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# Chemistry students' identity empowerment through ethnochemistry in culturally responsive transformative teaching (CRTT)

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**Abstract.** The paper portrays the second year report of a three-year longitudinal study of ethnochemistry integration in Culturally Responsive Transformative Teaching (CRTT) teaching model in secondary schools. The CRTT develop based on Culturally Responsive Teaching (CRT) as an approach that includes students' characteristics and cultural references in all aspects of learning and transformative learning framework. The study developed CRTT teaching model in the first year of study and consists of five phases of self-identification, cultural understanding, collaboration, critical reflections, and transformative construction. The qualitative methodology approach has been employed with observation, interviews, and reflective journals as data collection. The CRTT teaching model was implemented in chemistry classrooms from two secondary schools. The study involved 68 students of year-10 in the topic of electrolyte and non-electrolyte solution. The data was analyzed from the basic principles of cultural identity category. The results showed that the integration of ethnochemistry in CRTT teaching model has engaged students in empowerment their cultural identity and nationalism, cultural differences awareness, and learning identity development. The teaching model is also relevant to the policy of national curricula of nationalism in relation to character and culture identity development.

## 1. Introduction

Indonesia with its diversity in values, beliefs and practices consists of more than 17,000 islands and more than 300 ethnic groups [1]. In the classroom, cultural background differences affect students' values and ways of thinking and teacher-student interaction. According to [2], teachers need to understand their students' cultural background to engage them in learning experiences. Therefore, it is important to develop 'cultural awareness', not for perpetuating division but for developing understanding of diversity. It is important to equip the students to understand cultural differences as pointed out by [3], students need to have knowledge and skills to engage in differences of age, gender, sexual orientation, class, region, religion, race, ethnicity, ability, and nationality. Meanwhile, the process of globalization and cross-cultural interaction between ethnic groups influence the students' cultural identity and character. [4] stated that education should be able to develop students' competence and maintain their cultural identity. As related to student learning, students' learning stages can be identified as, rote learning, in-depth meaning making, and learning as a cultural phenomenon [5]. However, the study of Indonesia's cultural diversity in relation to chemistry learning for creating meaningful learning experiences has not been widely explored. Therefore, it is important to engage students with their cultural background.



The culturally-based teaching approaches is important in developing social and cultural identity. One of teaching approaches that can integrate culture in the classroom is Culturally Responsive Teaching (CRT) which an approach employs students' cultural references for students' learning engagement[4]. According to Gay [6], CRT applies the cultural knowledge, prior experiences, and performance styles of diverse students to create meaningful learning experiences for these students through their strengths. Multidimensional CRT involves content of curriculum, context of learning, classroom climate, relationships of student-teacher, instructional techniques, and assessments. Students can also participate actively in their own performance evaluations by being better human beings and more successful learners [6]. In the context of learning chemistry from cultural perspectives, ethnochemistry can be integrated. Ethnochemistry as a part of ethnoscience looks at culture from a chemistry perspective which involves a cross-discipline of social sciences and humanities perspectives [7]. In this study, the integration of ethnochemistry in CRT as one way to integrate scientific inquiry within students' cultural background. CRT could empowers students by using cultural referents to develop knowledge, skills, and attitudes [8]. In the culturally responsive teaching, teachers play an important role in engaging students in these ways of knowing. In learning within cultural phenomenon, students will have the opportunity to engage not only Western Science but also their own culture. Students should have abilities to harmonise their own culture (their everyday language) aligns with Western science Learning outcomes and experiences [8]. According to [9], cultural processes involves the dynamic process because of its personal meanings and subjectivity. Therefore, teachers could engage students in their personal worlds by integrating culture in science learning [7].

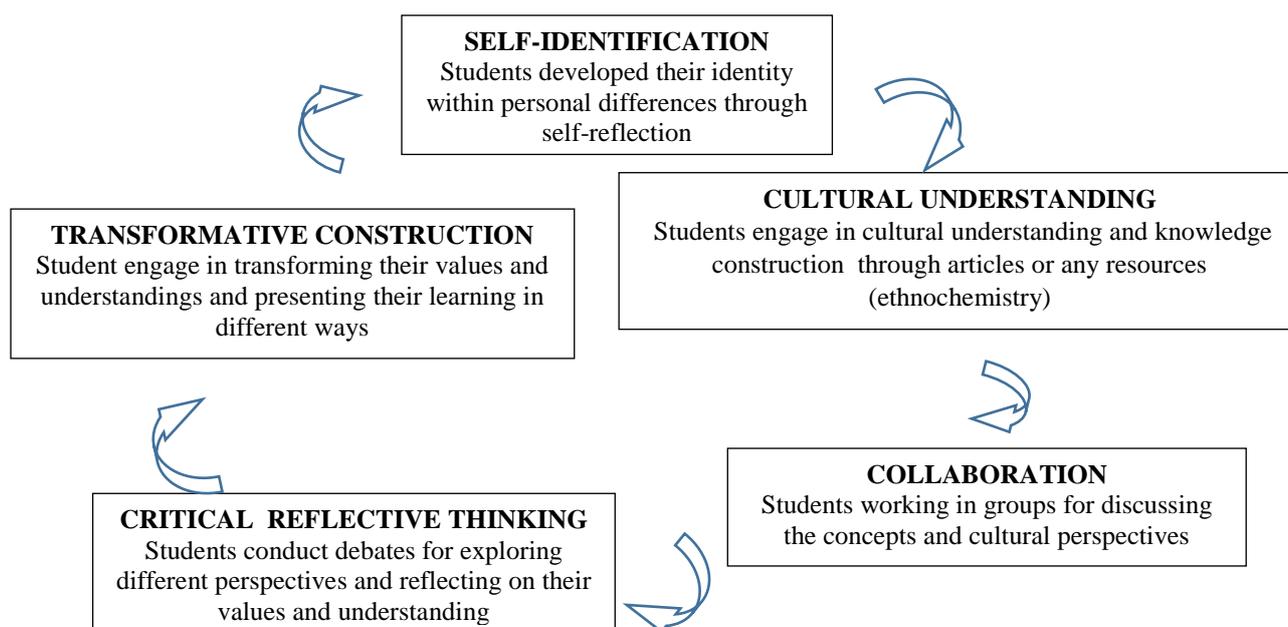
Chemistry, is one branch of science that studies materials that exist in the universe, the interactions among them and changes in energy-related or caused by the changes of nature [10-12]. In chemistry learning, students are expected to understand chemistry concepts in order to solve problems through building their individual knowledge [13-14]. However, in order to achieve this, students face challenges as many chemistry concepts are considered complex and difficult to contextualize with student lives [15]. In addition to the characteristic of chemistry learning is intact and meaningful if it is associated with the three levels of macroscopic, microscopic and symbolic [16-18]. However, the research shows that generally, students experience difficulties with chemistry because of their inability to visualize the structure and process at the submicroscopic level and connect it with the other chemical representative levels [19].

In the Indonesia context, several problems are evident as related to learning chemistry generally. Linking abstract concepts with students' daily lives, an overloaded curriculum, and rote learning or memorizing all contribute to the problem of effective chemistry education [20]. It is expected that students not only understand chemistry concepts, but also relate the issues to chemistry and play an active role in solving problems, either in the form of ideas or actions. Thus, to achieve these objectives, learning chemistry must be able to be a means of developing students' abilities in social life; to resolve the kinds of problems that require the chemistry teacher to be more creative in applying chemistry to contextual issues in everyday life to create meaningful learning experiences. In relation to chemistry education in Indonesia, one of the main aims in Curricula 2013 is to develop students' scientific inquiry and national character through meaningful chemistry learning experiences. In addition, curriculum 2013 embraces student-centered learning in accordance with their background, characteristics, and a students' prior knowledge and the teacher should act as a facilitator in learning so that students can engaged in their learning experiences [21].

Therefore, this research focuses on the integration of Culturally Responsive Transformative Teaching (CRTT) teaching model which has been developed in the first year of study. The CRTT teaching model is developed based on the principles of CRT and transformative learning consists of five phases of self-identification, cultural understanding, collaboration, critical reflections, and transformative construction. The previous study of CRT approach in chemistry learning has empowered students in chemistry learning [22]. In this paper, the integration of ethnochemistry in CRTT teaching model was explored in the concept of electrolyte and non-electrolyte solution in year-10 chemistry classrooms. In this paper, the implication of CRTT teaching model is explored in relation to students' identity.

## 2. Methods

The research employed a qualitative method with observation, interviews, reflective journals, and document analysis as data collection. The research was conducted at secondary schools in year 10 in one public school and one private Islamic school, in relation to the concepts of electrolyte and non-electrolyte solution. The participants consist of 68 students from two classrooms in each school. The study consisted of three main phases: 1) exploring classroom and students' cultural background through observations and interviews, 2) CRTT teaching model development, and 3) CRTT implementation by exploring students' identity. The CRTT teaching model involves 5 main steps of self-identification, cultural understanding, collaboration, critical reflective thinking, and transformative construction [22]. In these five steps, students had opportunities to develop self-understanding of their character, their learning style, and their cultural identity. They also learned about others and collaborated as shown in the model below.



**Figure 1.** Culturally Responsive Transformative Teaching (CRTT) teaching model

The process above (figure 1.) provides opportunities for teachers and students in exploring their identity and respecting differences. It also involves personal and social learning.

## 3. Results and Discussion

The study results show the process of integrating ethnochemistry in a CRTT teaching approach in the context of chemistry learning. The researchers worked with the teachers to integrate the model for engaging students. Discussions are explained in two parts according to the model of integration and are followed by the implications that can be made on student empowerment in chemistry learning.

### 3.1. Culturally Responsive Transformative Teaching (CRTT) Teaching Model

In the first step of **self-identification and cultural understanding** was the process by exploring students' diverse backgrounds through an in-depth interview. It was found that 80% of students were born in Jakarta, however, most of their parents came from Java which is a different ethnic group. The students reflected on their cultural identity within different roles as family members and as students. The researcher conducted classroom observations before implementing the CRT so as to understand

classroom culture. **For cultural understanding, the content integration** principle by [23] was employed by providing learning materials associated with the students' cultural background, daily lives, and the chemistry curricula. There were two articles of Jeruk Nipis and Green Coconut Water in relation to the concepts of electrolyte and non-electrolyte solution. Besides, they had to explore their own cultural practices in relation to chemistry concepts, the presented in the classroom. The stories have been developing in different chemistry curricula for engaging students in learning their culture from chemistry perspectives. Students are expected to find the relation of chemistry concepts and of the electrolyte and non-electrolyte solution that they find in the story. Through this content integration, the teacher can develop positive teacher-student relationships through positive relationships between teachers and students. Teachers must believe in their students' ability and provide them with valuable experiences into the classroom [23].

After students have reflected on themselves the next step in the research process was **the collaboration** with teachers and students. In this step, the teachers developed positive student-student interactions by implemented different teaching models. Students engaged in active discussions and collaborations within a group. Teachers provided time for the students to interact with their peers in positive interactions helping them to improve collaboration and communication skills. The next phase, after collaboration, was **critical reflective thinking and transformative construction**. Debates were conducted so that the students could explore different perspectives and reflect on their values and understanding. After reflecting, students engaged in transforming their values and understanding and presenting them in different ways by reflecting on the question *How have the values and perspectives that they hold transformed because of the learning experiences?* The question is relevant to the five ways of being involved in transformative learning, as expressed by [24]: cultural-self knowing (self-realisation), relational knowing (opening to difference), critical knowing, visionary and ethical knowing (over the horizon thinking), and knowing in action (making a difference). These ways of knowing provide opportunities for students to understand themselves and develop the cultural awareness of appreciating differences, especially in collaborating with others.

### 3.2. Students Identity Empowerment in Chemistry Learning

The CRT approach has impacted on student empowerment in chemistry learning through cultural identity and nationalism, cultural differences awareness, and learning identity development. These aspects were found in each of the different schools. The following case study in each school will be explored in detail other papers.

3.2.1. *Cultural identity and nationalism.* The ethnochemistry approach not only develops knowledge, but also cultural identity and nationalism. According to [25], identity is a learning process which is constructed with the emotions involvement by the students. The study is relevant according to the definition of cultural identity as development by [26] which describes identity as self-understanding of the social and cultural. When students collaborated with other students they developed their identity was socially constructed in a social/cultural context which included sharing beliefs, relationships, customs, symbol systems (language), knowledge, physical settings, and objects [27]. According to [28], identity involves all factors that constitute our lives, including genetic makeup, our parents, culture, experiences (bad and good, love and suffering). In the following statement students show their cultural identity after it was integrated with the learning culture.

*"We learned our own which I realized that it is important to maintain my culture and understand others"*

*(Student Interview, School A, February 1, 2017)*

*"In the chemistry learning, the students were engaged and asked the critical questions regarding the cultural practices of Green Coconut Water in the culture (Observation, School B, January 30, 2017)*

*"We have to maintain our indigenous knowledge, especially the traditional medicine, so it can compete with modern medicine"*  
(Students' Reflective Journal, School B, January 30, 2017)

In addition to introducing the idea of bringing their indigenous knowledge into the chemistry classroom, [5] the idea of pluralism in learning science relates to the interaction between students culture and the Western science. Students also face different cultural experiences of their own experiences (and the cultures of science itself. Therefore, learning should recognize this border crossing of cultural experiences. [5] proposes a different idea of enculturation by engaging students through their own identity which recognizes the equity of all students. In addition, it will help teachers to engage students' in their personal worlds [9].

The integration of ethnochemistry was an innovation in the chemistry classrooms in this study. The students felt the learning environment was different to the usual chemistry learning environment where practice in solving the mathematics problems in chemistry was the norm. The CRT approach stimulated their curiosity and motivated them to, not only learn chemistry concepts but also identify different cultural practices. Below is a statement from a student who showed curiosity in the ethnochemistry. The students look more enthusiastic when exploring the chemistry concepts in the cultural practices. Their motivation was stimulated by integrating ethnochemistry in the learning because it is related to everyday thinking. Nanochemistry has stimulated the students learning motivation by describing the chemistry concepts as applied in cultural traditions which make students more interested in chemistry learning. This has led to meaningful learning experiences as recognized by studies of student understanding that support solutions through the use of meaningful learning experiences [29-30]. In this study, students engage in a new learning approach, environment, and in relation to students' daily lives.

*"We were engaged with the application of chemistry concepts in everyday life, especially in relation to our culture"*  
(Students Interview, School B, January 30, 2018)

The CRT approach provides opportunities for students in respecting others' cultures and uses these opportunities for their learning. Culturally responsive teachers develop intellectual, social, emotional, and political learning by "using cultural referents to impart knowledge, skills, and attitudes" [31] explains that culturally responsive teachers not only focus on students' scores, but also cultural identity [3]. In addition to integration, the culture of society and everyday life also relates to nationalism. In relation to this, students stimulated to develop their nationalism, students explained that they become engaged with Indonesia culture. Because of the impact of globalization, they came to understand that they have a limited understanding of their own culture which is considered to be a loss of their cultural identity [28].

*3.2.2. Cultural Differences Awareness.* The students also learned the different cultures they have to complete the project of exploring their own culture in relation to chemistry concepts. Therefore, at the same time, they have to work with others from different cultures in completing the tasks.

*"Its excited that I learned other cultures and worked together to completed the task"*  
(Student Reflective Journal, School A, February 1, 2017)

*" I realized we are different, it should be a problem, but I prefer working with others who care about others and willing to complete the task"*  
(Student Interview, School B, February 6, 2017)

Based on the above statement from either interviews or reflective journals, the students expressed how they felt when cooperating with each other. They also said they learned to understand and appreciate each other. They realise that it was challenging for working with others who shared differences. They have to learn to collaborate with others, develop empathy and communicate clearly in order to succeed in group working.

Grouping students based on the differences in gender, achievement levels, and ethnic groups helped students develop their empathy with others. Attitudes to listen and respect others' opinions are the characteristic of empathy of accepting another person's perspective, be able to listen to others and be sensitive to the others' feelings. Cultural competence is the ability to successfully teach students who come from different cultures. It helps to develop students' personal and interpersonal awareness, and a set of skills of effective cross-cultural teaching [32]. The teachers tried to understand students' differences and provide different learning experiences. Students developed attitude to be sensitive to others which is demonstrated through the following statement.

*"Even though I prefer to work with my close friends as I know them closely, but working with others has helped to understand others and learn new things  
(Students Interview, School A, February 6, 2017)*

Students indicated that they became more used to talk and getting to know their classmates' character which leads to being good collaborators. In addition, the teaching approach which was implemented helped students to develop their self-confidence. Students appeared confident when discussing in groups by expressing opinions and conveying information held to classmates. In addition to the above, there are suggestions that culturally responsive learning has stimulated students to develop responsibility. The learning process, using cooperative discussions, engaged them in understand the task objectives to be completed.

**3.2.3. Learning Identity.** Students understand that they have developed their understanding of their identity as the learners. They were realized that they usually learn chemistry from textbook and followed the teachers' instructions. Becoming active learners became challenging since they have to move from their comfort zone from the passive learners to the active learners. In addition to the teachers are empowered to bring culture alongside chemistry concepts helped students develop their knowledge. Teachers should engage students to construct their own knowledge through active processes [33]. In addition [34] stated that the students need to develop their knowledge by interact with their environment.

Students learned to develop their learning identity through their own culture. In this teaching model, students have to collaborate with others in order to construct their understanding of electrolyte and non-electrolyte solution. Even though, the students still focused on learning to the test and giving the right answers. In this stage, the students have been challenged by critical and creative thinking in facing the given problems.

*"It is exciting that we had different learning experiences, from practicum, debate, and learning cultures. We are challenged to solve the problem given"  
(Student Reflective Journal, School A, February 8, 2017)*

*" We are not only sitting in the classroom, we are thinking. We feel free to express our ideas"  
(Student Interview, School B, February 15, 2017)*

*"We criticize the problem solution to find out the best, it becomes important to argue in discussion"  
(Student Reflective Journal, School A, February 1, 2017)*

The statements demonstrate that the students showed their engagement while solving a problem. Students stated that during the lesson the teacher assigns students to develop their critical voices in the debate. The above statements show that it is important for students to build an effective understanding of chemistry concepts as according to [35], it is important for students to retain new knowledge with their critical thinking which required them to be active learners.

Finally, integrating cultural ethics and values into the chemistry learning should be developed in relation to empowering students' identity development within character education. The problem is not in the usefulness of knowledge but in how to help them in using their knowledge for their future roles. The previous study showed that the students faced the challenges in shifting the learning from focusing into exams [36]. Teachers should facilitate students in understanding their identity by approaching with the contemporary context of problems, interests, issues, and concerns. However, both teachers and students need to shift their values and beliefs in their perspectives of teaching and learning.

#### 4. Conclusion

The CRTT teaching model has been implemented in this study which consists of the five main steps of self-identification, cultural understanding, collaboration, critical reflective thinking, and transformative construction. The students showed empowerment in developing their cultural identity and nationalism, cultural differences awareness, and learning identity. The learning experiences have stimulated their learning motivation and curiosity in order to develop their knowledge of chemistry and culture. The implementation of CRTT stimulated students' awareness of the role of chemistry in their everyday lives, especially in their culture that also affected their cultural understanding. In applying this approach, the teacher should develop their creativity and ability to prepare the learning resources for students, especially in ethnochemistry topics. This approach also provides the opportunity for parents to participate in students learning as part of the learning community.

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