International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 383-387, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1005

E-Learning General Chemistry (Organic) Computer-Based Test

Jamalum Purba
Chemistry Education Study Program
Faculty of Mathematics and Science
Universitas Negeri Medan
Medan, North Sumatera,
Indonesia

Harvei Desmon Hutahaean
Electrical Engineering
Education Departemen
Faculty of Engineering
Universitas Negeri Medan,
Medan, North Sumatera,
Indonesia

Freddy Tua Musa Panggabean
Chemistry Education Study Program
Faculty of Mathematics and Science
Universitas Negeri Medan
Medan, North Sumatera,
Indonesia

Ani Sutiani
Chemistry Education Study Program
Faculty of Mathematics and Science
Universitas Negeri Medan
Medan, North Sumatera,
Indonesia

Abstract: 21st century learning is required to be technology-based to balance the demands of the millennial era with the aim that students will become accustomed to 21st century life skills. The 21st century with the rapid development of information and technology also demands changes and adjustments in learning evaluation activities, one of which is based on computer-based tests (CBT). This study aims to develop e-learning for General Chemistry courses on organic materials based on CBT and developed through the ADDIE model. This study produced a book and e-learning of General Chemistry on organic material based on a computer based test (CBT) and has been declared valid (appropriate) and proven effective to improve student HOTS achievement. The validity is met qualitatively based on the assessment of the expert validator and the effectiveness is met based on the implementation of CBT-based e-learning in organic learning as well as evidenced by the results of statistical hypothesis testing with a probability value of <0.05 with an average value of difference or increase in student HOTS of 40,167±11,099.
Keywords: e-learning, CBT, HOTS, organic chemistry

1. INTRODUCTION

The development of modernization and globalization of the 21st century has brought tremendous impact in all fields including education. Since the emergence of a global movement calling for new learning models for the 21st century, there has been a growing opinion that formal education must be changed. This change is important to bring up new forms of learning needed in overcoming complex global challenges. The changes in question are not related to changes in curriculum content, but changes in pedagogy, namely changes in acting from simple action to comprehensive action and the transition from traditional teaching to technology-based teaching [1].

21st century learning demands many things from a teacher or lecturer, especially those related to abilities and skills. In the first role, the teacher or lecturer prepares students to be able to have 21st century skills [2]. 21st century learning has the main goal of building students' learning abilities and supporting the development of students to become lifelong, active, independent learners. The demands of the professionalism of 21st century educators are not on the ability of educators to know and be proficient about everything, but educators have the expertise to find out together with their students, become role models of trust, openness, and perseverance to their students to face the realities of digital life in the 21st century [3].

The 21st century is also called the industrial revolution era 4.0, which is the century of rapid development of science and technology that requires students to be able to adapt and follow these developments. The most important thing in 21st century education is to encourage students to have a deep knowledge base and understanding to be able to become life-long learners. Thus, the education system needs to consider a number of aspects that are domains in 21st century education [4]. 21st century learning is required to be technology-based to balance the demands of the millennial era with the aim that later students will become accustomed to 21st century life skills. Students living in the 21st century must master science, metacognitive skills, be able to think critically and creatively, and be able to communicate or collaborate effectively.

effectively, this situation illustrates the gap between expectations and reality [5].

Technological developments trigger the rapid development of e-learning, various kinds of software or programs that have been provided for learning media that can be accessed at any time and any place [6]. E-learning is a distance learning model that plays a big role in education [7]. The term E-Learning is learning delivered using a computer via a CD-ROM, internet or intranet. E-learning or online is learning that uses learning resources through technology and other media [8].

E-learning is an option and solution for the implementation of learning in the digital era and since the Covid-19 pandemic, which requires students to continue learning from home by utilizing the internet network. Learning using e-Learning requires students to be more independent in learning, thus learning with e-learning can increase student activities. Learning with e-learning can also guide students to learn independently so that learning can shift from teacher-centered learning to student-centered learning [9].

E-learning has four characteristics, namely: a) utilizing electronic technology services; b) take advantage of the advantages of computers; c) using independent teaching materials; and d) using computers to store learning schedules, learning outcomes and matters relating to learning administration [10]. In addition to characteristics, e-learning also has benefits as a supplement (additional), as a complement (complementary) and as a substitute (substitute).

In addition to the ability to develop the learning process, an educator, both teachers and lecturers, is required to have the ability to evaluate and assess student learning outcomes. The ability of educators in mastering evaluation techniques is indicated by their ability to design evaluation patterns, develop instruments, set goals, see the results obtained by students, and choose appropriate actions as an effort to follow up on evaluation and assessment results. Therefore, an educator, both teachers and lecturers, must be able to make the right evaluation media, because the evaluation media is very influential in increasing students' understanding and learning achievement. Conversely, if the evaluation media is not appropriate, there will be errors in measuring learning outcomes and student understanding.

The 21st century, with the rapid development of information and technology, also demands changes and adjustments in evaluation activities which generally use paper and pencil based tests (PBT) which are now turning to computer based tests (CBT), namely evaluation or assessment activities using computer media and based online. managed by the server [11]. CBT is a test used to measure learning achievement using a computer [12], through internet access with assessments carried out automatically by a computer [13], so it does not require paper, pen or pencil to answer each question [14], student responses to the test can be stored and analyzed electronically and widely used [15].

The shift from paper-based learning evaluation to computers in order to reduce the weaknesses of paper-based learning evaluation, and to realize paperless in the current digital era must be done. This is because CBT has several advantages including being more time efficient in doing it, students do not need to use paper or pens, just sit quietly and answer the questions available on the computer [12], are allowed to take tests at the right time for participants, reduce time for the work of assessing tests and making written reports, eliminating logistical work such as distributing and storing tests using paper, test takers can immediately know the results [16]. CBT is also very helpful for educators in conducting diagnostic tests. It is easier for educators to prepare, process, and make academic policies for students [17].

Seeing the existing phenomena related to the development of modernization and globalization of the 21st century, the rapid development of information and technology and the Covid-19 pandemic which still requires students to continue learning from home using the internet network, it is necessary to develop e-learning on CBT-based General Chemistry learning which is expected can support the implementation of an effective and efficient learning process. The development of CBT-based e-learning is expected to facilitate lecturers and students in the general chemistry learning process and is expected to assist lecturers in conducting diagnostic tests and in making academic policies for students. This study aims to describe the feasibility (validity) and effectiveness of CBT-based e-learning developed in improving student learning outcomes in general chemistry learning organic chemistry.

2. METHOD

To answer research problems, the method used is a development method that refers to the ADDIE development model. The ADDIE development model uses 5 stages as the name implies, namely: Analysis, Design, Development, Implementation, and Evaluation [18]. The research procedure was carried out through stages, including: (a) Analysis, namely conducting analysis to collect information related to student needs and reviewing literature related to the product being developed; (b) Design, which is the stage carried out to identify goals and design e-learning for General Chemistry learning CBT-based organic chemistry that will be developed; (c) Development, is the stage to realize the design into a product that is ready to be implemented; (d) Implementation, namely implementing the developed product, namely e-learning General Chemistry learning CBT-based organic chemistry; and (e) Evaluation, namely conducting an evaluation by analyzing the effectiveness of e-learning learning General Chemistry on CBT-based organic chemistry on the achievement of student learning outcomes..

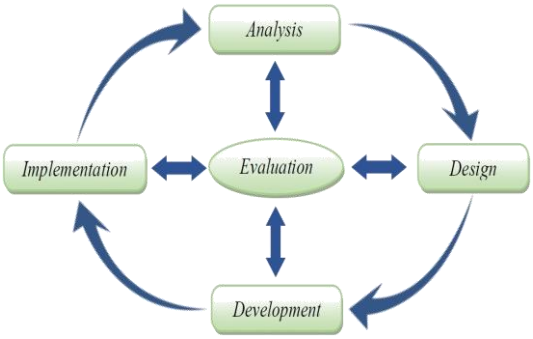

Figure 1. ADDIE Development Model

The techniques and instruments used in this study include (a) interviews used for data collection when conducting research as a preliminary study material to look for problems to be studied and used in product trials both at the time of validation to experts and product trials in the field as consideration in improving the teaching materials developed; (b) the validation sheet used to obtain data on the results of the expert's validation of the HOTS-based integrated media teaching materials developed to test their feasibility or validity; and (c) a test instrument designed to obtain data on students' higher order thinking skills. The test is structured

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 383-387, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1005

and developed according to the HOTS indicators including C4, C5 and C6.

The data obtained in the form of qualitative and quantitative data. Qualitative data were obtained from the assessment, advice and input of media experts and material experts based on the expert validation sheet instrument. Quantitative data was obtained from the achievement of student test results through CBT-based tests on organic materials. The effectiveness and improvement of student learning outcomes were analyzed using a t-test with a paired sample t-test approach with the help of the SPSS program.

3. RESEARCH RESULT

The product developed in this study is e-learning on computer-based test (CBT) General Chemistry learning organic material. CBT-based e-learning is prepared and developed with the aim of facilitating lecturers and students in the learning process of General Chemistry on organic matter and is expected to assist lecturers in conducting diagnostic tests and in making academic policies for students. The products produced and have been declared feasible by expert validators are then applied to students to analyze the effectiveness of the products produced.

Figure 2. E-Learning-Based General Chemistry Book

3.1 Produk Feasibility

The feasibility (validity) of CBT-based e-learning in the General Chemistry course, the Stoichiometry material developed was evaluated and assessed by expert validators based on the feasibility of the material and the feasibility of the media.

Table 1. Validation results on material aspects

Component	Aspect	Mean Score		Total Mean	Criteria
		I	II		
E-Learning	Contents	4.33	3.83	4.08	Valid
	Presentation	3.90	4.22	4.06	Valid
	Language	4.40	4.40	4.40	Valid
	Graphic	4.22	4.20	4.21	Valid
	Mean Total (E-Learning)			4.19	Valid
CBT	Contents	4.50	4.50	4.50	Valid
	Construct	4.00	4.50	4.25	Valid
	Language	4.67	4.33	4.50	Valid
	Mean Total (CBT)			4.42	Valid

Table 1 shows the results of material expert validation on the e-learning component of General Chemistry learning, the average total score is 4.18 or is declared valid. In the CBT component, the average total score was 4.57 or declared valid. Overall, the results of the material expert validator's assessment concluded that the e-learning of General Chemistry learning organic material based on CBT was valid or feasible to be applied in learning.

Table 2. Validation results on material aspects

Component	Aspect	Mean Score		Total Mean	Criteria
		I	II		
E-Learning	Software engineering	4.50	4.40	4.45	Valid
	Interface view	4.22	4,33	4.22	Valid
	Verbal Communication	4.38	4.25	4.32	Valid
	Mean Total (E-Learning)			4.33	Valid
CBT	Software engineering	4.40	4.00	4.20	Valid
	Interface view	4.44	4.33	4.39	Valid
	Verbal Communication	4.13	4.38	4.26	Valid
	Mean Total (CBT)			4.28	Valid

Table 2 shows the results of media expert validation on the e-learning component of learning general chemistry organic matter, the average total score was 4.29 or declared valid. In the CBT component, the average total score was 4.23 or declared valid. Overall, the results of the media expert validator's assessment concluded that the e-learning of General Chemistry learning organic material based on CBT was declared valid to be applied in learning.

3.2 Student learning outcomes

The achievement of student learning outcomes is obtained through tests given before and after utilizing e-learning generated through a computer based test (CBT). This stage was carried out to 30 students and carried out in 3 (three) stages including: (1) the initial stage, namely the initial test (pretest) through CBT before students were given action using the resulting e-learning, (2) the second stage, namely the learning process where students learn online through e-learning which is accessed and downloaded using a laptop, computer or android device on the Chemistry Education Department e-learning site, and (3) the third stage, namely the final test (posttest) via CBT.

Table 3. Achievement of student HOTS results

Data	Min	Max	Mean	Std. Dev.	K-S Test	Sig
Pretest	25	48	36.23	6.061	.628	.825
Posttest	53	95	76.40	8.939	.937	.343

Table 3, shows the achievement of students' initial HOTS test results (pretest) before being given the action, the average score was 36.23±6.061 and the data had a normal distribution with the Kolmogorov-Smirnov test = 0.628 and p = 0.825. After taking action through e-learning learning general chemistry organic material from the posttest results obtained an average student HOTS score of 76.40±8.939 and the data has a normal distribution with the Kolmogorov-Smirnov test = 0.937 and p = 0.343.

3.3 Product Effectiveness

The effectiveness of e-learning in general chemistry learning of CBT-based Stoichiometry material that was developed was analyzed from the increase in student learning outcomes in

completing tests through the CBT application using a pretest-posttest design. The test results were analyzed using a t-test or a paired sample t-test approach with the help of the SPS program.

Table 4. Product effectiveness test results

		Paired Differences		t	df	Sig (2-tailed)
		Mean	Std. Deviation			
Pair 1	Posttest -pretest	40.167	11.099	19.823	29	.000

Table 4, the tcount value is 19,823 with a probability (sig.) of 0.000 < 0.05, so it can be concluded that the implementation of e-learning for general chemistry learning on organic materials based on CBT has proven effective in improving student HOTS learning outcomes on organic materials with an average difference. The average score (posttest-pretest) is 40,167±11,099.

The product developed in this research and development is in the form of e-learning for general chemistry learning based on CBT by taking into account the material and media aspects. General Chemistry learning e-learning organic material is designed based on CBT. The results of the expert validator's assessment of the CBT-based e-learning general chemistry learning developed have met the valid criteria and are feasible to be applied in learning. The validity of the CBT-based general chemistry e-learning learning was met qualitatively based on the assessments of the material expert validators and media expert validators who as a whole were declared to meet the valid criteria.

The implementation of e-learning for general chemistry learning organic material based on CBT has also proven effective in increasing students' HOTS. The effectiveness of e-learning learning in General Chemistry based on CBT is statistically fulfilled based on the increase in student HOTS in completing tests in the form of CBT. The student response to the e-learning of General Chemistry learning organic material based on CBT produced is also very positive.

The findings of this research and development have implications for lecturers that to improve HOTS and student learning outcomes, it can be done by developing innovative learning and one of them is CBT-based e-learning. Through this CBT-based General Chemistry learning e-learning, it can help students improve their understanding, mastery and HOTS.

4. CONCLUSION

This research resulted in books and e-learning general chemistry computer-based organic material based test (CBT) which was developed through the ADDIE development model and has been declared valid (feasible) and proven effective to improve student HOTS achievement. The validity (feasibility) is met qualitatively based on the assessment (validation) of the validators of material experts and media experts who as a whole are declared to have met the valid criteria. The effectiveness is fulfilled based on the implementation of e-learning in General Chemistry based on a computer based test (CBT) in organic learning and is proven by the results of statistical hypothesis testing with a probability value of <0.05. The increase in student HOTS results is evidenced by the increase in student HOTS learning outcomes before and after using the CBT-based e-learning General Chemistry. The average value of the difference or increase in student HOTS is 40,167±11,099.

5. ACKNOWLEDGEMENTS

We would like to thank LPPM Universitas Negeri Medan for funding our research and all participans and supervisors that contributed to the work in this study.

6. REFFERENCES

[1] Afandi, T. Junanto, and R. Afriani, “Implementasi Digital-Age Literacy dalam Pendidikan Abad 21 di Indonesia,” in *Seminar Nasional Pendidikan Sains*, 2016, pp. 113–120.

[2] F. T. M. Panggabean, P. O. Pardede, R. M. D. Sitorus, Y. K. Situmorang, E. S. Naibaho, and J. S. Simanjuntak, “Application of 21st Century Learning Skills Oriented Digital-Age Literacy to Improve Student Literacy HOTS in Science Learning in Class IX SMP,” *J. Mantik*, vol. 5, no. 36, pp. 1922–1930, 2021.

[3] R. D. Prayogi and R. Estetika, “Kecakapan Abad 21 : Kompetensi Digital Pendidik Masa Depan,” *J. Manaj. Pendidik.*, vol. 14, no. 2, pp. 144–151, 2019.

[4] F. T. M. Panggabean, P. M. Silitonga, and M. Sinaga, “Development of CBT Integrated E-Module to Improve Student Literacy HOTS,” *Int. J. Comput. Appl. Technol. Res.*, vol. 11, no. 05, pp. 160–164, 2022, doi: 10.7753/IJCATR1105.1002.

[5] L. Sugiyarti, A. Arif, and Mursalin, “Pembelajaran Abad 21 di SD,” in *Prosiding Seminar dan Diskusi Nasional Pendidikan Dasar*, 2018, pp. 439–444.

[6] F. T. M. Panggabean, J. Purba, and M. Sinaga, “Pengembangan Pembelajaran Daring Terintegrasi Media Untuk Mengukur HOTS Mahasiswa Pada Mata Kuliah Kimia Organik,” *J. Inov. Pendidik. Kim.*, vol. 3, no. 1, pp. 11–21, 2021.

[7] Guntoro, L. Costaner, and Sutejo, “Pelatihan Sistem Pembelajaran E-Learning pada Sekolah Menengah Kejuruan Dwi Sejahtera Pekanbaru,” *Din. – J. Pengabdi. Kpd. Masy.*, vol. 1, no. 1, pp. 39–45, 2017.

[8] A. T. Pudyastuti and C. A. Budiningsih, “Efektivitas Pembelajaran E-Learning pada Guru PAUD Selama Pandemic Covid-19,” *J. Obs. J. Pendidik. Anak Usia Dini*, vol. 5, no. 2, pp. 1667–1675, 2021, doi: 10.31004/obsesi.v5i2.873.

[9] I. Wahyudi, “Pengembangan Program Pembelajaran Fisika SMA Berbasis E-Learning dengan Schoology,” *J. Ilm. Pendidik. Fis. Al-BiRuNi*, vol. 6, no. 2, pp. 187–199, 2017, doi: 10.24042/jipfalbiruni.v6i2.1850.

[10] E. Supratman and F. Purwaningtias, “Pengembangan Media Pembelajaran E-Learning Berbasis Schoology,” *J. Inform. J. Pengemb. IT*, vol. 03, no. 03, pp. 310–315, 2018, doi: 10.30591/jpit.v3i3.958.

[11] Agustinasari, E. Susilawati, and I. Fitriati, “Peningkatan Kemampuan Guru SMAN 2 WOHA dalam Melakukan Evaluasi Pembelajaran Menggunakan CBT,” *J. Masy. Mandiri*, vol. 4, no. 2, pp. 273–280, 2020.

[12] I. Fitriati and I. Irawati, “Implementasi Computer Based Test English Computer (CBT-EC) Untuk Efesiensi

Evaluasi Bahasa Inggris Komputer di STKIP Taman Siswa Bima," *J. Ilmu Sos. dan Pendidik.*, vol. 2, no. 2, pp. 204–210, 2018.

[13] U. M. Putri and S. Rahayu, "Aplikasi Computer Based Test (CBT) Sebagai Alternatif Evaluasi Hasil Pembelajaran Siswa," *J. Sist. Inf.*, vol. 4, no. 2, pp. 153–164, 2018.

[14] M. Ardiansyah, "Analisis Penilaian Tengah Semester Menggunakan Sistem CBT Pada Mata Pelajaran Matematika di SMK Islam Perti Jakarta," *Res. Dev. J. Educ.*, vol. 7, no. 1, pp. 29–38, 2021.

[15] W. Annisak, Astalini, and H. Pathoni, "Desain Pengemasan Tes Diagnostik Miskonsepsi Berbasis CBT (Computer Based Test)," *J. EduFisika*, vol. 02, no. 01, pp. 1–12, 2017.

[16] H. Supranoto, "Penggunaan Soal HOTS Ekonomi Berbasis CBT untuk Meningkatkan Hasil Belajar Siswa Kelas XII SMAN 2 Ulubelu," *J. Pengemb. Profesi Pendidik Indones.*, vol. 1, no. 1, pp. 1–9, 2021.

[17] I. Rosida and E. B. Susatyo, "Analisis Pemahaman Konsep pada Pembelajaran Larutan Penyangga Model Discovery Learning Menggunakan Tes CBT," *Chem. Educ.*, vol. 10, no. 2, pp. 62–69, 2021.

[18] J. Purba, F. T. M. Panggabean, and A. Widarma, "Development of Online General Chemistry Teaching Materials Integrated with HOTS-Based Media Using the ADDIE Model," *Int. J. Comput. Appl. Technol. Res.*, vol. 11, no. 05, pp. 155–159, 2022, doi: 10.7753/IJCATR1105.1001.