Students empowerment in chemistry learning through the integration of dilemma teaching pedagogy in plastic waste

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Abstract. The research aimed to engage students in reflecting their values through the integration of dilemma teaching pedagogy in chemistry classroom. Dilemmas stories have been engaged students in values awareness through critical and dilemma thinking in the issues of plastic waste. The research was conducted in four secondary schools in Indonesia with 457 students, with depth case study in two classrooms of year 12. The mixed-method study as a methodology provided different perspectives to understand the participants. The survey as quantitative data collection used the Constructivist Values Learning Environment Survey (CVLES), followed by qualitative data through semi-structured interviews, and classroom observations. The CVLES obtained perceptions of student engagement with the story, the teacher’s supportive role, critical thinking skill development, and students’ learning to listen actively and think about the chemistry learning. The results show that the students and the researcher engaged in critical reflection on their values, collaboration with others, on their roles in participating in environmental education, social issues, and in deep chemistry learning. In addition, the dilemmas stories play important roles in developing character education which is relevant to new Indonesia curricula.

1. Introduction
Character and value education become an important issue in new curriculum in Indonesia. According to [1] the most important factor in the character and value development is how young children cope with the problems in their society. In everyday life, often students are faced with the problems that often lead to conflicts that require them to make decisions. Students will experience conflict when the learning process in the classroom is different from daily lives [2]. Rahmati in [3] stated that educators need to help students in dealing with these conflicts through meaningful learning.

Chemistry is one of the branches of science, which is important to be understood by students, because chemistry is closely related to students’ lives [4, 5, 6]. Therefore, chemistry learning should be linked to the students’ cultural background, making it relevant to the students’ life and creating meaningful learning [7, 8]. Thus, the process of learning chemistry, should not only focus on knowledge, but also on how the application of chemistry in solving problems in everyday life. Chemistry learning by giving complex problems that generate emotions and dilemmas can educate students to think critically, cooperate, accept and negotiate ideas, and solve problems that exist in everyday lives.

Dilemmas stories is a learning approach by using story which contain dilemma as a learning media to engage students in learning process and has various implications such as developing critical thinking skills, reflection on values, social interaction, emotional learning, and problem solving [9]. Study on dilemmas stories has been conducted in Indonesia in many chapters of chemistry matter such electrolyte
and non-electrolyte solutions [10] and redox reaction [11]. Besides, study of dilemmas stories in Indonesia has various impacts, such as reflection on values, curiosity, responsibility, and argumentation [12] and critical reflection on their values, collaboration with others, on their roles in participating in environmental education, social issues, and deep chemistry learning [13]. In this study, dilemmas stories approach was integrated in chemistry learning to develop students’ empowerment by raising the topic of plastic waste as a public issue today.

2. Methods
This study implied survey research design by combining with qualitative methods, which have been used successfully in various learning environment studies [14]. According to [15], mixed method research is good design to build the strengths of both quantitative and qualitative data by giving different perspective of the complex picture. The dilemmas stories approach was conducted through steps of engagement, dilemma problem posing, discussion, sharing, and reflections.

The research was conducted in four secondary schools in Indonesia with 457 students, with depth case study in two classrooms in year 12. The Constructivist Values Learning Environment Survey (CVLES), semi-structured interviews, and classroom observations were applied as methods of data collection. Data was analysed referring to CVLES item scale.

3. Result and Discussion
Development of dilemmas stories in relation chemistry topics and problems in Indonesia developed throughout the study. The study involved two steps of analysis of student’s perceptions through CVLES questionnaire followed by qualitative data. The reliability of CVLES questionnaire 0.81.

| Scale                  | Mean  | S D   | Alpha Reliability | Mean Correlation |
|------------------------|-------|-------|-------------------|------------------|
| Deep Engagement        | 4.22  | 0.73  | 0.75              | 0.51**           |
| Teacher Support        | 4.37  | 0.64  | 0.74              | 0.49**           |
| Collaborative Decision Making | 4.10  | 0.82  | 0.70              | 0.44**           |
| Empathic Communication | 4.54  | 0.56  | 0.88              | 0.72**           |
| Critical Self-reflection | 4.20  | 0.65  | 0.75              | 0.50**           |
| Critical Social Thinking | 4.37  | 0.86  | 0.44              | 0.25**           |

N=457, **P<0.01

The result show that the value of r table = 0.092. If the R count is greater than r table, then the results show a correlation. Internal consistency shows the consistency of instruments to measure and stable in the same situation but different circumstances [16, 17]. The higher value of reliability coefficient indicates the more consistent results will be produced. A value of 0 indicates no relationship between
items on a given scale, and 1 shows absolute internal consistency [18]. The most common measure of internal consistency is Cronbach's alpha (α). Alpha values above 0.7 are generally considered acceptable and satisfactory, above 0.8 are usually considered to be quite good, and above 0.9 are considered to reflect exceptional internal consistency [19]. In social science, the estimated range of acceptable alpha values is from 0.7 to 0.8 [20]. These criteria are used in accordance with the measuring instrument used. From the reliability value given in table 1, most of aspects have high value. There is 1 dimension that has reliability of 0.44, which is critical social thinking. This value is smaller than 0.7 as mentioned earlier. One of the causes of the low reliability values is the research subjects were not consistent in giving responses as a result of fatigue and anxiety because it affected their performance in doing the tests [21]. Based on table 1, the smallest mean is in collaborative decision-making which students faced the challenges in making decision through group working as they have to dealing with group differences. In addition to the highest mean is in empathic communication, students tried to understand that different people have different opinions. In general, students perceived positive perceptions on their environment.

3.1. deep engagement
The students engaged in dilemmas stories as they described as meaningful learning experience which is ‘fun’ and as ‘different’ from usual chemistry learning. The teachers play important role as facilitator in values learning environment as conversation below.

Teacher : How do you feel about learning chemistry using dilemmas stories?
Student 17 : Very interesting, it is so different with the usual chemistry learning
Teacher : How was the different?
Student 17 : Learning chemistry is difficult and sometimes I feel bored, but with dilemmas stories it was like we were in a real case. We learnt chemistry through the case
(Student Interview, 6 February 2018)

The result above is relevant to [22] that dilemmas stories teaching engaged students in chemistry learning and has various implications such deep chemistry learning and learning from the stories. Besides, students’ engagement has been found which is indicated by students feeling like they were in a real case of the story because it is related to their everyday life.

*The story is very interesting and delivered in easy-to-understand language and it was so related to our daily lives*
(Student Reflective Journal, Student 4, 6 February 2018)

*After learning with plastic waste dilemma, now we are more selective in using plastic goods, especially the items that just only be used once, because it can cause the environmental problem*
(Student Interview 18, 27 February 2018)

Learning chemistry generally has several problems such as less associate with everyday life, difficulties in linking chemistry students in different contexts, curriculum materials that are too dense, the chemistry that seem unrelated to the life of the community, as well as traditional learning approaches which tend to memorize [23]. Thus, in the chemistry lesson, the teacher is expected to be more creative in applying chemistry to the contextual issues in everyday life.

3.2. teacher support
The teacher’s role as a facilitator, agent provocateur, or devil’s advocate is vital within our values learning environment. The teacher is more of a guide than a ‘dispenser of value’. This is revealed from the following students’ reflective journal.

*The teacher helps us in expressing opinions and helping in exchanging opinions*
(Student Interview 29, 6 February 2018)

The teacher encouraged students to maintain the surrounding environment, cares about environmental problems, especially which is related to chemistry. Students are reminded to always maintain health and how to reduce the use of Styrofoam as a food container as revealed by the following reflective journal.
Teacher facilitated us to consider different perspectives for using Styrofoam containers, such as health problems
(Student Interview 18, February 6, 2018)

Based on the teacher support in this study, students become motivated and try to be active during their learning process, this finding is relevant to [24] stated that discussed with students is very instrumental in involving students in dilemmas stories, and in-depth discussion with students have an impact on student life.

3.3. collaborative decisions making

Students discussed to solve the dilemmas questions in the story after they think individually. Each group member expressed their opinions, exchange ideas to unite opinions and respect other's opinions.

We were given group discussion assignments to answer the dilemmas question by working with friends and respecting friends' opinions
(Student interviews 14, 6 February 2018)

Group discussions encouraged students to think critically to solve problems together. The students’ discussion seemed positive, because some of students’ reflective journals described the experience as ‘fun’ learning. This finding is proven by the students’ reflective journal below.

Cooperation between students in discussion sessions is very compact. Encourage us to be more critical in thinking and solving problems, so students are more active
(Reflective Journal, Student 8, February 6, 2018)

Students faced the conflict and try to solve the problem in dilemmas stories collaboratively. This learning type is powerful to reflect on their values and beliefs. According to [25], even when teachers know that social learning is an important goal they also feel responsible for a certain amount of content that should be learned, and so they sense a conflict. The students engaged in the dilemmas and reflect on their own values, especially in put the priority of themselves and others for making decisions.

3.4. empathic communication

Empathy as the capacity to share and understand another’s state of mind or emotion [26] has been explored in this study. Empathy helps students to communicate their ideas in a way that makes sense to others, and it helps students understand when they communicate each other. In this study, communication runs smoothly, students can work together and exchange their ideas to unite opinions and respect each other's opinions.

I can communicate and appreciate various friends’ opinions and exchange ideas
(Classroom Observation, Student 8, 6 February 2018)

Communication also takes place during the representatives of each group come to the front of the class to present their group discussion result. The students presentation encouraged them brave to speak and more confident to appear in front of class as revealed by the reflective journal as follows.

I can explain directly the results of my group discussion about the Styrofoam dilemma
(Students Interview 18, 6 February 2018)

Empathy and confidence are crucial aspects in developing ideas and solutions, in problem solving, effective communication and avoiding or preventing conflicts. Empathy is an important capability, which all people must develop in order to progress and continue with their life [27].

3.5. critical self-reflection

When forced to make a decision, students seem to engage in both critical self-reflection and critical thinking [28]. Critical self-reflection has been found when students reflects on their values in order to solve a problem. Critical thinking is an analytic, systematic problem-solving approach that builds largely on existing knowledge, as stated by the students.
After the story was read by teacher, I learned about the dangers of using Styrofoam and I was afraid to use Styrofoam frequently
(Reflective Journal. Student 16, 6 February 2018)

It turns out that there are many stories related to chemistry in everyday life that encouraged me to observe more chemicals in life
(Students interview 25, February 6, 2018)

Based on the result, dilemmas stories encouraged students try to reduce the use of plastic and developed students’ environmental awareness. This is relevant to [29] stated dilemma story pedagogy offers a promising means to develop critical skills with which students can engage as socially responsible citizens in informed decision-making about the appropriate use of science for addressing global issues such as climate change and environmental sustainability.

3.6. critical social thinking
Stories of Styrofoam dilemmas related to the latest social issues regarding environmental pollution, so students can understand the application of chemistry concepts in life extensively. Through dilemmas story, students can learn chemistry concepts about polymers.

   Learning with dilemmas stories make me know the dangers of plastic and other types of plastic and make me aware about the dangerous of plastic
   (Student Interview 29, 27 February 2018)

   I feel dilemmas stories give positive impact because the story concerns everyday life, I am not only knows the polymer formula but also the dangerous disease caused by Styrofoam
   (Student Interview 27, 6 February 2018)

According to [30], science knowledge is largely based on social construction, but individuals may generate their own science knowledge through their own experiences. The integration of dilemmas stories in chemistry learning also very pleasant, so students expect other useful and interesting stories to be known that facilitate them in mastering chemistry concepts, as revealed in the following reflective journal.

   I think the dilemmas stories is good, effective, and fun. Not too tense, relaxed, and useful in everyday life. I hope there are many more useful and interesting stories to know
   (Reflective Journal, Student 17, February 6, 2018)

This result is relevant to the research conducted by [31] which shown that dilemmas stories can be used as a tool to overcome controversial issues that involve students in communicating with others, accepting the opinions of others and practicing their own emotions and those of others.

4. Conclusion
The results of the study showed that the average value of the questionnaire was 4 on a scale of 5, indicating that learning with dilemmas stories was successful. From the qualitative results, it is also produced learning with dilemma stories that make students more interested and motivated in chemistry learning because it is linked to everyday life. In this study, teacher has participated as the facilitator and allowed the students to express their opinions and ideas in class, students actively involved in group discussion, so they developed empathic communication skills in groups and reflect creative ideas and critical thinking.

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