Development of the Chemistry in Life Course Toolkit to Improve the Quality of Student Learning during the Covid-19 Pandemic

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Abstract. The Covid-19 pandemic has forced the education process to run virtually. Therefore, every learning process requires e-learning which is arranged systematically to improve the quality of student learning. This study aims to develop e-learning content (modules, handouts, assessment instruments, presentation slides, and video podcasts) in a Moodle-based LMS for the "chemistry in life" course at the Department of Science Education, State University of Malang. The development was carried out using the R&D method by Borg and Gall and product trials were carried out on 112 students with a pretest-posttest design model. The results of the validation questionnaire by the experts showed that the product developed was feasible to use. The Wilcoxon test on the students' pretest and posttest results showed a significance of 0.000 which was smaller than $\alpha = 0.05$ and indicated a difference between the students' pretest and posttest results. The mean value of N-Gain shows the number 0.4373 which is included in the category of intermediate improvement from the students' pretest scores to the students' posttest scores.

Keywords: E-Learning, R&D, Chemistry in Life, Moodle

1 Introduction

The learning process in the classroom is always built by several elements, namely educators, students, learning strategies, learning media, and teaching materials. These five elements of learning are very influential on the success of a learning process. The learning process is said to be successful if students experience changes in behavior as a result of the stimuli and experiences they receive during the learning process. However, the learning process generally always has its problems. This problem is often caused by one of the five elements of the learning process. Problems in the learning process are usually specific depending on the characteristics of the class [1–5].

The Department of Science Education, Universitas Negeri Malang has four courses related to the field of chemistry. They are Basic Chemistry, Elements and Compounds, Physical Chemistry, and Biochemistry. Elements and Compounds courses include courses in the field of chemistry which are considered difficult for students of the Department of Science Education, Universitas Negeri Malang.

This is due to the very broad nature of the learning materials covering elements, organic compounds, and inorganic compounds. In addition, these materials are considered not essential to be thoroughly mastered by students of the Department of Science Education, Universitas

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Negeri Malang, who are expected to become science teachers at the Junior High School level in the future. Therefore, stakeholders in the Department of Science Education, Universitas Negeri Malang, agreed to replace the Elements and Compounds course with Chemistry in Life in the 2020 curriculum. The Chemistry in Life course is expected to be more focused on chemistry concepts that are close to student life so that it is more suitable to be taught to prospective Junior High School science teachers who will teach science in everyday life to Junior High School students.

However, the change of Elements and Compounds courses into Chemistry in Life courses in the 2020 Curriculum of the Department of Science Education, Universitas Negeri Malang gave birth to a new problem. Stakeholders in the Department of Science Education, Universitas Negeri Malang must rearrange all learning tools that will be used in the course [6–8]. This is due to its very different nature from the Elements and Compounds course. The learning tools in question are modules that contain material, handouts, evaluation questions, and learning media.

In addition, the central government's policy for the implementation of Distance Learning during the COVID-19 pandemic will also continue in 2021 [9–12] and the policy of the Chancellor of the Universitas Negeri Malang requires the learning process to be carried out through SIPEJAR (Moodle Based LMS) leads to the development of learning tools for Chemistry in this Life courses must be digital-based. Therefore, digital learning tools for Chemistry in Life courses in the 2020 Curriculum of the Department of Science Education, Universitas Negeri Malang are indispensable to support the lecture process.

2 Research Method

The development of digital learning tools for the Chemistry in Life course was carried out by adapting the development model of Borg and Gall (1997) [13]. The development of digital learning tools for the Chemistry in Life course is divided into several stages. The first stage is the preliminary stage where the researcher analyzes the learning outcomes of the course and analyzes the needs of the equipment and what content is needed. The second stage is the development stage where researchers design product prototypes, product validation to experts, product prototype revisions, and product trials. The third stage is the dissemination and implementation of products in learning.

The product prototype validation stage is carried out by two experts by filling out a validation questionnaire. The product trial was conducted on 112 students by filling out a product readability test questionnaire. All questionnaires in this study used a Likert scale of 1-4 and the results were analyzed using descriptive statistics. The researcher also tested the effectiveness of the product using a pretest-posttest design with the Wilcoxon method to see the difference between the pretest and posttest data and the N-Gain to see changes in the value from pretest to posttest.

3 Result and Discussion

By the development method carried out, the development team conducted an analysis of the CLO and SCLO of the Chemistry in Life course at the Department of Science Education, Universitas Negeri Malang. From this analysis, the development team concluded the distribution of materials as shown in Table 1 below.

Table 1. Results of Analysis of Course Learning Outcomes (CLO) and Sub Course Learning Outcomes (SCLO)

CLO	SCLO	Class Type	Number of Meetings	Tool Type
5.1	5.1.1	Theoretical	4 Meetings	Modules/Books, PowerPoint, Videos
	5.1.2	Theoretical	1 Meeting	Modules/Books, PowerPoint, Videos
	5.1.3	Theoretical	2 Meetings	Modules/Books, PowerPoint, Videos
	5.1.4	Theoretical	3 Meetings	Modules/Books, PowerPoint, Videos
5.2	5.2.1	Experiment	2 Meetings	Experiment Handout
	5.2.2	Experiment	1 Meeting	Experiment Handout
	5.2.3	Experiment	1 Meeting	Experiment Handout

Based on Table 1, there were 10 meetings devoted to theoretical topics and 4 meetings for practical topics. The remaining 2 meetings are for the midterm and end-semester exams. From the analysis above, the development team concluded that a module or book containing 10 chapters was needed according to the number of theoretical topics. The module or book is registered with the ISBN so that it can be used both in print and digitally. In addition, experiment handouts are also needed for 4 practicum topics that can make it easier for students to understand what they will do in the laboratory. To accompany the modules or books that have been made, the development team agreed to make learning media in two forms, PowerPoints and explainer videos for each of these topics [14–16].

For the remaining 2 meetings, the development team made two test assessment instruments in the form of multiple-choice of 50 items which were divided into 25 items for the Mid-Semester Examination and 25 item questions for the Final Semester Examination. After the draft module or book, PowerPoint, explainer video, and assessment instrument were developed, the development team asked two experts who have competence in the fields of chemistry and education to conduct an assessment and correction of the draft learning device using a questionnaire. Validation has been provided by the development team by using the Google Form application. Table 2 shows the validation results from these experts.

Table 2. Expert Validation Results for Learning Toolkit

Product	Aspect	Score
Book	Media	99
	Material	96
Experiment Handouts	Media	98
	Material	100
Media PowerPoint and Video Explainer	Media	94
	Material	100
Assessment Instrument	Cognitive Assessment Instruments	98
	Instruments for Assessment of Presentation Performance and Preparation of Papers	100
	Practicum Performance Assessment Instruments and Report Preparation	100
Average Score		**98**

As shown in Table 2, the learning tools developed for the Chemistry in Life course at the Department of Science Education, Universitas Negeri Malang gets an average score of 98 from the two validators, which indicates the tools that have been compiled by the development team are very valid and can be used in the trial stage. Some aspects of validation do not seem to get

the maximum value because there are still some shortcomings found by the validator. Some suggestions from the validator include the problem of writing errors (typo) and the need to include information about the cognitive level on the cognitive assessment instrument for each question [17–19].

Product trial involving students of the Department of Science Education, Universitas Negeri Malang who took the Chemistry in Life course in the 2021/2022 academic year. The students who took the product trial were divided into three classes/offerings, namely offering A with 40 students, offering B with 37 students, and offering C with 39 students, so that a total of 112 students took part in the trial. The trial was carried out in two stages. The first stage is to ask students to see the device that has been developed by the development team and fill out a readability questionnaire to assess the feasibility of the device.

The second stage is to give pretest and posttest to students to measure the effectiveness of the learning tools that have been made by the development team in improving students' cognitive abilities. This second stage is carried out using only the cognitive assessment instrument for the Mid-Semester Examination due to the limited time available to carry out the effectiveness test up to the Final Semester Examination.

The readability test was carried out by asking 112 students of the Department of Science Education, Universitas Negeri Malang who took the Chemistry in Life course in the 2021/2022 academic year to fill out a readability test questionnaire for modules, experiment handouts, and media. The product of the assessment instrument was not included in the readability test because the assessment of the assessment instrument was more suitable to be carried out by experienced experts than the subject of the assessment instrument.

The results of the readability test on the module, experiment handouts, and media are shown in Table 3 below.

Table 3. Module, Experiment Handouts, and Assessment Instruments Readability Test Results

Product	Score
Book	90
Experiment Handouts	91
Media *PowerPoint* and Explainer Video	86
Average Score	**89**

Based on the results of the readability test conducted by the development team to students of the Department of Science Education, Universitas Negeri Malang who took the Chemistry in Life course in the 2021/2022 academic year from Table 3, the development team obtained scores for books, practicum handouts, and PowerPoint media and explainer videos are 90, 91, and 86 with an average value of 89. This value is in the very high category range [20] so that the learning tools that have been made by the development team can be declared very suitable for use in the lecture process.

Effectiveness test data totaling 112 pretest values and 112 posttest values were first tested for normality to see whether the data were normally distributed or not. Based on the results of the normality test of the pretest and posttest data in Table 3, the pretest and posttest data showed a significance value of 0.032 and 0.000 respectively when analyzed using the Kolmogorov-Smirnov method. The two significance values are smaller than the value of $\alpha = 0.05$ which indicates that both the pretest and posttest data are not normally distributed [21]. On the other hand, the pretest and posttest data also yielded a significance value of 0.250 and 0.000 respectively when analyzed using the Shapiro-Wilk method. The significance value of the

pretest data looks bigger than the value of α = 0.05, while the significance value of the posttest data looks smaller than the value of α = 0.05.

This indicates that the pretest data is normally distributed, while the posttest data is not normally distributed [22]. Based on the description above, the development team decided that it was not possible to perform a parametric difference test on the pretest and posttest data, so as an alternative, the development team conducted a nonparametric difference test using the Wilcoxon method.

Wilcoxon test results on pretest and posttest data using SPSS can be seen in Table 4 below.

Table 4. Wilcoxon Test Results on Pretest and Posttest Data

Test Statistics	
	Posttest - Pretest
Z	-8.679[b]
Asymp. Sig. (2-tailed)	0.000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Based on the Wilcoxon test results on the pretest and posttest data shown in Table 4, the development team obtained a significance value of 0.000. The significance value is smaller than the value of α = 0.05. The conclusion from the Wilcoxon test is that Ha is accepted [23], which means that there is a significant difference between the pretest data and the posttest data produced by students of the Department of Science Education, Universitas Negeri Malang after attending lectures using learning tools that have been made by the development team. After that, the development team also conducted an N-Gain test on the pretest and posttest data to see the direction of the change in the pretest to posttest data.

Based on the results of the N-Gain test on the pretest and posttest data, the development team obtained a mean N-Gain value of 0.4373. This value is in the medium category. According to Hake (1999), the N-Gain value with a range of 40% to 55% is in the less effective category [24]. This indicates that the learning tools used are less effective in increasing the cognitive level of the students of the Department of Science Education, Universitas Negeri Malang. After the development team discussed with each other to find the cause of the ineffectiveness of the learning tools, the development team concluded that several factors caused the less effective results, including the following:

a. The pretest and posttest data used only come from the cognitive assessment instrument for the Mid-Semester Examination (UTS) so that it cannot describe the cognitive level of students as a whole in one semester.
b. Students do not do practical work directly in the laboratory due to the COVID-19 pandemic, which forces learning to take place online.
c. The existence of a limited face-to-face policy since November 2021 at the Universitas Negeri Malang also causes some participants to not be served optimally because online and offline learning must be carried out at the same time.

However, apart from several factors causing the ineffectiveness of the results of the effectiveness test on pretest and posttest data conducted by students of the Department of Science Education, Universitas Negeri Malang, the development team has created a valid learning tool based on the validation process and feasible based on the readability test process by the user. Therefore, the development team will continue to make improvements to the resulting devices to be more effective and make it easier for students to take Chemistry in Life course at the Department of Science Education, Universitas Negeri Malang.

4 Conclusion

A learning toolkit has been produced that can be used both for offline and online learning and can also be used through Moodle LMS for the Chemistry in Life course at the Department of Science Education, Universitas Negeri Malang. The learning tools consist of books with ISBN, practical handouts with IPR, PowerPoint media, and explainer videos as well as assessment instruments. The learning device was considered very valid by the validator (score 98) and very feasible by the user (score 89) to be used in the lecture process.

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