Analysis on strength, weaknesses, and challenges in Chemistry Learning Course: a descriptive study to enhance the quality of learning

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Abstract. Chemistry Instructional Planning (CIP) is one of courses provided by most of Chemistry Education Department as a part of Chemistry Education curriculum. The course aims to enhance chemistry prospective teachers’ capabilities in designing lesson plan (LP). Descriptive study was conducted to explore the strength, and weaknesses of CIP curriculum and its implementation. The results were expected to contribute in improving the quality of CIP course (CIPc). The objects of this research were secondary data curriculum, LP made by student, and learning situation. The research instruments were curriculum assessment format, assessment rubric of LP and class observation sheet. The result shows that some strengths were found in the curriculum and implementation of the CIPc. In general, the course has facilitated students to design learning step by step. However, the weakness that must be anticipated was learning process has not trained the metacognition skills. This skills are needed in designing LP to exercise argumentation, and reflecting skills. Therefore, reorientation of CIPc and learning is recommended to fit with expectation.

1. Introduction

The preparation of prospective teachers with the required qualifications and competencies is the responsibility of the Institute for Education and Teaching Personnel (Lembaga Pendidikan dan Tenaga Kependidikan – henceforth LPTK). The learning process in LPTK is crucial for the development of teacher candidate competencies [1]. The more qualified the preparation of prospective teachers in LPTK, the more qualified the outputs would be.

The development of the prospective teachers’ competencies can be facilitated through the provision of a number of courses. CIP is one of the courses given by most of Chemistry Education Department as part of chemistry education curriculum. This course aims to develop the knowledge and skills of designing the lessons which are realized in the LP with a number of instructional tools.

The ability to design an instruction is one of the competencies teachers must possess. Instructional design will help teachers in organizing learning activities in the classroom [2]. Well-structured learning activities are needed in order to improve the quality of learning. The quality of good learning will have an impact on student learning outcomes. This implies that the success of students is determined by the quality of teachers. Thus, the ability to design the learning should be a concern in the curriculum both
in the LPTK and the teacher coaching institution. Nevertheless, some sources reveal the importance of teacher competence in designing LP enhanced learning [3, 4].

Based on the above explanation, this paper tries to explore how the Chemistry Education Department prepares prospective teachers in developing their competencies through CIPc as the first step in designing CIPc program.

2. Method
This research employs qualitative descriptive approach to describe and interpret the data which were obtained through the study on curriculum and LP documents, as well as observation on learning situation in CIPc. The curriculum documents are obtained from some LPTK located in West Java, East Java, and South Sulawesi. Meanwhile, the prospective teachers’ LP and documentation of learning process of CIPc are obtained from an LPTK in South Sulawesi.

Several instruments are used in data collection with the first instrument in the form of curriculum assessment consisting of aspects of course objectives, status, prerequisites, allotted time (semester)/credit hours, number of meetings, materials, lecturing strategy, and evaluation. The LP assessment rubric is used to explore the ability of prospective teachers. The ability to design an LP is categorized into five categories adapted from Kubiszyn and Borich, containing very good categories, good, sufficient, poor, and very poor [5]. Score ranges of each category were described 85-100 as very good, 75-84 as good, 65-74 as sufficient, 55-64 as poor, and 0-54 as very poor.

Observation sheet is used to portraying the learning situation in CIPc. The focus of the observation includes some aspects i.e. lecturing materials, the lecturing method and the lecture assessment which is later categorized as often performed, less performed and not performed during the instruction based on metacognition skills indicators containing the skills of planning, monitoring and evaluation according to Schraw [6].

3. Results and discussion

3.1. Description of the CIPc curriculum of several LPTKs
An overview of the content of the CIP curriculum was obtained by comparing the three major LPTK curricula in Indonesia presented in table 1. The CIPc is a compulsory subject at all universities. This indicates the importance of CIPc in the structure of the chemistry education curriculum. Based on the results of curriculum analysis, there are several similarities and differences reviewed from objectives, prerequisites, allotted time (semester)/credit hours, number of meetings, materials, lecturing strategy, and evaluations.

In terms of course objectives, P1 and P3 is focused on skills development, while P2 focuses on developing knowledge and skills. The course objectives in P1, P2, and P3 are certainly directed to accommodate the needs of the current curriculum (Kurikulum 2013), but only P2 explicitly reveals the activities of a student-centered, innovative and laboratory-based learning process in designing and developing instruction. This is very reasonable because the laboratory plays an important role and is an integral part of science learning because of the benefits gained through laboratory activities [7, 8].

In CIPc, some courses are required as prerequisite. There are similarities in the prerequisites subjects in P1 and P2. Nevertheless, the prerequisite of CIPc in P1 is stricter (more selective) because it is based on two aspects, i.e. having followed the lecture and passed the course. P1 requires the students to pass Chemistry courses I and II, Chemistry Learning and Instruction, Evaluation of Chemistry Learning and Chemical Learning Media. This is very important because in planning the lesson, knowledge on content and pedagogy must be mastered and further both must be integrated [9].

The CIPc in P1, P2, and P3 are held on the different semesters, i.e. semester VII, VI, and V. The amount of credit hours in P1 and P3 is 3 credit hours while in P2 it is 4 credit hours consisted of 16 meetings. Compared to P2 and P3, P1 conducts CIPc at a higher level of students, i.e. in the fourth year, because of the number of prerequisites that must be met.

Study materials at P1, P2, and P3, essentially consist of the same content which facilitate prospective teachers in designing chemistry instruction. The study material contains principle topics including curriculum analysis, analysis of school chemistry content, teacher’s pedagogical action analysis,
syllabus development techniques, LP components, writing techniques and development practice of LP, including the preparation of the teaching aids. In addition to the above topics, P2 allocates some meetings for the implementation of innovative LP through peer teaching.

The lecturing strategy in P1 uses conceptual, process skill, inquiry, constructivism, and clinical approach. The lecturing methods in P1 and P3 include lectures, recitation, individual/group assignments, case studies, and presentation. P1 accommodating developing skills to design the instruction as P1 provides individual consultation with two lecturers regarding their LP in form of discussions, brainstorming, and clinical supervision in addition to the classical face-to-face meetings.

Lecturing evaluation in P3 is conducted through midterm test, final exam, group assignment, and individual assignments. P1 uses group and individual tasks, consultation and oral examination of the LP. Evaluation conducted at P1 strongly supports the achievement of goals related to the development of learning design skills.

Based on the results of curriculum analysis in P1, P2, and P3, it can be concluded that the CIPc has been providing prospective teachers with necessary knowledge and skills in designing classroom instruction. However, there is no further elaboration of the skill indicators in question.

**Table 1.** Map of curriculum content of Chemistry Education Study Program from three LPTKs in Indonesia.

| Aspect               | Prodi 1 (P1)                                                                 | Prodi 2 (P2)                                                                 | Prodi 3 (P3)                                                                 |
|----------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Course objectives    | Providing professional experience to chemistry prospective teachers in the   | Having knowledge and skills in planning and developing innovative          | Having skills in curriculum analysis and designing chemistry                |
|                      | form of skills in conducting curriculum analysis and designing school chemistry | and effective high school chemistry teaching programs, student-centered    | LP, which is one of the main tasks of a teacher                             |
|                      | LP which is one of the teacher's tasks                                      | chemistry instruction and laboratory-based chemistry instruction          |                                                                            |
| Status               | Compulsory subject                                                          | Compulsory subject                                                        | Compulsory subject                                                         |
| Prerequisites        | Having attended lectures on Basic Profession Courses (Mata Kuliah Dasar     | Secondary School Chemistry Curriculum Review, Chemistry                  | Unrevealed                                                                 |
|                      | Profesi - MKDP), Profession Courses (Mata Kuliah Keahlian Profesi - MKKP)  | Education Assessment, and Chemistry Teaching Media                       |                                                                            |
|                      | and passed Chemistry of School I and II, Chemistry Learning and Instruction,|                                                                           |                                                                            |
|                      | Evaluation of Chemistry Instruction and Chemistry Teaching Media            |                                                                           |                                                                            |
| Semester/ credit     | VII/3                                                                       | VI/4                                                                      | V/3                                                                       |
| hours                | 16                                                                          | 16                                                                        | 16                                                                        |
| Number of meetings   | 1) Curriculum analysis, analysis of school chemistry materials and analysis  | 1) The function and role of chemistry instructional planning; 2) Approach  | 1) Curriculum analysis, analysis of school chemistry materials, and        |
| Materials            | of teacher pedagogy measures; 2) Development and technique of making annual | in the design of teaching programs development; 3) Analyzing materials    | analysis of teachers' pedagogical actions; 2) Annual and semester           |
|                      | and semester program plan; 3) Development and techniques of making         | of chemistry and formulating relevant learning objectives; 4) Development  | program plan development techniques; 3) Syllabus development techniques;   |
|                      | syllabus; 4) Explanation of LP components; 5) LP writing and development;  | of an authentic assessment tool; 5) Selection of appropriate innovative    | 4) LP development techniques; 5) Students worksheet, instructional         |
|                      | 6) Practice of making LP and its components                                 | learning strategies to achieve learning objectives; 6) Development of     | media, learning materials, and assessment sheets development techniques; 6) |
|                      |                                                                           | steps in learning activities; 7) Implementation of chemistry               | Development of an overview of chemistry materials and concept maps         |
|                      |                                                                           | instructional design through peer teaching                                |                                                                            |
| Lecturing strategy   | Learning approaches: 1) Face-to-face                                       | Unrevealed                                                               | Teaching methods: Lectures, recitation, individual & group assignments,   |
|                      | Classical: concepts, process skills, inquiry, and constructivist; 2)        |                                                                           | case study, presentation                                                   |
|                      | Consultation: constructivist and clinical approach.                         |                                                                           |                                                                            |
|                      | Methods: 1) Face-to-face classical: lectures, recitation, discussions,      |                                                                           |                                                                            |
|                      | assignments, case studies; 2) Face-to-face consultation: question and      |                                                                           |                                                                            |
|                      | answer sessions, brainstorming, task, and clinical supervision              |                                                                           |                                                                            |
| Evaluation           | Group and individual assignments, consultation, oral test on individual LPs | Unrevealed                                                               | Midterm exam, final exam, and assignments                                  |
3.2. Description of prospective teachers’ abilities in designing LP

LPs developed by prospective teachers have fulfilled the requirements in terms of completeness of RPP components based on the standard of basic and secondary education process [10]. Based on the results of data analysis, the ability of prospective teachers to design LP can be categorized into three categories i.e. sufficient, poor, and very poor with the largest percentage is in very poor categories. The distribution of the ability to design the LP is presented in figure 1.

Figure 1. Prospective teacher’s abilities in designing LP.

The description of prospective teachers’ achievement in designing each aspect of LP is based on the LP components with the categories presented in table 2. The table shows that prospective teachers’ abilities in designing LP fall in sufficient, poor, and very poor categories.

| Aspect                        | Item (option) | Achievement (%) | Category    |
|-------------------------------|---------------|-----------------|-------------|
| Indicator and objectives      | 4             | 57              | Poor        |
| Learning materials            | 1             | 74              | Sufficient  |
| Strategy and learning activities | 5          | 49              | Very poor   |
| Media and learning resource   | 2             | 74              | Sufficient  |
| Assessment of learning        | 3             | 52              | Very poor   |

Based on table 2, the main aspects to be highlighted are the formulation of indicators and learning objectives, the selection of the strategies and learning activities, and how the objectives are evaluated. These aspects are central components in designing LP. The alignment of objective, learning activities and assessment aspects in ensuring students' understanding is a feature of successful LP [11].

The result shows that the prospective teachers have some difficulties in terms of formulating indicators and learning objectives due to their lack of knowledge in formulating indicators and learning objectives, especially related to the use of operational verbs. In fact, the literature mentions those aspects as essentials for developing the instruction, especially the teaching steps and evaluation [12].

In terms of strategy and learning activities, prospective teachers have successfully defined learning strategies that include approaches, models, and learning methods. However those aspects are less reflected in the learning activities. This indicates the difficulties encountered by prospective teachers in applying the approaches, models and methods in designing the learning activities. The same obstacle is experienced by science teachers in designing LP [2].

In the aspect of assessment, there were some mismatches between the technique, the test form and the objective. Assessment rubric are incomplete and goals are not measured completely through the instrument.

The constraints that have been revealed provide an illustration that the ability of prospective teachers to plan, monitor, and evaluate the thinking process in designing lesson plans is still not well developed. All these skills are part of metacognition skills. Therefore, metacognition skills should be the focus in PPK lectures, so that the prospective teachers’ ability to design lesson plans could be improved.
3.3. Description of learning situation in CIPc

The observations were carried out to capture the learning situation in CIPc in P3 using an observation sheet containing aspects of methods, materials and assessment of learning. These aspects are categorized into being frequently performed, less performed, and not performed during the lesson with descriptive analysis results using percentages as in figure 2. Figure 2 shows that the aspects of the ‘less performed’ category are higher average than the other categories. However, generally it can be concluded that many aspects of the instruction still need to be improved.

![Figure 2.](image)

**Figure 2.** Representation of CIP lecture in terms of method, materials, and evaluation.

The aspects of the instruction that need to be improved related to the learning method are the provision of direction to create learning targets, mapping the material, and strategies to achieve the goals of the instruction. Viewed from the aspect of learning materials related to LP components, it appears that the prospective teachers have not been facilitated in developing their underlying argument in designing LP. It is evaluated from the breadth and depth of the material based on learning objectives, the conformity of approach with learning objectives, the suitability of selected learning model with learning approach, the suitability of learning model with media and selected learning resources. Finally, the aspect of learning related to evaluation that deserves attention is the form of tasks that are given. Those tasks have neither facilitated the prospective teachers to improve their ability in monitoring their thinking process during the learning, nor facilitated the prospective teacher in self-assessment.

The aspects of learning related to the methods, materials and assessment of learning revealed are the components of metacognition. This indicates that CIPc have not been sufficient in accommodating the development of prospective teachers’ metacognition skills in designing LP. Metacognition skills are indispensable in learning because metacognition enables prospective teachers to manage their cognition and correct their shortcomings as an attempt to learn the necessary knowledge which enable meaningful learning to occur [6, 11]. Thus, metacognition is important in the activities of designing instruction because the activities of managing cognition can be done by providing arguments or reasons for their thinking process in designing instruction and the process facilitates reflection activities.

4. Conclusion
CIPc have facilitated prospective teachers in designing LP based on the analysis on curriculum, prospective teachers’ LP documents and lecture observation. However, it is generally found that the curriculum and learning process do not adequately accommodate the development of prospective teachers’ metacognition. This ability is indispensable in designing LP to practice argumentation and reflection skills. Therefore, the reorientation of the CIPc and its instruction is recommended to align it with the objectives of the study program and the purpose of higher education.

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