Empowering students' engagement in organic chemistry learning through integration of dilemma stories with number head together

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Abstract: This paper portrays research into an innovative curriculum project of dilemma stories which was conducted at a secondary school in Jakarta, with 44 students of year 12. The research focused on the development and implications of a dilemma stories approach with the Numbered Heads Together method in Organic Chemistry learning. The dilemmas stories on the topics of formaldehyde, alcoholic drinks, paracetamol drugs, and butter and margarine were developed in this research study. A qualitative approach was implemented with multiple methods including interviews, reflective journals, and classroom observations. Data analysis was conducted based on the themes found throughout the learning process. The results of the research showed the effects of this innovative approach on students' development of higher order thinking skills, argumentation skills, collaboration skills, problem solving skills, personal values reflection, and responsibility. Students learnt to solve the dilemma problems in real situations which related to chemistry learning. The teacher became involved in this innovative approach for engaging students and improving their learning quality. In conclusion, the dilemmas stories approach has engaged the teacher and students in meaningful chemistry learning experiences.

1. Introduction
Chemistry is one of the most important branches of science, it enables learners to understand what happened around them [1]. Chemistry learning studies materials and its characteristics, changes, and energy, therefore students are expected to understand the relation between these concepts in order to develop and apply their knowledge. Therefore, it is important to create the bridge between the unfamiliar concept and students’ knowledge [2]. Students are expected to understand the basic chemistry concepts in order to understand chemical processes that are in everyday phenomena [3]. Therefore, chemistry learning not only focuses on knowledge development but also application for solve the problems in daily lives. [4] points out that students should deal with the complex, challenging, realistic with teacher as a facilitator. These tasks will help them to develop their thinking and soft skills.

One of the challenging tasks which can help students to develop their skills is dilemmas teaching pedagogy that involves dilemmas stories. Dilemma stories are stories with characters and a storyline
that contain one or more ethical dilemma scenarios [5]. Dilemmas teaching pedagogy is a tool to develop the important soft skills for their future in a society, like communication skills in community, emphatic communication, critical thinking, especially to solve the problem, and making decision. Moral education is often focused around dilemmas [6]. According to [7] dilemmas stories is a collection of stories that have a dilemma not only motivate students to learn and have a deeper understanding, but also the ability to solve problems and make decisions. Dilemmas stories involves active learning strategy. Active learning strategy involves providing opportunities for students to meaningfully talk and listen, write, read, and reflect on the content, ideas, issues, and concerns of an academic subject [8].

Research with dilemmas stories approach previously had been conducted in Australia. For instance, the research by Chow with The Prime Minister Dilemma Story [9], and Ethical Dilemma Story Pedagogy by Elisabeth Taylor [10]. In Indonesia, dilemmas stories done with elektrolit and non elektrolit matter [11] and redox reaction [12]. The research indicated that learning models application which is oriented to student activity can improve social skills for instance, communication skills on group discussion and working together is cooperative learning.

In this study, dilemmas stories approach was integrated with Number Head Together (NHT) which is oriented to student activity with cooperative learning principles. According to [13] Number Heads Together encourage student to improve teamwork and sense of responsibility through meaning cooperative learning meaningful [8]. Teamwork more developing their understanding and appreciate about individual differences. The study focused in organic chemistry which is considered as difficult subject with abstract concepts [14], in fact it is closely related to daily lives. Therefore, it was expected the new approach can help students to engage with organic chemistry learning in order to develop their competences.

2. Methods

This research conducted at Secondary high school in Bekasi in year 12 with 44 students,. The methodology used qualitative research with multiple methods of interview, observation, and reflective journal. This research consisted steps of analysis the context, dilemmas stories development, teaching approach’s implementation, and assessment. The teaching approach was shown below.

![Figure 1. Steps on NHT-Dilemmas stories approach](image)

The researcher developed the stories of formalin, alcholic drinks, paracetamol drugs, and dilemmas stories of butter and margarin. Formalin and alcohol drinks stories were read by students in each team. Stories’ description can be seen in table 1 below:
Table 1. Stories description

| Title                        |
|------------------------------|
| **Formaldehyde in Tofu**     |
| This article is about formaldehyde as preservative is found in tofu. Students know that formaldehyde is prohibited for food. Therefore, students have to decide whether to use this chemical ingredient in tofu products or not.                         |
| **Alcohol drinks**           |
| This article tells about alcoholic drinks. Students being informed the popular alcoholic beverage of Tuak. In dilemmas stories, students also learnt the danger of Oplosan (boot-leg alcohol)/ methanol poisoning.                                    |
| **Paracetamol**              |
| In this story, students learned about functional groups, Paracetamol (acetaminophen) contains three functional groups: hydroxyl group (OH), amide group (HN-CO-R), aromatic group (benzene ring). They had to decide the overuse of the medicine. |
| **Butter and Margarine**      |
| Students learned about saturated and unsaturated fats. They enjoy to eat baked potato/cake. Students feel confused as to whether they should stick with butter or margarine. They understood the saturated fat increased heart diseases risk.                           |
| Data from multiple data collections provided information of students’ engagement in dilemmas stories approach in Organic Chemistry learning. Data analysis steps which is done by [15] are cultivating and preparing the data, overview data, analyze more detail by data code, and applied coding process to describing categories or themes which are presented in descriptions and transcripts of interviews, reflective journals, and observations. |

3. **Results and Discussion**

The approach has engaged the students in meaningful learning experiences. Several themes were explored throughout the study which were explored below.

3.1 **Collaboration Skills**

The approach has encouraged students to work together. Students worked in group of 4-5 students for each group which gave them opportunity to express their ideas and solve the problems with dilemmas. They learnt to understand and appreciated others’ opinion as student’s statement below.

_The team members worked together and gave opinions to solve the problems which was outstanding experiences” (Reflective Journal, Zahra, Formaldehyida Story, January 23)._

In the discussion, students learnt to consider different perspectives as solutions for dilemmas in the stories [16]. They had to find ways of cooperating, compromising, and sometimes persuading people, when they don’t agree with them. However, it also points out the benefit of collaboration among students as they learnt to appreciate the differences, since have to make decisions as a group [17]. Even though it was considered as meaningful learning experiences, some students were disengaged as they don’t like chemistry learning through stories. They more focused on practices on chemistry test. It was challenging experiences for teacher as facilitator to engage students in different learning experiences [18].

3.2 **Higher Order Thinking Skills**

The learning experiences in analysis stories, understanding dilemmas, and solve the problems have engaged students in developing higher order thinking skills. Teacher asked when interviewed students whether dilemmas stories provoke them to think critically through problems as student’s statement below.

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The dilemmas story made us think carefully about alcohol, oplosan drink is happening in our society. We must assertive and take the action by using our chemistry knowledge for informing our society about the dangerous chemistry knowledge to society” (Student interview, Daus, Alcohol drink story, January 23)

Students has been empowered to help society by using his chemistry knowledge. This research relevant with [19] research that when students are empowered to take a decision, students will develop their critical thinking and reflect their own values. Based on observation on January 23th, students actively asked questions in relation to alcohol drink issues in society such as Tuak drinks (traditional alcohol). Student with Batak tribe background asked their parents at home about Tuak drinks and discussed about application of his chemistry knowledge. In the classroom, the use of higher order thinking skills is enabling students to maintain information and to apply problem solving solution to real world problems [20]

In addition to, the dilemmas problems have challenged students to develop their critical questions through collaborations. According to [21], working together will engage students to develop critical thinking skills [21]. In this study, during dilemma of Paracetamol, Chandra asked,

“Previously, I watched the danger of overuse paracetamol on TV program, then the doctor advises to change Paracetamol with salicylate acid for mother’s pregnancy. Can we change Paracetamol with Salicylate acid not only for mother’s pregnant, but also for human with all condition? (Discussion, Chandra, Paracetamol Story, February 6).

The researchers found students’ curiosity and enthusiastic by asking critical questions and exploring different information resources.

3.3 Argumentation skills
In this learning experiences, students have learnt to develop argumentation skills. During dilemmas stories challenges, students were engaged in express their opinions to find out best solutions of the problems. Different students have different ideas, therefore argumentation happened among the groups. The argumentation conversation happen in the class during formaldehida story. Dilemmas questions was: what will you do for your business (students play role as businessmen), continuing formaldehida usage or not?

Faisal: Of course, we can not use Formaldehida for tofu. In our opinion, we will choose natural preservatives.

Hadi: I partly disagree with Faisal group. We thought to stay using formaldehyde with small amount of it as chemical preservatives which are effective, it is important for business for getting more money.

Wawan : I think, it is important to realize, our religion is not allowing us for being liar, especially during trade. God will punish a dishonest salesman

Teacher: Be careful, in introduction, it had been explained that formaldehida used as dangerous preservative which not allowed to use in the food, because it is dangerous for human.

Teacher clarified student question about formaldehyde usage in food. According [22] said that formaldehyde contain can be disadvantages and dangerous for human health. Formaldehyde is a chemistry material which is forbidden usage like regulation of health minister number 722/Menkes/Per/IX/1988. Thus, when students engage and provide opinions with high quality arguments, it can help them to develop their knowledge, beliefs, and values [23].

In addition, dilemmas stories approach has empowered students’ self-confidence. Students feel more confident and comfortable to express their argumentation through group working as Vita statement.
I felt nervous when I was chosen to speak in front of class. But eventually, I felt brave to tell my group opinion in front of the class (Interview, Vita, Formaldehida Story January 23).

Therefore, dilemmas stories approach has engaged and challenged student to think critically about the problem which happens in environment. Students learnt to use their knowledge to provide best solutions. Students actively participated to give an opinion with various point of views.

3.4 Personal Values
Dilemmas stories provided students in value learning experiences. They reflected on their own values during the discussions. For example, in Formaldehyde issue, made students reflected the own value such as religious attitude to solve the problems like figured by Cita.

“Although Tuak (Traditional Alcohol) has less concentration of alcohol, it is illegitimate for Moslems” (Reflective Journal, Cita, Alcohol Drinks, February 9)

According to UU Sisdiknas 2003, religion and national culture are the values sources of national education [24]. Religious attitude also appears when argumentation happened in the class when one of students sharing groups opinion to stay using Formaldehyde for tofu because they just want to get advantages. It makes other students who named Wawan remained that every attitude with said,

“God will punish a dishonest salesman” (Discussion, Wawan, Formaldehida Story, January 23).

Religious value is one of example values that used by students to take decisions including when they were confronted by complicated situation and different opinions. It is considered as the process of students’ empowerment in develop their national character.

3.5 Responsibility
In this approach, students requested to have responsibility to understand the decisions made by cooperative group [25]. When teacher called number randomly, it challenged students to have a responsibility to understand about group discussion as Doni statement below.

“We have to be ready with our decision. Because we do not know whether we are chosen to share opinion in the class or not (Interview, Doni, Formaldehida, January 23).

Doni has learnt to understand the problem solution as group decision since he must prepare to explain it in front of his classmate. In addition to leadership also appears when discussion which is shown by students who active participate in school organization, they arranged group rules and manage their team properly. According to [26], responsibility and leadership will develop when they joined school organization. So, when they faced about the problem in dilemma story, they can think, propose, and share new ideas to solve the problems.

4. Conclusion
The dilemmas stories-NHT approach with steps of students’ number off, dilemma problem posing, discussion, evaluation, and reflections has engaged students in deep learning to develop their soft skills beside understanding Organic Chemistry concepts and its applications. The study found students have been empowered to develop their higher order thinking skills, argumentation skills, collaboration skills, problem solving skills, and personal values, and responsibility. Dilemmas stories has provided students opportunity to think as a team and to find the problems’ solutions. Therefore, it has empowered students to engage in problem solving and decision making. In addition to teacher roles as facilitator to shifting students’ comfort zone as passive learners to actively participate in their learning experiences, beside explored students’ values. The research has limitation in deep exploration of understanding the implication of dilemmas in students learning and teaching practices, beside it was
only implemented in Organic Chemistry learning, therefore, further research in different context and deep exploration need to be conducted.

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