Titration pre-lab demonstration videos in basic chemistry laboratory activity: Design and development

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Abstract. There are difficulties for first-year chemistry students to adapt to chemistry laboratory activities due to their lack of experience in their schools. As a result, it affects their confidence and also their safety awareness in the laboratory. One of the very basic required skills in a chemistry laboratory is undertaking titration. This multi-year study aims to design and develop chemistry pre-laboratory demonstration videos to make students familiar with the required laboratory skills before they start laboratory activities. The data were collected by paper-based and online questionnaires, observation, and interview. According to the evaluation by users and experts, the usability and feasibility of the videos were categorized as very high. Moreover, corrections and suggestions were implemented to improve the quality of the videos.

1. Introduction
Practicum implementation in a chemical laboratory aims to find concepts, these practicum activities will reduce the level of abstract concepts and possible conceptual errors [1]. However, practicum in the laboratory cannot be separated from the possibility of danger from various types of chemicals. In addition, the accidents can occur due to the negligence and carelessness of the work and ignorance of students regarding the correct procedure for using tools and materials [2]. One of the important things in laboratory skills for students is how to successfully practice and keep being safe from workplace accidents. Regarding many of chemical laboratory skills, one of the most basic and most frequently used is undertaking the titration [3].

One method that can be used in learning process is the demonstration method, a learning method by demonstrating and showing students about a process, situation or object, whether in fact or just an imitation. The demonstration method is inseparable from a verbal explanation by the teacher. Research conducted by Seery [4] shows that using demonstration video can improve students' skills, in terms of knowledge, experience, and self-confidence. Extensive research has shown that demonstration video as a teaching tool effectively increase students understanding of the experiment and student independence in the laboratory [5,6]. Moreover, using pre-lab demonstration video be able to improve students’ preparedness for chemistry practicum classes [7] and completed their experiment in less time [8]. However, the evidence for using pre-lab demonstration video in Indonesia is still difficult to find.

The main aim of this study is to design and develop pre-laboratory demonstration videos in chemistry laboratory basic skills. In this paper, the focus of the videos was in titration skill. The research questions for this study were: (1) What are the challenges in basic laboratory chemistry...
practicum for first-year students? (2) How to design and develop the pre-laboratory demonstration videos in chemistry laboratory basic skills? (3) How is the feasibility of the videos developed based on experts and students assessment?.

2. Methodology

2.1. Participant
This study involved 81 first-year students who took basic chemistry practicum in Universitas Negeri Jakarta, Indonesia and were the chemistry pre-laboratory demonstration videos users. In addition, to evaluate the quality of the demonstration video, 3 experts in the field of chemistry and 3 experts in the field of media were involved to conduct an assessment and provide input regarding the chemistry pre-laboratory demonstration videos that was developed.

2.2. Instrument and procedure
To collect the data from participants, the research team used paper-based and online questionnaires, observation, and interviews. There are two types of questionnaires: (1) The questionnaire for the students; (2) the questionnaire for the experts which consisted of 17 items with a Likert-type scale (1-4). To ensure that the instruments used are reliable, reliability testing is carried out. Cronbach Alpha's reliability coefficient for student instrument is 0.907, while there is no reliability testing for the expert instrument because content validity of the instrument has been carried out in order to answer the research questions. Moreover, observations and interviews were conducted to deepen the data from the questionnaire, so that the pre-laboratory demonstration video on titration could be in accordance with the needs of the users and meet the eligibility criteria from the results of expert assessment.

The stages of design and development of video demonstrations on basic skills of titration refer to the ADDIE model, namely Analyze, Design, Develop, Implement, and Evaluate. The ADDIE model is the simplest model and is a summary of some of the previous models. ADDIE is also a concept that is appropriate for product development in the field of education. Branch [9] states that making products using the ADDIE process now means that it is the same as using the most effective tool.

In the analyze phase, the researchers interviewing lecturers in a basic chemistry practicum course, doing the observation on basic chemistry practicum course, and giving questionnaires to the first-level chemistry students and chemistry laboratory assistants to find out challenges in basic laboratory chemistry activities. In the design and develop phase, the researchers designed and developed the titration demonstration videos including making the storyboard, shooting, and editing the videos. In the Implementation phase, the developed videos were implemented in the basic chemistry practicum. After that, the evaluation phase carried out; bringing the videos to experts and students through YouTube. In fact, the evaluation phase was carried out at each stage in order to produce the videos based on assessments and input from the students and experts through questionnaires and interviews.

3. Result and discussion

3.1. The challenges in basic chemistry practicum
Based on the results of interviews and questionnaires from the lecturers and assistants of basic chemistry labs. The following are the challenges that occur to the first-year students in carrying out basic chemistry laboratory activities:

- They do not read the work chart
- A noisy atmosphere
- They do not know how to use the tool correctly
- The students feel the chemistry lab is difficult and tiring
- Lack of procedures understanding
- Lack of knowledge about laboratory theory and skills
- Lack of work experience in the laboratory
In addition, based on a questionnaire to students, 75.9% of students still did not know all the practical tools to be used and only 20.7% knew how to use the practicum tools correctly before the practicum was conducted. According to the experience of lecturers, many students get difficulties in terms of titration, even those that are somewhat easier such as filtering and installing distillation devices. Not much different from the material skills expected by laboratory assistants, namely 38% of laboratory assistants chose basic skills to do a titration, 31% introduction and how to use practical tools, 8% how to assemble distillation equipment, 15% make solutions and dilute solutions, and 8% basic skills filter.

3.2. Design and develop the pre-laboratory demonstration videos

This research produced product in the form of video demonstration media for basic chemistry laboratory preparation with the contents of basic titration skills.

The steps of designing and developing videos in this study were:

- Determine the concept of video
- Select the demonstration video material
- Make the initial video design
- Make the video storyboards
- Select the software
- Take the shoot
- Edit the videos

After this stage, the demonstration videos of the titration that will be produced and tested by experts and users (students). This video is divided into five segments, namely: introduction (introduction of tools and materials used for basic skills in practicing titration), safety laboratories, laboratory preparation for titration, titration, and calculations and conclusions.

3.3. The feasibility of the videos developed

3.3.1. Video assessment by the experts. Based on the results of the material and language expert validation, suggestions were obtained for improvement or revision, namely the use of appropriate symbols, the use of significant numbers in calculations, adding information to the calculation formula to reduce multiple interpretations for the viewers, improving general formulas, adding scenes using volumetric pipette to show how to use the volumetric pipette. The results of the video feasibility based on the assessment of material and language experts are presented in table 1.

| Table 1. The videos feasibility based on the assessment of material and language experts |
|---------------------------------------------|--------|------------------|------------------|
| Aspect               | Indicator                                                                 | item(s) | Average Percentage | Criteria of feasibility |
| Content and material | Suitability of the video with the objectives and indicators of learning | 1,2     | 97.9%             | Very good               |
|                      | Concept accuracy                                                             | 3,4     |                  |                         |
|                      | Procedure accuracy                                                           | 5,6,7   |                  |                         |
|                      | Accuracy of terms, notations, symbols or icons                               | 8       |                  |                         |
| Video presentation   | Systematic consistency of presentation                                       | 9       | 96.7%             | Very good               |
|                      | Easy to understand                                                          | 10,11,12|                  |                         |
|                      | Match the duration of the video to the material presented                    | 13      |                  |                         |
| Video role           | Provide initial knowledge for students                                       | 14,16   | 100%             | Very good               |
|                      | Prevent students from making mistakes when practicing                       | 15      |                  |                         |
|                      | Assist lecturers and staff to transfer knowledge of basic skills             | 17      |                  |                         |
Based on the results of media expert validation, suggestions were obtained for improvement or revision, namely: videos were divided into several segments, additional years on opening logos, selection of types of text used, consistency of UNJ logo location, transparency settings of objects in videos, and background settings in calculation scenes. The results of the video feasibility based on the assessment of media experts is presented in table 2.

### Table 2. The videos feasibility based on the assessment of media experts.

| Aspect          | Indicator                          | item(s) | Average Percentage | Criteria of feasibility |
|-----------------|------------------------------------|---------|--------------------|-------------------------|
| Visual video    | The composition of colors, images,  | 1,2,3   | 90.6%              | Very good               |
|                 | animations                          |         |                    |                         |
|                 | Image clarity                       | 4,5     |                    |                         |
|                 | Lighting accuracy                   | 6       |                    |                         |
|                 | Presenter’s appearance              | 7,8     |                    |                         |
| Audio Video     | Voice clarity                       | 9,10,11 | 93.8%              | Very good               |
|                 | Music compatibility                 | 12      |                    |                         |
| Typography      | Selection of font types             | 13,14   | 96.7%              | Very good               |
|                 | Selection of font size              | 15      |                    |                         |
| Programming     | Video duration                      | 16      | 92.5%              | Very good               |
|                 | Video presentation                  | 17      |                    |                         |

3.3.2. Video assessment by the students. Based on the assessment results of 81 students, overall the demonstration video of basic chemical practical preparation is very interesting to watch, the appearance is good and easy to understand. The students appraise that the video has a good quality, seen from the clarity of video images and color composition that makes the basic chemistry laboratory atmosphere fresher, and the use of attractive animations reduce the audience’s boredom. The video clearly shows the practicum steps and indirectly provides a sense of confidence in student practicum. This is reinforced by 93.31% recommending the video demonstration of basic chemistry lab work as a media of preparation in the implementation of basic skills practicing titration. The results of the video feasibility based on the assessment of students is presented in table 3.

### Table 3. The videos feasibility based on the assessment of students.

| Aspect                      | Indicator                          | item(s) | Average Percentage | Criteria of feasibility |
|-----------------------------|------------------------------------|---------|--------------------|-------------------------|
| Video display presentation  | Image clarity                      | 2       | 92.6%              | Very good               |
| and design                 | Voice clarity                      | 3       |                    |                         |
|                             | Suitability of colour, size, and   | 4       |                    |                         |
|                             | type of text                       |         |                    |                         |
|                             | Ease of video flow to be understood| 5       |                    |                         |
|                             | Video appealing                    | 1       |                    |                         |
| Programming                 | Accuracy of duration               | 6       | 90.0%              | Very good               |
|                             | Easiness of access                 | 7       |                    |                         |
|                             | Easy to use                        | 8, 9    |                    |                         |
| Video role                  | Help students understand the       | 1,10    | 93.4%              | Very good               |
|                             | procedures and techniques for      |         |                    |                         |
|                             | using tools                        |         |                    |                         |
|                             | Prevent students from making       | 11      |                    |                         |
|                             | mistakes when practicing           |         |                    |                         |
|                             | Provide initial knowledge for      | 12,13   |                    |                         |
|                             | students                            |         |                    |                         |
|                             | Training the independence          | 14      |                    |                         |
|                             | Helping students in basic chemical  | 15,16, 17|                   |                         |
|                             | lab preparation                    |         |                    |                         |

In the draft model, the video demonstration of basic chemistry labs is presented in one video with a duration of 16 minutes and 16 seconds. One video contains several material distributions which all are still related to the basic skills of the titration lab. Based on suggestions and input from media experts, the video demonstration was made into several segments to shorten the duration for not more than 10
minutes [10]. Short duration videos are more interesting to watch [11]. Short video duration, which is an average of 2 minutes per video, makes students’ attention focused on understanding the content of the video [12]. After revision based on the assessment and suggestions from the experts and students, a video series of basic chemical practicum preparation on the titration skills have been developed as can be seen in Figure 1.

**Figure 1.** A video series of basic chemical practicum preparation on the titration skills.

4. Conclusion
Based on the results and discussion, it can be concluded that this study has produced learning media in the form of a video demonstration of basic chemistry practicum preparation. The video has gone through a series of stages of development. The series of basic chemistry laboratory skills video in titration skills divided into five segments, namely introduction (introduction of tools and materials used for basic skills practicing titration), safety labs, titration lab preparation, titration, and calculations and conclusions. Based on the results of the experts and users (students) assessment, the videos that have been developed have very good feasibility, so the videos are feasible to be used as a medium for basic chemical practical preparation before taking the laboratory majors.

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