

Development of General Chemistry Learning Media (Thermochemistry) Using Web Based Learning Model

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

Pasar Maulim Silitonga
Chemistry Education Study
Program
Faculty of Mathematics and
Natural Science
Universitas Negeri Medan
Medan, North Sumatera,
Indonesia

Marudut Sinaga
Chemistry Education Study
Program
Faculty of Mathematics and
Natural Science
Universitas Negeri Medan
Medan, North Sumatera,
Indonesia

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

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

Abstract: The use of innovative and constructive learning media in reconstructing students' knowledge, abilities and creativity is something that a lecturer needs to consider. One of the media that can be applied in the learning process is learning media using web based learning. This research and development aims to describe the feasibility (validity), effectiveness and improvement of student learning outcomes through learning media using a web based learning model that was developed in general chemistry learning of thermochemical material through the ADDIE development model. This research and development resulted in books and learning media for General Chemistry on thermochemical material using a web based learning model that has been declared valid (appropriate) and has been proven to be effective in improving student learning outcomes. Validity is met qualitatively based on the assessment of the validators of material experts and media experts. Effectiveness is met based on the results of implementation and proven by statistical hypothesis testing ($p < 0.05$) with the average value of the pretest-posttest difference or an increase in student learning outcomes of $25,633 \pm 7,739$.

Keywords: Learning media, general chemistry, thermochemistry, WBL

1. INTRODUCTION

One of the main problems in the education system in Indonesia is the problem of the quality and outcomes of the learning process. This problem is related to the provision of learning materials and materials that are not widely accessible without being limited by distance and time constraints [1]. In addition, the development of modernization and globalization of the 21st century has also had a tremendous impact in all fields including education [2]

Since the advent of optical cable technology and web browsers, the flow of information spread around the world has become increasingly out of control and has resulted in the so-called 'digital information explosion'. Through a search engine, one can easily find the desired reference material in real time at a very, very low cost. All of this is possible because teaching materials and interaction processes have been successfully digitized by technological advances [3].

The rapid development of information and communication technology has also changed the order of human life. Education in the 21st century has been in the knowledge age with the acceleration of extraordinary increases in knowledge and is supported by the application of media and digital technology called the information super highway. The style of

learning activities in the knowledge age must be adapted to the needs of the knowledge age [4].

Learning materials must provide a more authentic design for going through challenges where students can collaborate to create solutions to solve learning problems. Problem solving leads to questions and searches for answers by students which can then be searched for problem solving in the context of learning using available information resources [5].

21st century learning also demands many things from a teacher or lecturer, especially those related to abilities and skills. In its first role, the teacher or lecturer prepares students to be able to have 21st century skills [6].

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 for 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 [7].

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. 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. effective, this situation illustrates the gap between expectations and reality [8]

Along with the development of technology and information in the digital era of the 21st century today, efforts to improve the quality of learning can be carried out through the use of technology in a system known as online learning [9].

The characteristics of online learning include: a) relying on the independence of students in learning, b) the use of computer-based electronic media, c) the use of various functions of electronic media so-called Multimedia, and d) the use of hardware, software, and internet networks. The key to success in an online class is not what technology is used but how it is used and what information is communicated using that technology [10].

The learning process is basically a communication process that involves delivering messages (material) from the instructor (teacher or lecturer) to the recipient (students), and in the process of delivering the message, a media is needed so that the message can be well received. Media is one of the important components in a communication process, including in the learning process [11].

Learning media is a communication channel tool, the media comes from Latin which has the meaning of an intermediary between the source of the message and the recipient of the message. Media are various types of components in the student environment that can provide stimulation for learning [12]. Learning media is anything that can be used to transmit messages from sender to receiver so as to stimulate the thoughts, feelings, concerns and interests and willingness of students in such a way that the learning process occurs in order to achieve learning objectives effectively [13], that can help students to achieve learning goals [14].

The technique of using and utilizing media in its implementation also contributes greatly in attracting the attention of students in the learning process, because basically the media has two main functions, namely the media as a tool and the media as a learning resource for students [15].

The use of innovative and constructive learning media in reconstructing students' knowledge, abilities and creativity is something that a lecturer needs to consider. Therefore, a lecturer needs to plan innovative and creative strategies, teaching materials and learning media by utilizing technology-based learning.

Utilization of technology is one of the efforts made for learning media, so that learning does not have to be done face-to-face between educators and students [16]. One of the media that can be applied in the learning process is learning media using web based learning.

The Web or often referred to as the WWW which stands for World-Wide Web is the latest means to navigate cyberspace. The web is a distributed internet service with the concept of hypertext between documents related to the HTML (Hyper Text Mark Up Language) language for document format. [17].

Website is the entire web page contained in a domain that contains information. A website usually consists of many interconnected web pages [18]. The Web facilitates a student-centered approach, creating a motivating, active and flexible learning environment. The web can be used as a learning

medium to make it easier for students to understand concepts or learning materials [19].

Web Based Learning is a system that can communicate easily by utilizing internet facilities so that communication activities can be carried out without being limited by distance, place and time [20]. Web based learning (web-based learning) is learning related to teaching materials presented through web browsers such as internet explorer, mozilla firefox, opera, netscape, and others [21] [1]. Web Based Learning is a distance learning system based on information technology through between web pages [17].

To make Web Based Learning into the form of the internet and can be implemented in the form of online learning, it is necessary to use the programming language in it. Programming languages that are usually used to create internet-based application programs include HTML, Java, PHP and so on. PHP (Hypertext Preprocessor) is one of the web-based programming languages. PHP is server-side programming, meaning that the PHP code written will be executed on the server side so that visitors cannot see the source code of the PHP script that was built. In addition to using the PHP programming language to design Web Based Learning, it also requires a database as a storage medium to accommodate many questions and also learning applications, the database used is MySQL [17].

Web-based learning media that utilizes information and communication technology is very helpful for teachers in carrying out learning activities. In addition, students can also be helped with easy access and learning activities using the internet and to help students understand lessons easily and can be learned by students anytime and anywhere. Web-based learning media can be equipped with various interesting learning materials so that they can direct students to do real practice in the learning process, the learning process can be carried out more effectively and efficiently. In addition, the learning process can also be an arena for asking questions, motivation and enthusiasm that is more interesting for students in independent learning [22].

Based on the phenomena and descriptions above, it is necessary to develop General Chemistry learning media using the Web Based Learning model which is expected to support the implementation of an effective and efficient learning process, as well as the limited time in face-to-face learning (conventional) can be replaced and given online access using media web-based learning. Utilization of learning media using the Web Based Learning model is also expected to increase the efficiency of student learning outcomes.

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 [4]. The research procedure is 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 the objectives and make the design of General Chemistry learning media for thermochemical materials using a web based learning model 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 General Chemistry learning media products for thermochemical materials using a web based learning model; and (e) Evaluation, which is to evaluate by analyzing the effectiveness of the General Chemistry learning media on thermochemical material using a web based learning model on student learning outcomes.

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 General Chemistry learning media for thermochemical material using a web based learning model developed to test its feasibility or validity; and (c) a test instrument designed to obtain data on the achievement of student learning outcomes in thermochemistry learning. The test is structured and developed in accordance with the indicators and competencies of the achievement of the General Chemistry course on thermochemical material.

The data obtained in the form of qualitative and quantitative data. Qualitative data were obtained from the assessment, advice and input of media expert validators and material experts based on the expert validation sheet instrument. Quantitative data was obtained from the achievement of student test results through tests on thermochemical material. 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 a general chemistry learning media using a web based learning model. General Chemistry learning media using a web based learning model was compiled and developed with the aim of making it easier for lecturers and students in the General Chemistry learning process. The validation or feasibility of general chemistry learning media using a web based learning model is evaluated by expert validators in their field. 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 1. General chemistry learning book/media model of web based learning

3.1 Product Feasibility

The feasibility (validity) of General Chemistry learning media using the developed web based learning model is 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

Aspect	Mean Score		Total Mean	Criteria
	I	II		
Content	4.33	4.00	4.17	Valid
Presentation	4.33	4.33	4.33	Valid
Language	4.40	4.40	4.40	Valid
Graphics	4.22	4.20	4.21	Valid
Total Mean			4.28	Valid

Table 1 shows the results of material expert validation, the average total score is 4,28 or is declared valid. Thus, based on the results of the material expert validator's assessment, it was concluded that the General Chemistry learning media on Thermochemistry material using a web based learning model was valid or feasible to be applied in the learning process.

Table 2. Validation results on the media aspect

Aspect	Mean Score		Total Mean	Criteria
	I	II		
Software engineering	4.40	4.40	4.40	Valid
Interface view	4.22	4,00	4.11	Valid
Verbal communication	4.25	4.13	4.19	Valid
Total Mean			4.23	Valid

Table 2 shows the results of media expert validation, the average total score is 4,23 or is declared valid. Thus, based on the results of the media expert validator's assessment, it was concluded that the thermochemical material in General Chemistry learning media using a web based learning model was valid or feasible to be applied in learning.

3.2 Achievement of Student Learning Outcomes

The achievement of student learning outcomes is obtained through tests given before and after utilizing the material on General Chemistry learning media using a web based learning model. 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) before the students were given action, (2) the second stage, namely the learning process where students learn online by utilizing the material on the internet. General Chemistry learning media using a web based learning model that has been produced, and (3) the third stage, namely the final test (posttest).

Table 3. Student learning outcomes

Data	Min	Max	Mean	Std. Dev.	K-S Test	Sig
Pretest	37	73	58.83	8.647	.149	.086
Posttest	63	100	84.47	9.247	.141	.130

Table 3, shows the achievement of the students' pretest results before being given the action, the average value was $58,83 \pm 8,647$ and the data had a normal distribution with the Kolmogorov-Smirnov test of 0,149 and $p = 0,086$. After taking action by utilizing the learning media of General Chemistry using thermochemical material using a web-based learning model, the posttest results obtained an average student score of $84,47 \pm 9,247$ and the data has a normal distribution with the Kolmogorov-Smirnov test of 0,141 and $p = 0,130$.

3.3 Product Effectiveness

The effectiveness of General Chemistry learning media using the developed web-based learning model was analyzed from the increase in student learning outcomes in completing tests using a pretest-posttest design. The test results were analyzed using a paired sample t-test approach using the SPSS program.

Table 4. Product effectiveness test results

		Paired Differences		t	df	Sig (2-tailed)
		Mean	Std. Deviation			
Pair 1	Posttest -pretest	25.633	7.739	18.141	29	.000

Tabel 4, diperoleh nilai t_{hitung} sebesar 18,141 dengan probabilitas (sig.) sebesar $0,000 < 0,05$ sehingga disimpulkan bahwa implementasi media pembelajaran Kimia Umum pada materi termokimia menggunakan model *web based learning* yang dihasilkan terbukti efektif dalam meningkatkan pencapaian hasil belajar mahasiswa dengan selisih rata-rata nilai (posttest-prettest) sebesar $25,633 \pm 7,739$.

The product developed in this research and development is in the form of general chemistry learning media for thermochemical material using a web based learning model by taking into account the material and media aspects. The results of the assessment of practitioners and expert validators on General Chemistry learning media using the developed web-based learning model have been declared valid and feasible to be applied in learning. The validity of the general chemistry learning media using the web based learning model is met qualitatively based on the assessments of the material expert validators and media expert validators which are overall stated in the valid category.

The implementation of General Chemistry learning media on thermochemical material using a web based learning model has also proven effective in improving student learning outcomes. The effectiveness is met statistically based on the increase in students' ability to complete the tests carried out. Student responses to General Chemistry learning media using the resulting web-based learning model are also very positive.

The findings of this research and development have implications for lecturers that to improve the ability and achievement of student learning outcomes, it can be done by

developing innovative learning and one of them is General Chemistry learning media using a web based learning model. Through general chemistry learning media using this web based learning model, it can help students improve their understanding, mastery and abilities.

4. CONCLUSION

This research and development resulted in books and learning media for General Chemistry on Thermochemistry using a web based learning model. General Chemistry learning media using a web based learning model was developed through the ADDIE development model and has been declared valid (feasible) and proven effective to improve student learning outcomes. The validity (feasibility) is met qualitatively based on the assessment (validation) of the material expert validators and media experts which are overall stated in the valid category. The effectiveness is fulfilled based on the implementation of General Chemistry learning media using a web based learning model and is proven from the results of statistical hypothesis testing with a probability value of $< 0,05$. The increase in student learning outcomes is evidenced by the increase in student learning outcomes before and after using General Chemistry learning media using the resulting web-based learning model. The mean value of the pretest-posttest difference or increase in student learning outcomes is $25,633 \pm 7,739$.

5. ACKNOWLEDGEMENTS

We acknowledge LPPM Universitas Negeri Medan for providing our research, and indeed all respondents and supervisors who supported with this project.

6. REFERENCES

- [1] J. Rahmadoni, "Perancangan Simulasi Pembelajaran Kriptografi Klasik Menggunakan Metode Web Based Learning," *Intecom J. Inf. Technol. Comput. Sci.*, vol. 1, no. 1, pp. 34–43, 2018.
- [2] 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.
- [3] 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.
- [4] 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.
- [5] M. Q. W. Aji, "Mengembangkan Kecakapan Abad 21 Mahasiswa Melalui Model Pembelajaran Inkuiri," *Teknodika J. Penelit. Teknol. Pendidik.*, vol. 17, no. 02, pp. 70–84, 2019.
- [6] F. T. M. Panggabean and J. Purba, "Pengembangan E-Modul Terintegrasi Media Berbasis Adobe Flash CS6 Untuk Meningkatkan Kemampuan Pemecahan Masalah Kimia Mahasiswa," *J. Inov. Pembelajaran Kim. (Journal*

- Of Innovation in Chemistry Education*), vol. 3, no. 2, pp. 116–122, 2021.
- [7] 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.
- [8] L. Sugiyarti, A. Arif, and Mursalin, “Pembelajaran Abad 21 di SD,” in *Prosiding Seminar dan Diskusi Nasional Pendidikan Dasar*, 2018, pp. 439–444.
- [9] 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.
- [10] P. Pannen, *Kebijakan Pendidikan Jarak Jauh dan E-Learning di Indonesia*. Jakarta: Kemenristek Dikti, 2016.
- [11] 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. Pembelajaran. Kim. (Journal Of Innovation in Chemistry Education)*, vol. 3, no. 1, pp. 11–21, 2021.
- [12] M. Fransisca, “Pengujian Validitas, Praktikalitas, dan Efektivitas Media E-Learning di Sekolah Menengah Kejuruan,” *J. Ilm. Pendidik. Tek. Elektro*, vol. 2, no. 1, pp. 17–22, 2017.
- [13] 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.
- [14] N. R. Wahyuaji and Suparman, “Deskripsi Kebutuhan Media Pembelajaran E-Learning Berpendekatan STEM Untuk Mengembangkan Kemampuan Berpikir Kritis dan Kreatif Siswa SMA Kelas XI,” *Semin. Nas. Pendidik. Mat. Ahmad Dahlan*, pp. 194–199, 2018.
- [15] A. H. Elyas, “Penggunaan Model Pembelajaran E-Learning dalam Meningkatkan Kualitas Pembelajaran,” *J. War.*, vol. 56, no. April, pp. 1–11, 2018.
- [16] J. F. Sinuraya and J. B. N. B. Barus, “Minat Mahasiswa Program Studi Pendidikan Olahraga dalam Mengikuti Pembelajaran E-Learning di Universitas Quality Berastagi,” *J. Educ. Hum. Soc. Sci.*, vol. 4, no. 1, pp. 526–534, 2021, doi: 10.34007/jehss.v4i1.692.
- [17] K. Siregar, “Perancangan Prototype Aplikasi Pembelajaran Budaya Batak Menggunakan Metode Web Based Learning (WBL),” *JUKI J. Komput. dan Inform.*, vol. 1, no. 1, pp. 39–45, 2019.
- [18] M. A. Ihsan, T. R. Liza, D. Setiawan, and Asmaidi, “Web-Based Learning Media Application,” *J. Mantik Penusa*, vol. 3, no. 2, pp. 51–54, 2019.
- [19] V. D. Susanti, T. Andari, and A. F. Harenza, “Web-Based Learning Media Assisted By Powtoon in Basic Mathematics Course,” *Al-Jabar J. Pendidik. Mat.*, vol. 11, no. 1, pp. 11–20, 2020.
- [20] S. Bakti, N. A. Hasibuan, L. T. Sianturi, and R. D. Sianturi, “Perancangan Aplikasi Pembelajaran CorelDraw X3 Menggunakan Metode Web Based Learning,” *J. Ris. Komput.*, vol. 3, no. 4, pp. 32–35, 2016.
- [21] R. Firmansyah and I. Saidah, “Perancangan Web Based Learning sebagai Media Pembelajaran Berbasis ICT,” *Informatika*, vol. 3, no. September, pp. 176–182, 2016.
- [22] H. D. Saputra, N. Nasrun, and W. Wakhinuddin, “Development of Web-Based Learning Media in Vocational Secondary School,” *Volt J. Ilm. Pendidik. Tek. Elektro*, vol. 3, no. 1, pp. 37–41, 2018.