Didactical design based on sharing and jumping tasks for senior high school chemistry learning

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Abstract. The purpose of this research is to develop the didactical design of senior high school chemistry learning based on sharing and jumping tasks in shift equilibrium chemistry. Sharing tasks used to facilitate students slow learners with help by other students of fast learners so they engage in learning. While jumping tasks used to challenge fast learners students so they didn’t feel bored in learning. In developing the didactic design, teacher activity is not only to focus on students and learning materials but also on the relationship between students and learning materials. The results of the analysis teaching plan of shift equilibrium chemistry in attached Senior High School to Indonesia University of Education showed that the learning activities more focus on how the teacher teaches instead of how the process of students’ learning. The use of research method is didactical design research (DDR). Didactical design consisted of three steps i.e. (a) analysing didactical condition before learning, (b) analyzing metapedadidactical, and (c) analyzing retrospective. Data were collected by test, observations, interviews, documentation and recordings (audio and video). The result showed that the didactical design on shift equilibrium chemistry was valid.

1. Introduction

Science learning in the 21st century expected students to have the learning skills which include critical thinking and be able to solve problems, creative, innovative, able to communicate and to collaborate. However, based on data from TIMSS (Trends in Mathematics and Science Study) results reported in 2015, Indonesia’s science is ranked 45th out of 48 countries while in 2011 Indonesia is ranked 40th out of 42 countries [1]. Indonesian students need to improve their ability to integrate information, to draw conclusions, to critical thinking and to be able to disseminate their knowledge. Therefore, a student centred learning in line with the demands of the 2013 curriculum to meet the 21st century learning as described above. Generally, school-based learning is teacher-centered and less maximize student’s involvement in learning activities. Similarly, the high schools in Bandung that implement the 2013 curriculum are still applying teacher-centered learning. Teacher-centered learning is one-way interaction only (transfer knowledge), hence, students becoming bored and doing activities outside of learning such as chatting and drawing [2,3].

Chemical learning should be taught at three levels: macroscopic, submicroscopic, and symbolic levels [4]. The shift equilibrium chemistry is studied in every odd semester for XI class of senior high school. It is one of the essential concepts and always appeared in the National Examination (UN) for the last 5 years. Shift equilibrium chemistry lesson has the abstract concept characteristics described at
the submicroscopic level as it relates to the particles in a chemical reaction. The students have difficulty when connecting the phenomenon of chemical reactions and physical changes in the shift in the direction of chemical equilibrium [5]. Based on the analysis of the learning design on equilibrium chemistry topics used by high school teachers, it seems that teacher-centered learning activities regardless of student responses to developed didactic situations and obstacle that may occur during learning process.

In designing the required learning process of teacher thinking that occurs in three phases there are before, while learning takes place and after learning [6]. The teacher thinking process that occurs in three stages and the result of analysis of the process has the potential to produce innovative didactical design. The learning community ensure the learning rights of every students without exception, improving the quality of learning and simultaneous achievement between quality and equality of learning not only students but also teachers in the classroom [7]. In collaborative learning, there are learning activities that are carried out variation namely individual, group interaction, interaction between groups, and class activities. This provides the possibility for each student to do learning process optimally so that their learning rights are more secure [6].

Collaborative learning is a learning based on Vygotsky's social constructivism theory. The theory of social constructivism is known as the Zone of Proximal Development (ZPD). According to ZPD theory Vygotsky learned through instruction and intermediaries is a hallmark of human intelligence. Helped by the teacher, students understand and do more things than if the students learn on their own. In particular Vygotsky also argued that in teachers, peers also affect the cognitive development of students. The collaborative group work may accelerate the development of students' abilities. The collaborative learning is a study conducted in groups aimed at encouraging students to find the diverse opinions or thoughts that arise from each individual in the group. It also suggests the relationship of mutual learning is a two-way learning and there is a reciprocal relationship that provides benefits for students to understand the learning materials [7].

In the learning activities involves the ability of a diverse students understanding. Because of that, it is necessary to design a learning process using two types of tasks, namely shared tasks (sharing tasks) is an individual task through collaborative in small groups that contain basic materials and materials that refer to the purpose of learning. In addition to sharing task there is also a jumping task (jumping tasks) that contains problems that aims to improve students' ability. The problems which is given to jumping tasks are the development and application of material concepts [7]. In learning, sharing and jumping tasks provide benefits for all students either students who have low cognitive abilities and students with high cognitive abilities. Shared learning and jumping tasks also improve the affective and psychomotor abilities [2]. The didactic design based on sharing and jumping tasks has been done on the topic of the empirical formula and molecular formula and the topic of electrolyte and non-electrolyte solution based on self-reflection and learning obstacle [3]. Based on the results, didactical design sharing and jumping tasks on the topic of empirical formulas and molecular formulas may reduce the learning obstacle of students learning and become a reflection of teachers in designing learning on the next topic. Based on the explanation above, we are interested to do the research on learning design through development of didactical design on the topic of shift equilibrium chemistry based on sharing and jumping tasks to enhance the quality of learning.

In general, aims of this study is to produce the didactical design of collaborative learning on the topic of shift equilibrium chemistry based on sharing and jumping tasks to enhance quality of learning. Based on the background above, the research formula is "How to form didactical design based on sharing and jumping tasks on the topic of shift equilibrium chemistry that impact on the quality of learning?". The research was conducted to know (1) the student's difficulty in learning a shift in the direction of chemical equilibrium and (2) the didactical design based on sharing and jumping task as an innovative learning design solution
2. Methods

2.1. Design research
This research was designed using didactical design research (DDR). The activities of didactical design research have three steps [3], i.e. (1) Analysis didactical situation before learning process in term of didactical design (didactical and pedagogic anticipation), (2) Analysis metapedadidactical, and (3) Analysis retrospective is analyzing relationship between analysis didactical situation and metapedadidactical results.

2.2. Participant
The result of didactical design in lesson and chapter designs will be validated empirically.

2.3. Data collection and analysis
The observations were made by analyzing of lesson plan of shifts equilibrium chemistry based on the revised 2013 curriculum. In addition, interviews on teacher-related problems and learning obstacle that always found in the learning of shift equilibrium chemistry were also conducted. The results of this interview will be considered to determine the sharing and jumping tasks used in lesson design.

2.4. Procedure
This study mainly focused on analysis of essential matters that are related to the shift of chemical equilibrium concept. The analysis was carried out by examination of the basic competencies in the curriculum 2013, revision, and analysis of the national exam contents especially about the shift of chemical equilibrium concept in the last five years. In addition, the analysis of learning design used by teachers was carried out to describe the learning activities. Furthermore, semi-structured interviews were conducted to teachers in order to analyze the learning obstacle experienced by students during the learning of shifts equilibrium chemistry. The didactic design of chemical equilibrium shift concept was designed based on the essential concepts analysis, students learning obstacle, re-personalization and re-contextualization of lesson and chapter designs based on sharing and jumping tasks.

3. Results and Discussion
Based on the analysis of essential concepts of chemical shifts equilibrium, the factors affecting in the shift of chemical equilibrium are including volume change, pressure, concentration, and temperature. In addition, students also required to design an experiment related to chemical equilibrium shift factors (Table 1).

| Basic competence | Learning Materials | Learning activities |
|------------------|--------------------|---------------------|
| 3.8 Analyze the factors affect the shift in equilibrium direction and its application in industry | • The shift in equilibrium and the factors that influence it • Application of chemical equilibrium | Design and experiment with factors affecting the direction of equilibrium shift (concentration, volume, pressure and temperature) and report it |

Furthermore, the analysis results of the National Examination in the last five years issues of shift equilibrium always appear each year (Figure 1).
25. Berikut ini adalah reaksi keseimbangan (reversibel) yang terjadi pada reaksi:

\[ Fe^{3+} (aq) + SCN^- (aq) \rightleftharpoons FeSCN^{2+} (aq) \]

(kuning) (Tak berwarna) (Coklat tua)

Jika pada reaksi tersebut ditambahkan 1 tetes larutan FeCl3 pekat, maka sistem ....

(A) bergerak ke kiri warna akan semakin kuning tua

(B) bergerak ke kanan warna akan bertambah lebih coklat tua

(a)

30. Gas D2 dan M2 bereaksi membentuk DM menurut reaksi keseimbangan berikut:

\[ D_2 (g) + M_2 (g) \rightleftharpoons 2 DM (g) \quad \Delta H = -X \text{ kJ} \]

Jika volume diperbesar, pada suhu tetap maka sistem keseimbangan ...

| Pergeseran Keseimbangan | Konsentrasi DM | Harga Ke |
|-------------------------|----------------|---------|
| (A) Tidak Bergerak      | Berkurang      | Tidak Berubah |
| (B) Bergerak ke Kiri    | Berkurang      | Semakin Besar |
| (C) Bergerak ke Kanan   | Berkurang      | Semakin Besar |
| (D) Tidak Bergerak      | Tetap          | Tidak Berubah |
| (E) Bergerak ke Kanan   | Bertambah      | Semakin Coklat |

(b)

**Figure 1.** The questions of shift equilibrium chemistry in the national exams on (a) 2016 and (b) 2015

The analysis of lesson plan, teaching materials in some high schools that are using the revised curriculum 2013 indicates that the used design of the lesson are still conventional. In particular, the teacher's learning step shows how the teacher focuses on the matter of shift equilibrium factor and hopefully the students can understand the concept. In initial activity (aperception), the teacher only asks and answers the subjects related to chemical reactions and conveys the learning purpose. At this stage, the apperception of the teacher does not motivate the students, because it is only a comprehension check. Preliminary activities should be used to motivate students in learning by providing a contextual phenomenon that makes students analysis and think about the phenomenon. In the core activities, teachers perform the 5 M (observing, questioning, collecting, associating, and communicating) of unorganized thinking, because the core activities are not related to each other. In addition, the teacher's activities only focus on how to teach and to inform the material of equilibrium shifts. Prediction of students’ responses of didactic anticipation is not teacher concern. Learning designed by teachers in lesson plan is still an outline of the learning activities (figure 2).
| Kegiatan | Waktu |
|---------|-------|
| **A. Pendahuluan** | |
| 1) Guru menyiapkan peserta didik untuk belajar (berdoa, absensi peserta didik, mengkondisikan peserta didik untuk duduk berkelompok) | 2’ |
| 2) Apersepsi : Guru bertanya kepada peserta didik untuk mengingatkan kembali tentang kesetimbangan homogen dan heterogen dengan menyebutkan masing-masing contoh. | 3’ |
| 3) Motivasi : Guru menyampaikan ilustrasi “Coba perhatikan misaikan ada sekelompok siswa yang sedang belajar dalam suatu ruangan dengan tenang dan dalam keadaan konsentrasi belajar. Tiba-tiba ada orang gila yang masuk ruangan, bisa dibayangkan apa yang terjadi? Siswa-siswa pasti akan lari keluar dan mencari ruangan baru untuk kembali tenang dalam belajar. Begitulah suatu kesetimbangan kimia yang telah dicapai oleh suatu reaksi. Jika diberi gangguan juga akan mengalami pergeseran untuk mencapai kesetimbangan kembali. Peristiwa seperti itu disebut dengan pergeseran kesetimbangan. Dalam hal ini berlaku hukum aksi-reaksi. Hal ini sesuai dengan Azas Le Chatelier yang akan kita pelajari pada pertemuan hari ini. | 4’ |
| 4) Guru menyampaikan tujuan pembelajaran hari ini | 1’ |
| **B. Kegiatan Inti :** | |
| 1) Peserta didik diminta untuk membaca bahan ajar dengan teliti. *(mengamati)* | 5’ |
| 2) Peserta didik diminta untuk memperhatikan video pembelajaran dan powerpoint yang ditampilkan guru. *(mengamati)* | 20’ |
| 3) Guru bertanya kepada peserta didik tentang apa yang dimaksud dengan tetapan kesetimbangan serta apa saja faktor-faktor yang mempengaruhi pergeseran kesetimbangan. Guru mengiring peserta didik untuk bertanya tentang bagaimana cara kerja faktor-faktor tersebut dalam menggeser kesetimbangan. *(bertanya)* | 3’ |
| 4) Guru membaca soal secara acak. Peserta didik *bekerja sama* dalam kelompok diskusinya mengerjakan soal yang telah dibacakan oleh guru pada kotak-kotak yang ada dalam LKPD sesuai dengan nomor soal yang disebutkan oleh guru. *(mengumpulkan data)* | 30’ |
| 5) Setelah pembacaan soal dan jawaban peserta didik telah ditulis di dalam | |

*Figure 2. The design of teacher learning on the topic of shifts equilibrium chemistry*
In learning design, it is necessary to develop a didactical situation, predict students’ responses and anticipation didactic pedagogical (ADP) by teachers. The learning design does not merely lead to lesson plans, but it needs Chapter Design and Lesson Design (LD) as an innovation from the previous lesson plan. Recognizing the situation and pedagogy occur in a learning is a very complex case, therefore, the teacher needs to develop the ability to be able to view the event comprehensively, identifying and analyze, and do the right action so that the learning stages run smoothly and students learn optimally [6]. The learning design can be optimized and solved the student’s learning obstacle common.

In this research, innovation of learning design in the form of lesson design and chapter design based on sharing and jumping tasks on the topic of shift equilibrium chemistry. Sharing tasks undertaken in the learning activities are joint tasks in small groups aimed at facilitating the slow learner by helping the other friends. While jumping tasks aim to challenge fast learner students to think critically so they do not feel bored during learning. In this study, sharing tasks were performed on experimental activities of equilibrium shifts that were affected by changes in concentration. In practice students are expected to collaborate in the group solve the problem in the form of questions on student worksheets. Students are expected to predict and explain the cause of the colour change of the solution that occurs when the temperature and concentration change on the equilibrium system. In addition, students are given exercises related to changes in temperature, volume and pressure in equilibrium chemistry. Phenomenon of chemical equilibrium shifts due to changes in volume and pressure is shown with an aid of animation. Furthermore, the jumping tasks conducted are teachers providing a problem related to the application of equilibrium shifts in industry. Teacher will ask "How does the industry have to do to get the excess ammonia (NH₃) product in the NH₃ formation equilibrium process? Give your reason! ". This problem is given to all students related to concept of chemical equilibrium shift with the existing problems. The following are the lesson design and chapter design products produced.

![Figure 3: lesson design of shift equilibrium chemistry](image-url)

**Lesson Design**

- **Konsep Ensesial:**
  - Aspek belajar
  - Faktor pengaruh
  - Keseimbangan reaksi (kepada tercipta, terkini, suhu)

- **Metode pembelajaran:**
  - Diskusional
  - Kemampuan
  - Praktikum

- **Penilaian:**
  - Lembar kerja siswa
  - Praktekum

**Pembelajaran Kolaboratif Sharing dan Jumping Task pada Pergerasan Keseimbangan Kimia**

| Kegiatan awal (10 menit) | Kegiatan inti (40 menit) | Kegiatan akhir (30 menit) |
|-------------------------|-------------------------|--------------------------|
| Penilaian pertama       | Metode praktekum        | Target pembelajaran      |
| Perhatikan pergeseran   | Sharing 1               | Siswa mampu              |
| didalam tubuh           | Sharing 2               | menganalisis alasan      |
| yang terjadi            | Sharing 3               | mengidentifikasi dan     |
| ke arah kiri            | Sharing 4               | menganalisis alasan      |
| Penilaian kedua         | Sharing 5               | mengidentifikasi dan     |
| Peralatropa              | Sharing 6               | menganalisis alasan      |

**Metode Praktekum:**

- **Share:**
  - Kegiatan pertama: Penilaian pertama, konsentrasi, volu, suhu pada produksi NH₃.
  - Kegiatan kedua: Metode praktekum, pemahaman dan pembiasan aspek keseimbangan kimia.

**Target pembelajaran:**

- Siswa mampu menganalisis alasan dan mengidentifikasi pengaruh dari keseimbangan kimia.
- Siswa mampu merancang dan mengembangkan hasil praktekum faktor lain yang mempengaruhi pergerasan keseimbangan kimia.
4. Conclusion
The results of study showed that the topic of shift equilibrium chemistry is an essential material that always appears in every national exam. In the learning activities of shift equilibrium chemistry, teachers are still using conventional learning design. In teacher learning activities less attention to didactical situation (student relationship with the material) and anticipation didactic pedagogical due to prediction of student responses that appear. In this research, innovation of learning design in the form of lesson design and chapter design based on sharing and jumping tasks on the topic of shift equilibrium chemistry. Sharing tasks undertaken in the learning activities are joint tasks in small groups aimed at facilitating the slow learner by helping the other friends. While jumping tasks aim to challenge fast learner students to think critically so they do not feel bored during learning. Then, suggested to implement of lesson design base sharing and jumping tasks on shift equilibrium chemistry for next chemistry learning

5. References
[1] Puspendik Kemendikbud 2016 Silabus Mata Pelajaran Kimia SMA/MA (Jakarta: Kemendikbud)
[2] Cahyani M D 2017 Pembelajaran kolaboratif sharing task dan jumping task pada topik rumus empiris dan rumus molekul berdasarkan hambatan belajar siswa dan refleksi diri guru (Bandung: Universitas Pendidikan Indonesia)
[3] Jayatri V R 2017 Pembelajaran kolaboratif sharing tasks dan jumping tasks pada konsep larutan elektrolit dan non-elektrolit berdasarkan hambatan belajar siswa dan refleksi diri guru (Bandung: Universitas Pendidikan Indonesia)
[4] Osman K and Lee T T 2014 Impact of interactive multimedia module with pedagogical agents on students’ understanding and motivation in the learning of electrochemistry International Journal of Science and Mathematics Education 12 2 395-421
[5] Akaygun S and Jones L L 2013 based design and development of a simulation of liquid–vapor equilibrium Chemistry Education Research and Practice 14 3 324-344
[6] Suryadi D 2013 Didactical design research (DDR) dalam pengembangan pembelajaran matematika Prosiding Seminar Nasional Matematika dan Pendidikan Matematika 3-12
[7] Sato M 2014 Mereformasi sekolah topik dan praktek komunitas belajar (Tokyo: Pelita)

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