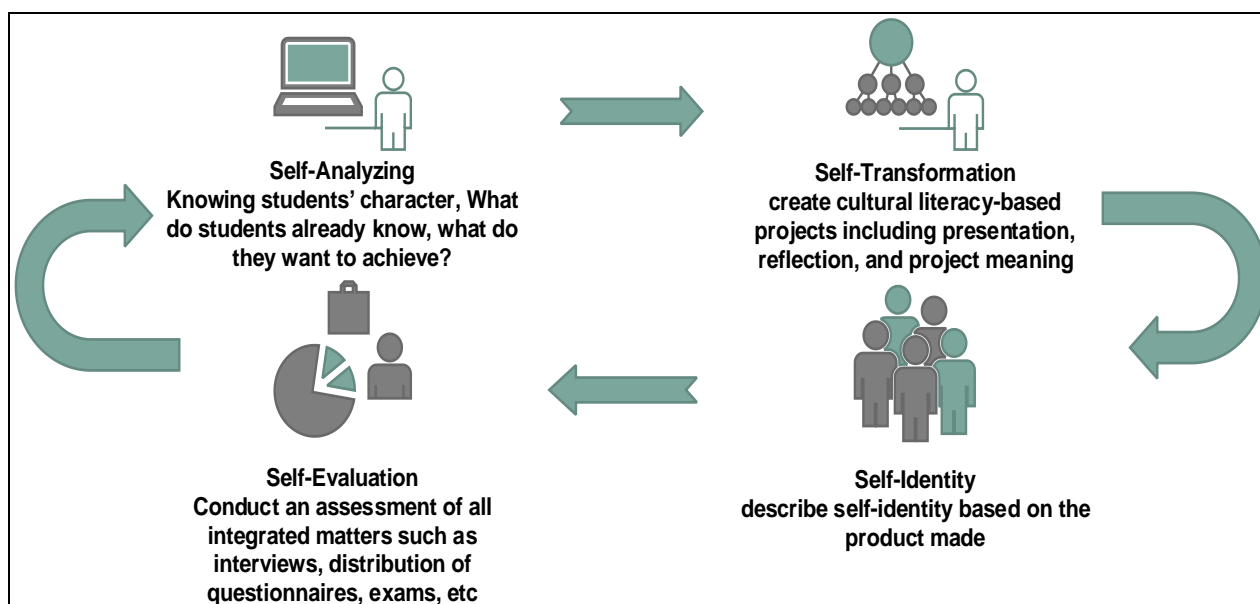
can influence students' understanding and bring them more meaningful experience. Teachers who present learning in a cultural context can strengthen students' cultural identity and literacy, hone critical thinking, have new perspectives, and have a complete understanding of knowledge (Lee, 2001; Rahmawati et al., 2019; Siwatu, 2007; Taylor & Sobel, 2011).

This research is a visualization of the importance of diversity integrity in a learning design, including culture. The results of interviews and observations of chemistry education students reveal that culture is rarely presented in the learning process for several reasons. First, there are no science and culture learning resources, so students have difficulty understanding the material. Second, teachers tend to do textual-based teaching so students' understanding is limited to the material's content. Third, most teachers do not carry out pre-learning assessments, so students' initial abilities and needs cannot be identified. As a result, students are accustomed to teaching patterns that do not integrate aspects of diversity, such as culture in learning science (chemistry). This research can be the basis for developing instructional design, teaching skills training, and curriculum. An instructional collaboration can transform students

cognitively, affectively, and psychometrically in designing learning. Those collaborations include culturally responsive teaching, transformative teaching, chemistry learning, and project-based learning.

## 2. Research Method

The method is carried out in stages by adopting a qualitative approach (Schreiber & Asner-Self, 2011). There are six essential attributes of qualitative research used: view of reality, causality, engagement with participants, explanation of the study, type of primary research analysis, and hypothesizing. These attributes become the basis for developing the research issues carried out. In addition, the concept of conducting research is oriented to investigating students' cognitive understanding of chemistry based on cultural projects. Then, students design a learning design through a lesson plan based on the project they are working on. Design projects developed by students using the provided templates as shown in Figure 1. Tracking project results in data, documentation, and interviews will be interpreted into a concrete research description according to the findings and attributes adopted.



**Figure 1. Visualization of Project Implementation by CRCT Model**

The research sample uses Chemistry Education Students from the Faculty of Teacher Training and Education, Lambung Mangkurat University batch 2019. The student has completed six semesters of study and has not taken any learning design courses. Students are novice teachers who need to be considered and prepared for quality education in the future (Alles et al., 2019; Tinkler et al., 2019). The study Tinkler et al. (2019) adds that the quality of students is primarily determined by the quality of teachers, especially the treatment of teachers in the classroom. It means that novice teachers are vital to the education sector, so it is crucial to prepare novice teachers.

Documentation, observation, and interviews are part of the data collection techniques. Project development is carried out periodically, where students go through several stages until the project is finally completed. The assignments given are also evaluated gradually by the lecturers. The following is a visualization of the implementation of the research in question.

### **3. Result and Discussion**

Culture significantly affects how teachers carry out teaching, the learning process, and the potential of students to solve problems (Taylor & Sobel, 2011). With teachers aware of the presence of cultural influences in a learning system, teachers begin to understand a learning concept that can be a bridge for students to communicate in class (Barke et al., 2012; Taylor & Sobel, 2011). Culture is a complex part of human life, including science, belief, art, morals, and customs (Taylor & Sobel, 2011). This thinking is in line with Hammond (2015) that culture has three basic levels: values, norms, and beliefs. Those are significantly related to the research result because by doing the culture-based project, students find some findings such as making lesson plan-based cultural context, developing project by integrating culture in chemistry material, and developing teaching materials.

Students' difficulties are triggered because they find it difficult to release their acquired

knowledge based on observations without scientific review; this situation is called preconceptions (Barke et al., 2009). These preconceptions need to be transformed into scientific concepts so that students are not disabled in constructing their understanding (Barke et al., 2009; Gilbert & Treagust, 2009; Chu & Garcia, 2014; Rahmawati & Ridwan, 2017). Along the way, Barke et al. (2012) explained that scientific understanding is still inconsistent, so many misconceptions exist. In addition, Barke et al. (2009) are also said that students are still unstable in understanding the subject matter. As novice teachers, students must be prepared to have broad skills and literacy to present an innovative learning process. The presentation of learning with CRCT is new in the chemistry learning process. With a variety of supporting theories such as transformative learning (Damianakis et al., 2020), multi-representation of chemistry (Cheng & Gilbert, 2009), the essence of chemistry education (Barke et al., 2009, 2012), culturally responsive pedagogy (Hammond, 2015; Taylor & Sobel, 2011) and other relevant theories are reinforcements in the concept and implementation of CRCT. In addition, the results of interviews and observations of chemistry education students add to the description of the importance of teaching and learning chemistry. In addition, chemistry education is a bridge of knowledge to change preconceptions into scientific concepts. The implementation of CRCT is an alternative way to train students to present a learning process oriented toward achieving scientific concepts (Barke et al., 2012).

#### **3.1. Self-Analyzing**

Analysis based on learning needs is vital for teachers to carry out, especially since Covid-19 is present in human life. The Covid-19 issue is an opportunity for every human being to transform into a better person (Korkmaz & Toraman, 2020). However, educators experience various problems in dealing with the educational process caused by the pandemic era. The recommendation Korkmaz and Toraman (2020) is to review the post-Covid-19 education aspect. Self-analyzing is an initial action for teachers to know in depth the identity and mental readlines of students

readiness of students before learning. Self-analyzing, such as learning styles, interviews, step-by-step observations, and identifying various learning problems, is a scientific analysis that comprehensively describes what the teacher should do in class. In the context of teaching, the identity of students is a significant component of how learning designs are developed. The view Avraamidou (2016a) that identity is a multidimensional instrument to see how a teacher transforms. Students are novice teachers who need to be prepared as humans who not only understand the content of the material, but students know themselves, understand what is being taught, and understand the meaning of education. Testimonials (self-analyzing) were conducted to describe the various perspectives of students. One of the students said most teachers who teach this subject are not very interesting and only teach the essence of the syllabus without relating it to everyday life that is close to the students. It will create a boring learning atmosphere and cause the material not to be appropriately delivered and impractical. In addition, there are still many chemistry teachers whose educational background is not in chemistry. Even though they may have had an upgrading program before, the provision provided was more about mastering the material and not how it was delivered (Widianingsih, Personal communication, June, 2022).

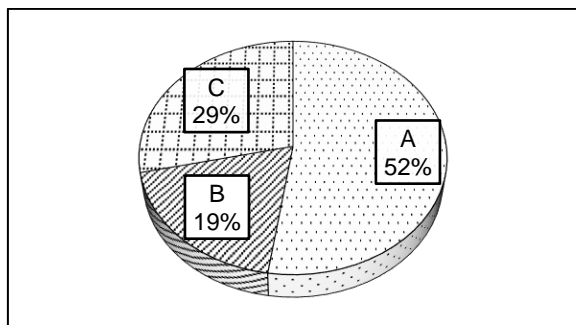
Integrating aspects of human life into a chemistry learning presentation. The integration of daily life in the learning process of students makes the material studied more meaningful and effective. A chemistry teacher whose background is not in chemistry. A teacher needs to involve the context of authentic human life in the learning process, and teachers need to have skills and competencies in teaching. In some cases, the teacher in the school is not a teacher with a chemistry education background. It is wrong for the school that does recruitment related to the topics. On the other hand, an analysis of cultural literacy was also carried out as part of self-analyzing. The question is whether a teacher needs to understand aspects of student diversity such as cultural background,

family background, language, parenting, gender, and the things involved in the student's living environment. The student said it was essential. A teacher should know students' backgrounds because, indirectly, this dramatically affects the development of each individual's understanding. These different characteristics must be made in an assessment. Furthermore, the teacher can understand the diverse aspect of each student and make appropriate learning designs according to the characteristics of each student to support the success of his understanding. Even if the teacher knows these aspects can prevent misconceptions that exist in each individual and understand only the learning difficulties of students and the factors that can hinder the development of their knowledge (Widianingsih, Personal communication, June, 2022).

The diversity aspect is vital for teachers to pay attention to because this aspect affects the development of students. Taylor and Sobel (2011) explain that teachers who are sensitive and responsive to cultural differences in learning are needed in a school environment. The teacher's self-awareness (in context, perspective, and belief) of cultural presence can significantly influence the planned teaching presentation (Taylor & Sobel, 2011). On the other hand, Gilbert and Treagust (2009) explains that chemistry is a science closely related to aspects of human life, including the universe, nuclear energy, technology, the environment, and even humans themselves. Barke et al. (2012); Gilbert and Treagust (2009) provide a theory of chemical representation as a fundamental basis for understanding phenomena from a chemical point of view to study chemistry. That means, indirectly, studying culture offers a scientific experience of phenomena based on chemistry (Barke et al., 2012; Hammond, 2015; Taylor & Sobel, 2011).

In connection with the above explanation, learning styles analysis is also part of learning needs analysis. Individuals can understand knowledge with their learning style (Chetty et al., 2019; Gholami & Bagheri, 2013). Figure 2 is a data visualization of student learning styles

(students) where visual learning styles are the most significant percentage compared to the others at 52%. The data was obtained by distributing learning style questionnaires to students before the learning process. It aims to determine each student's learning style so that it is easy for teachers to assess learning concepts, especially assignments and evaluations (Rahayu et al., 2020; Haryana et al., 2020; Uzuntiryaki, 2007). The analysis of learning styles helps in integrating content into the learning process because student academic achievement is influenced by learning styles. Visual learning styles tend to be easier to understand and remember material (Rahayu et al., 2020; Litta & Budiarty, 2020; Uzuntiryaki, 2007). Visualization also certainly impacts students' cognitive processes, so the results of this analysis are beneficial for designing teaching and learning. However, each learning style has its skills in solving a problem, meaning that learning style analysis is essential for teachers.



**Figure 2. The Visualization of Student's Learning Style (A: Visual, B: Audio, C: Kinesthetic)**

### 3.2. Self-Transformation

One of the orientations for implementing research is that students create a project based on cultural literacy. The project is given the term "self-developed project" with the aim that students can find relationships between studies of chemistry through culture. Culture in the context of this project is where students examine their culture or the place where they grew up with that culture. The project can train students' reasoning power to understand the essence of science, such as chemistry. Then, the integration of culture in the project increases student cultural literacy so that students realize that chemistry is closely

related to life. The following is the "self-developed project" format in question.

The presentation of chemical materials in a 'self-developed project' based on cultural literacy can be very beneficial in strengthening and preserving local cultural values in our area (Norhasanah, Personal communication, June, 2022). The other student said, I was directed with systematic and conceptual learning in stages. Initially, I had no knowledge or awareness of the importance of science in culture. Still, the learning process gave me an understanding of the importance of science and culture in learning (Widianingsih, July 2022). The learning treatment I experienced made it very easy for me to understand how the context of chemistry is present in the culture of the people, especially in the cultural studies of South Kalimantan (Mawaddah, Personal communication, July 2022).

The reflection meeting above shows that the concept of CRCT affects students' self-awareness of the surrounding environment. In addition, integrating culture into the chemistry learning process changes the student's perspective on chemistry. Cultural literacy-based projects can be used as a renewal in teaching chemistry so that students have various learning offerings in the class. Then, in previous interviews, students revealed that there was no literacy regarding the involvement of cultural aspects in chemistry studies, so the self-developed project could be the primary reference in studying chemistry. Culturally responsive teaching effectively gives students a sharp mental model of a phenomenon. Taylor and Sobel (2011) strongly recommend that teachers can design culturally responsive teaching. Taylor and Sobel (2011) said culturally responsive teaching implements what research has shown to be effective instruction while employing a cultural lens to situate the content through students' existing mental schemas, prior knowledge, and cultural perspectives. Recommends many ways teachers can design their instructions to be culturally responsive. The project results of college students by CRCT, called "self-developed project" as shown in Table 1.

**Table 1. The Project Results of College Students By CRCT**

Name Cultural	Potential Chemical Terminology*	**Integration
<p><i>Batimung</i> aims to eliminate foul body odour. In addition, the steam from the spices can kill bacteria or germs that cause body odour and even scent the body while refreshing and relieving aches. Then, the <i>Batimung</i> process is also healthy because it also functions to remove toxins in the body (Khairunnisa, Personal communication, June, 2022).</p>	<p>Colligative properties of the solution. Because the <i>Batimung</i> process increases the boiling point and lowers the vapour pressure, it is included in the colligative properties of the solution. A solution's colligative property is a property that is only affected by the number of solute particles.</p>	<p>While boiling spices for <i>Batimung</i>, the boiling point that needs to be reached is quite long and must be at a high temperature. The process increases until the boiling point of the spice solution for <i>batimung</i> is more elevated than water. It is because water molecules are difficult to evaporate. The water has bonded with other compounds contained in the spice.</p>
<p><i>Hintalo Karuang</i> porridge is an offering and a dish in the tradition of <i>Mehanyari Kelambu</i> by the people of Banjar. <i>Hintalo Karuang</i> is generally made before the wedding ceremony. <i>Hintalo Karuang</i> porridge is interpreted to prevent disturbances from spirits (other worlds), and glutinous rice flour is interpreted as a symbol so that it will stick together until old age (South Kalimantan) (Norhasanah, Personal communication, June, 2022).</p>	<p>The chemical material in making <i>Hintalo Karuang</i> is the colloid system material, which uses the coagulation process. During the process, the whiting water used to make <i>Hintalo Karuang</i> acts as a coagulant to prevent the balls from sticking together.</p>	<p>The process of <i>making Hintalo Karuang</i> can be applied to colloidal material (coagulation). To produce <i>Hintalo Karuang</i>, glutinous rice flour that has been kneaded must be solidified with whiting water to create lumps of balls and separate from the dispersing medium. Betel lime water which is alkaline, is used as a coagulant, where the OH<sup>-</sup> ions will neutralize the charge of the glutinous flour particles. The <i>Hintalo Karuang</i> porridge dish is one of the typical culinary delights of South Kalimantan. This porridge is used as an offering in the tradition of <i>Mehanyari Kelambu</i>.</p>
<p>The <i>Batapung Tawar</i> culture intends to obtain security for what has been owned or cultivated. Protection for yourself, family, and neighbours (West Banjarmasin District, South Kuin Village, South Kalimantan) (Nurjannah, Personal communication, June, 2022).</p>	<p>The related materials are electrolyte and non-electrolyte solutions, colloidal materials, macromolecular materials, and chemical bonds. The electrolyte material and non-electrolyte solution relate to the material used in this process: water.</p>	<p>The main ingredient used for the fresh <i>Batapung Tawar</i> event is water, sprinkled using pandan leaves or banana leaves tied in small pieces. As for the water used by the general public, it still hasn't gone through the demineralization process, so it has the potential to warm up electric currents. So, avoiding direct contact with electronic devices and power sources is essential during the event.</p>
<p><i>Menginang</i> is one of the traditions of the Bukit Tribe in Batung Village, Piani District, Tapin Regency; the purpose of</p>	<p>The related material is organic chemistry. It is because it studies organic compounds, in this case, terpenes or compounds from plants.</p>	<p>Batung Village's people believe it can improve oral health and strengthen teeth. Clinically, the compounds contained in the</p>

Name Cultural	Potential Chemical Terminology*	**Integration
the local community to carry out the betel nut tradition is to relieve hunger, have the effect of solid teeth and gums, and breathe freshener (Rudi, Personal communication, June, 2022).	Medicinal chemistry is seen from the aspect of the purpose of betel nut is the use of chemicals for the health of the human body, in this case, dental and oral health.	ingredients for betel nut have antibacterial agents such as tannins (C <sub>76</sub> H <sub>52</sub> O <sub>46</sub> ) and catechins (C <sub>15</sub> H <sub>14</sub> O <sub>6</sub> ). At the same time, the calcium (Ca) content in whitening can strengthen tooth roots and repair the pulp of broken teeth.

**Description:**

\*Explain what culturally relevant chemical material is described and briefly explain the material.

\*\*Explain in depth whether there are logical, rational, empirical thoughts about the relationship between chemistry science and the culture you describe.

**3.3. Self-Identity**

According to Roth (2016) identity is self-representation to conceptualize whatever science teachers do, such as, who they are, how they do it, and how they develop in their professional work. Identity is a person's conception of themselves and how others 'see' them when they act, behave, think, do, feel, and position themselves in activities. Avraamidou (2016a) views that the teacher's identity is an essential part of the context of education. In addition, teacher identity is a process of how they (teachers) see themselves as the main component in the educational aspect (Mensah, 2016). Identity formation is a process of interpreting and reinterpreting teachers to their experiences because the formation process is dynamic (Avraamidou, 2016a; Roth, 2016).

The teacher's identity is how a teacher's mindset changes, how to transfer their knowledge, and how experience affects their perspective on teaching. Another attribute that influences the teacher's identity is a diverse environment in which a diverse community of attributes triggers a person to stand out and evaluate themselves as different (Avraamidou, 2016b, 2016a). As novice teachers, students need to understand themselves and their goals deeply. In the CRCT presentation, students are given a questionnaire based on the concept of identity. This questionnaire consists of questions that aim to determine how far students know themselves as novice teachers. Description of student responses to self-identity-based questions shown in Table 2

**Table 2. Description of Student Responses to Self-Identity-Based Questions**

The Questions	Responses
Why do you want to be a chemistry teacher?	<ul style="list-style-type: none"> <li>• Being a teacher is a noble job, and when I was in high school, I felt there were still few chemistry teachers. At my school, there was only 1 chemistry teacher (Baihaqi, Personal communication, June 2022).</li> <li>• The learning offered by the School Teaching Practices Program and the innovations motivated me to become a chemistry teacher (Widianingsih, Personal communication, June 2022).</li> <li>• It started when I decided on a major where at that time, I was challenged to wrestle in a field that most people didn't like (Norhasanah, Personal communication, June 2022).</li> <li>• Because when I was in high school, I saw that the chemistry teacher in teaching was elementary to understand, and also, as a teacher, we also learned about challenges (Fatimah, Personal communication, June 2022).</li> <li>• Because when I was a high school student and first-time studying chemistry, I felt that chemistry was one of the essential parts of</li> </ul>



The Questions	Responses
	<p>extraordinary things (Mawaddah, Personal communication, June 2022).</p>
<p>Describe a 'chemistry teacher' in your opinion?</p>	<ul style="list-style-type: none"> <li>• The chemistry teacher is disciplined, firm, and humorous (Fatimah, Personal communication, June 2022).</li> <li>• In my opinion, the chemistry teacher is a teacher who is famous for his on-time nature, and the most diligent teacher has a firm disposition (Norhasanah, Personal communication, June 2022).</li> <li>• The chemistry teacher is a teacher who can guide students to do suitable activities, understand the diversity factor, able to motivate students (Nurjannah, Personal communication, June 2022).</li> </ul>
<p>How do other people view you as a chemistry novice teacher?</p>	<ul style="list-style-type: none"> <li>• The chemistry teacher is tricky (Baihaqi, Personal communication, June 2022).</li> <li>• Some people give a bit condescending views when they know I am a "novice chemistry teacher" (Widianingsih, Personal communication, June 2022).</li> <li>• Why do I prefer to be a chemistry teacher over others or how learn something difficult like chemistry (Mawaddah, Personal communication, June 2022).</li> <li>• According to some of my friends, I have the potential to become a novice chemistry teacher. They say I am suitable to be a teacher because he is a patient and humble (Norhasanah, Personal communication, June 2022).</li> </ul>
<p>Has culture influenced your desire to become a chemistry teacher? If yes, what is the effect?</p>	<ul style="list-style-type: none"> <li>• Yes, culture has become one of my influences to teach chemistry that coexists with everyday life. Honestly, I just thought about it when I took the 'chemistry learning development design' course using the CRCT (Widianingsih, Personal communication, June 2022).</li> <li>• No. Nowadays, culture doesn't affect my desire to become a chemistry teacher. However, culture can influence a person's desire to become a chemistry teacher (Nurjannah, Personal communication, June 2022).</li> <li>• At first, culture did not affect my desire to become a chemistry teacher, but after participating in cultural project-based learning, I was finally interested (Norhasanah, Personal communication, June 2022).</li> </ul>
<p>How would you describe 'culture' as part of your identity?</p>	<ul style="list-style-type: none"> <li>• I describe "culture" as part of identity with language. The language used in communication is essential to determining a person's cultural identity (Widianingsih, Personal touch, June 2022).</li> <li>• Culture is a person's habits, so a person's identity is seen when he makes the habits he does (Nurjannah, Personal communication, June 2022).</li> <li>• Culture as identity can be represented through ' someone's hometown (Auliya, Personal communication, June, 2022).</li> </ul>
<p>Based on the self-identity above, each student has their perspective in seeing themselves as novice chemistry teachers. The presence of 'culture' is not the leading indicator of</p>	<p>someone becoming a teacher or a chemistry teacher. In addition, some things negatively affect the desire of students to become a teacher, so identity formation is dynamic. This</p>

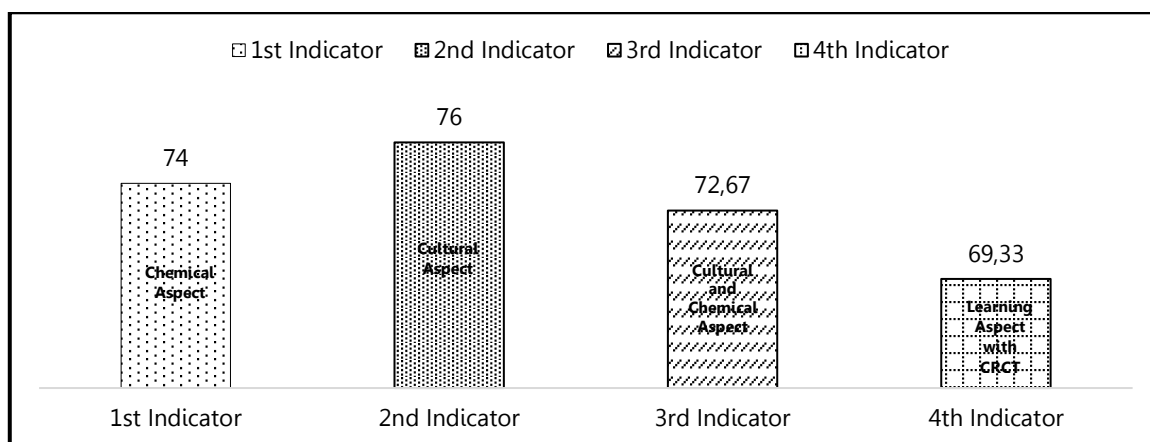
finding was also expressed by Avraamidou (2016a) that identity formation is dynamic and unstable, so teachers need further analysis to understand student identities. The data (Table 2) is vital data that needs to be analyzed because identity issues significantly affect student development, especially careers as chemistry teachers. Another attribute that influences the teacher's identity is a diverse environment where a diverse community of attributes triggers a person to stand out and evaluate themselves as different (Avraamidou, 2016a; Mensah, 2016; Roth, 2016). If identity formation is social, teachers must integrate social aspects in the learning context through various projects and brainstorming processes (Avraamidou, 2016a). Implementing the CRCT learning model is sufficient to open students' understanding of the importance of finding self-identity as future chemistry novice teachers. In addition, learning with CRCT provides an additional reference that the cultural aspect is the part that influences the learning process.

### 3.4. Self-Evaluation

Learning with culturally responsive chemistry teaching (CRCT) is innovative learning so that students are aware of the presence of science in every aspect of human life, especially culture. Teachers are the primary key to future quality education in human development and

quality education (Liu et al., 2019). Students are novice teachers who need to be considered and prepared for quality education in the future (Alles et al., 2019; Tinkler et al., 2019). Furthermore, Tinkler et al. (2019) added that the quality of students in the classroom is primarily determined by the quality of the teacher and, in particular, how the teachers treat the students at the school. Students are a very vital part of education, so it is crucial to prepare novice teachers who are resilient, creative, and innovative (Tinkler et al., 2019).

Critical thinking skills and experience are essential for a teacher to be professionally trained (Damianakis et al., 2020; Tinkler et al., 2019). Research Tinkler et al. (2019) shows that problem-solving and critical thinking-based learning can enrich participants' understanding and train reasoning power. The statement aims to show that novice teachers have cognitive abilities and skills, especially in society (Damianakis et al., 2020; Durmaz, 2018; Tinkler et al., 2019). Despite this strong call for practice, there is not yet much evidence that student teachers' learning opportunities are increasingly grounded in tradition. That is, CRCT learning is a renewal, especially in a university environment, so that an agency can produce novice teachers who are experienced and responsive to diversity-based learning.



**Figure 3. The Students Responses by Questionnaire Analyzing in CRCT**

Figure 3 shows that students positively assess the implementation of learning with CRCT. A questionnaire is one of the assessment results of the CRCT implemented in the classroom,

especially in the instructional design course. The questionnaire result (Figure 3) shows that culturally responsive chemistry learning needs to be sustainable. Sustainability aims to teach

students how to teach with different identities, such as cultural differences. In addition, the results of CRCT-based projects can be a legacy for teachers in the future. For example, if someone has students with a Banjarmasin cultural background, the teacher can have a framework and description of teaching for the culture in question. This statement is in line with Taylor and Sobel (2011) information that the diversity of students dramatically affects the quality of projects and how teachers design the learning process. Then, the interview (Table 3) is to strengthen the impact of learning with the CRCT model. One interview result is that compared to reading the material presented in the book, the

cultural integration in understanding chemistry makes the concept more embedded in my brain (Widianingsih, Personal communication, July 2022). The interview result illustrates that students experience cognitive and different perspectives after studying with CRCT, especially when working on cultural literacy-based projects. That is, CRCT learning provides meaningful learning for students, so learning based on cultural literacy is an innovative way to understand chemistry.

Description of student responses to self-reflection-based questions is shown in Table 3.

**Table 3. Description of Student Responses to Self-Reflection-Based Questions**

The Questions	Responses
<p>Is it appropriate to understand aspects of science such as chemistry by collaborating with the cultural aspect?</p>	<ul style="list-style-type: none"> <li>• Yes, I think it's very accurate. If we look at the facts on the ground, it is still rarely used; maybe even some teachers don't believe they can be related to each other (Widianingsih, Personal communication, July 2022).</li> <li>• Yes, I think it's very accurate. If we look at the facts on the ground, it is still rarely used; maybe even some teachers don't believe they can be related to each other (Widianingsih, Personal communication, July 2022).</li> <li>• Chemistry is a complex science to understand; it requires reasoning by collaborating with culture, making it easier to explain (Baihaqi, Personal communication, July 2022).</li> </ul>
<p>What is your opinion about implementing transformative learning with a cultural approach to understanding chemistry?</p>	<ul style="list-style-type: none"> <li>• Chemistry taught in schools generally uses the example of "western knowledge" which dominates the curriculum at every level of education (Widianingsih, Personal communication, July 2022).</li> <li>• Culture is close and side by side with our lives; it turns out that learning can be related to chemistry; through culture, chemistry will be attached and easier to understand (Baihaqi, Personal communication, July 2022).</li> </ul>
<p>Have you experienced progress or improvement in literacy (insight) after experiencing transformative learning, especially knowledge about the culture you are studying?</p>	<ul style="list-style-type: none"> <li>• Yes, this creates a different perspective than before about understanding the context of chemistry in culture (Widianingsih, Personal communication, July 2022).</li> <li>• Yes, I have progressed or increased in literacy or insight after experiencing transformative learning, especially knowledge about the culture that has been studied (Nurjannah, Personal communication, July 2022).</li> </ul>

The Questions	Responses
Representation of chemistry (learning chemistry in macro, sub-micro, and symbolic) closely relates to the cultural aspects studied?	<ul style="list-style-type: none"> <li>• Yes, very closely related. Moreover, this is related to materials that are usually used for cultural sustainability requirements, such as in the manufacture of food (Widianingsih, Personal communication, July 2022).</li> <li>• Chemical representations can improve understanding of chemistry conceptually, even make it more complete, to improve learning outcomes (Fatimah, Personal communication, July 2022).</li> </ul>
Do you understand chemistry more profoundly after studying it by integrating cultural aspects?	<ul style="list-style-type: none"> <li>• Compared to reading the material presented in the book, integrating cultural aspects in understanding chemistry makes the concept more embedded in my brain (Widianingsih, Personal communication, July 2022).</li> <li>• I understand chemistry more deeply after studying by integrating cultural aspects (Nurjannah, Personal communication, July 2022).</li> </ul>
If you were a teacher tomorrow, would you recommend the concept of transformative learning, where students understand the chemistry aspect through cultural studies? Write your reasons!	<ul style="list-style-type: none"> <li>• Yes, I would recommend transformative learning by understanding the chemical aspects of this cultural study (Widianingsih, Personal communication, July 2022).</li> <li>• Yes, I highly recommend transformative learning because it can add insight and preserve a culture that is almost unknown to students (Fatimah, Personal communication, July, 2022).</li> </ul>

Based on Table 3, it can be concluded that transformative teaching is the best way to introduce science through a cultural context because novice teachers will realize that chemistry and people's lives cannot be separated. Research findings can become the main reference for novice teachers in developing various learning tools, including teaching materials, lesson plan, assessments, etc.

#### 4. Conclusion

Culturally responsive chemistry teaching is an important thing that needs to be done by a teacher. Teachers create learning presentations that connect knowledge, beliefs, and cultural practices with science content, pedagogy, or language used in the classroom, and the student's academic experience becomes valuable and meaningful. The CRCT is an innovative learning approach to training college students' understanding (novice teachers). The research concludes that good

teaching is teaching that understands the needs of students, especially knowing their cultural background. To effectively teach from diverse backgrounds, schools need teachers who understand the impact of students' home and community cultures on their educational experience. This research can also develop an instructional design, train the teaching skills of novice teachers, and develop curriculum.

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