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The Development of Interactive Learning Media Based on Articulate Storyline 3 on Thermochemistry to Enhance Students' Conceptual Understanding

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ABSTRAK

Penelitian ini dilatarbelakangi oleh rendahnya pemahaman konsep siswa terhadap materi Termokimia yang bersifat abstrak serta keterbatasan media pembelajaran di SMA Teuku Umar Semarang yang masih didominasi oleh buku teks dan PowerPoint. Kondisi ini menuntut adanya inovasi media yang mampu memvisualisasikan proses kimia secara nyata. Penelitian ini bertujuan untuk mengembangkan media pembelajaran interaktif berbasis Articulate Storyline 3 yang mengintegrasikan fitur simulasi laboratorium virtual (Mini Lab) dan permainan edukatif (Mini Game) sebagai unsur kebaruan untuk meningkatkan pemahaman konsep siswa. Metode penelitian yang digunakan adalah Research and Development (R&D) dengan model 4D (Define, Design, Development, Disseminate). Subjek penelitian melibatkan 25 siswa kelas XII MIPA untuk uji coba skala kecil dan 33 siswa kelas XI MIPA untuk uji coba skala besar. Instrumen pengumpulan data meliputi wawancara, angket validasi ahli, angket respon, serta tes pemahaman konsep (pre-test dan post-test). Hasil penelitian menunjukkan bahwa media yang dikembangkan dinyatakan "sangat layak" dengan skor validasi ahli materi sebesar 35,5 dari 40 dan ahli media sebesar 59,5 dari 64. Efektivitas media terbukti signifikan dengan perolehan rata-rata N-Gain sebesar 0,834 (kategori tinggi) dan peningkatan persentase siswa pada kategori "sangat paham" dari 15,2% menjadi 84,8%. Selain itu, media mendapatkan respon "sangat baik" dari siswa (skor 3,82) dan respon "baik" dari guru (skor 3,00). Dapat disimpulkan bahwa media interaktif ini merupakan solusi pembelajaran yang valid, praktis, dan efektif dalam mengatasi kesulitan belajar pada materi Termokimia..

ABSTRACT

This research is motivated by students' low conceptual understanding of abstract Thermochemistry material and the limited learning media at SMA Teuku Umar Semarang, which is confined to textbooks and PowerPoint. This condition necessitates innovative media capable of visualizing chemical processes concretely. This study aims to develop interactive learning media based on Articulate Storyline 3, integrating virtual laboratory simulations (Mini Lab) and educational games (Mini Game) as a novelty to enhance students' conceptual understanding. The research method used is Research and Development (R&D) with the 4D model (Define, Design, Development, Disseminate). The subjects consisted of 25 Grade XII science students for the small-scale trial and 33 Grade XI science students for the large-scale trial. Data collection instruments included interviews, expert validation questionnaires, response questionnaires, and conceptual understanding tests (pre-test and post-test). The results showed that the developed media was declared "very feasible," with material expert validation scores of 35.5 out of 40 and media expert scores of 59.5 out of 64. The effectiveness of the media was proven significant, evidenced by an average N-Gain score of 0.834 (high category) and a substantial increase in students within the "very proficient" category from 15.2% to 84.8%. Furthermore, the media received a "very good" response from students (score 3.82) and a "good" response from teachers (score 3.00). It is concluded that this interactive media is a valid, practical, and effective solution for overcoming learning difficulties in Thermochemistry.

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INTRODUCTION

Education plays a pivotal role in the enhancement of human resource quality, where the current dynamics of scientific and technological advancement compel educational institutions to integrate technology as a form of instructional innovation. Resonating with Buchanan (2011), educators are required to adapt responsively to technological developments to create a relevant educational ecosystem. Fundamentally, education is a systematic process to optimize individual potential to form an intellectual personality with noble character and social competence (Trianto, 2010). Digital transformation in education has redefined the interaction patterns between teachers and students. Islami et al. (2022) emphasize that technology integration not only offers flexibility in learning access without spatial and temporal constraints but also transforms material presentation methods into a more participatory format. Through interactive features such as clicking or selecting options, student engagement increases, making the cognitive process less burdensome and more enjoyable.

In the science curriculum, Chemistry is a fundamental discipline examining the structure, properties, and transformation of matter. This discipline holds significant urgency in explaining natural phenomena and providing solutions to human needs challenges, ranging from the energy sector to health (Arsyad, 2017). One essential yet frequently perceived difficult concept is Thermochemistry. The difficulty level of this subject is confirmed by the study of Sherly et al. (2023), revealing that 88.9% of students find chemistry concepts difficult to grasp, and 97.2% of them specifically require media integrating text, visuals, audio, and animation to aid understanding. This necessity is relevant to the conditions at SMA Teuku Umar, Semarang City. Based on preliminary observations and interviews, although facilities such as computer laboratories and student devices are available, their utilization remains suboptimal. The dominance of printed books and static PowerPoint presentations causes student boredom and difficulty in visualizing abstract Thermochemistry concepts.

Prior literature reviews provide a strong empirical foundation regarding the effectiveness of interactive learning media based on software such as Articulate Storyline 3 or iSpring Suite. Various studies demonstrate that this type of media possesses excellent construct and content validity. For example, Sherly et al. (2023) noted that content validity reached 91.42% and media validity 95%, categorized as highly valid. Aligning with these findings, media development on algebra by Defi and Yuyun (2024) also obtained high validity (content 89%, media 84%). Furthermore, Nurmawa et al. (2022), who developed Articulate Storyline 3 media for Physics, concluded the product's feasibility with a score of 4.3 (highly feasible) and an instrument validity of 0.79, indicating that the media is competent in measuring and enhancing conceptual understanding.

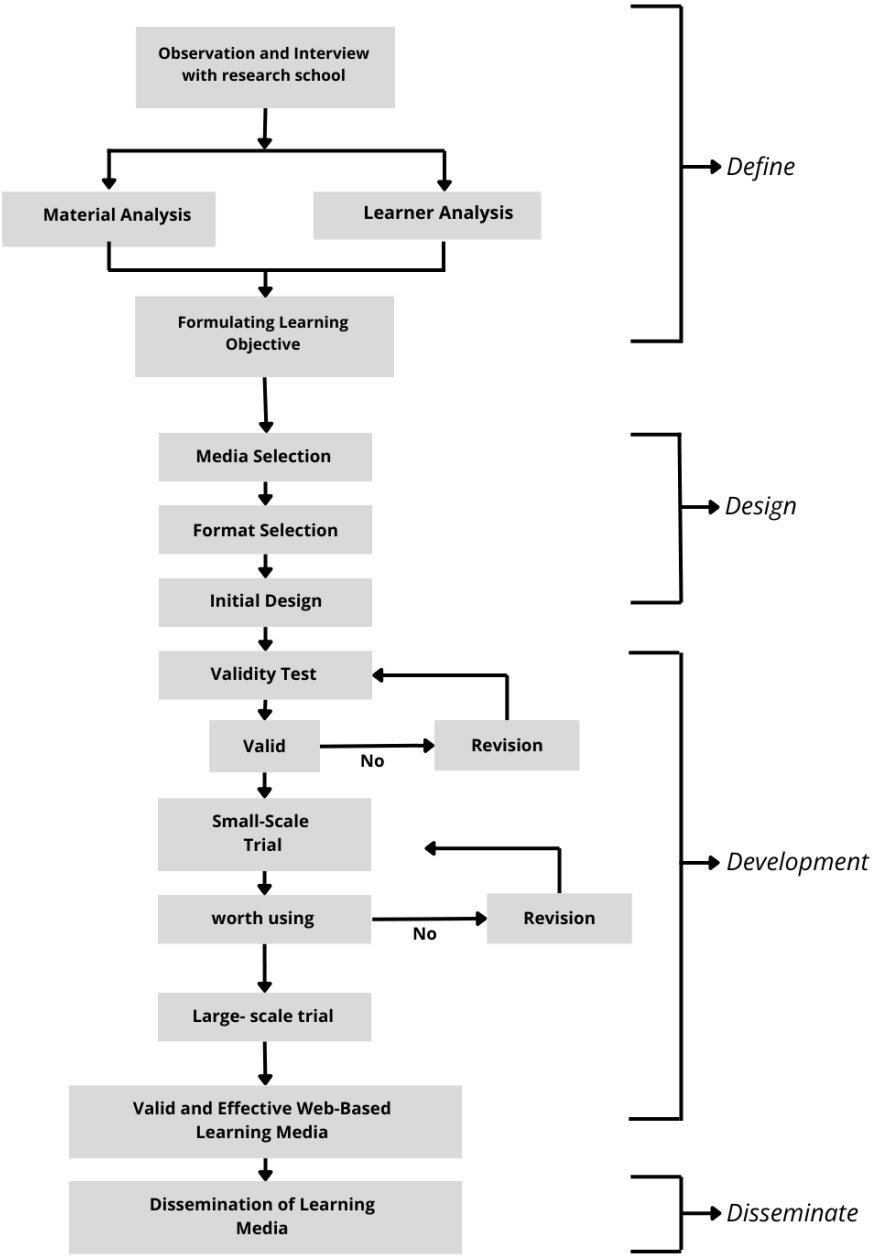
Beyond the validity aspect, interactive media has proven practical and capable of significantly capturing student attention. Positive student responses were recorded very high, reaching 94.33% in the very attractive category (Sherly et al., 2023) and a practicality level of 84% (Defi & Yuyun, 2024). The

most significant implication of applying this media is a tangible improvement in learning outcomes. This is evidenced by an N-Gain of 0.65, indicating an improvement in the medium category, and classical learning mastery reaching 79%. Grounded in the gap between field needs and empirical evidence regarding the effectiveness of interactive technology, this research aims to develop interactive learning media based on Articulate Storyline 3 for Thermochemistry. This development is expected to be a strategic solution to create valid, practical, and effective learning to optimize students' conceptual understanding.

Although the development of technology based learning media has been widely carried out, there are differences in focus that leave significant room for further exploration. Most previous studies have different orientations, such as the work of Sherly et al. (2023) who focused on redox material using iSpring Suite 11 Software, and the research of Defi and Yuyun. (2024) who utilized Articulate Storyline 3 but applied it to Mathematics subjects, specifically algebra. On the other hand, the reality of classroom learning presents pressing challenges. Thermochemistry material, which is rich in abstract concepts and mathematical calculations, is still taught using limited media such as textbooks and PowerPoint alone, so that students tend to be passive and have difficulty visualizing the concepts. This gap between the need for visualization of abstract material and the availability of aids is the basis for this research. This research presents a specific solution through the development of interactive media based on Articulate Storyline 3 for thermochemistry material, with the novelty of integrating virtual laboratory simulation features and educational games designed to transform student's conceptual understanding into more realistic learning experiences and create valid, practical, and effective learning in improving student's conceptual understanding.

METHODS

This study utilizes the Research and Development (R&D) method to develop and evaluate the effectiveness of learning media products. The development model adopted is the 4D model, which consists of four stages: Define, Design, Development, and Disseminate. The research was conducted at SMA Teuku Umar, Semarang City. The research subjects consisted of 25 Grade XII MIPA students for the small-scale trial (readability test) and 33 Grade XI MIPA students for the large-scale trial (effectiveness test). The 4D model design development can be seen in Picture 1.



Picture 1. 4D Development Procedure

Data collection techniques included interviews with the chemistry teacher during the define stage, and the distribution of questionnaires to validate media feasibility by material and media experts, as well as to determine teacher and student responses. Additionally, the test method, in the form of pre-test and post-test, was employed to measure the improvement in students' conceptual understanding. Data analysis for media feasibility and user responses utilized descriptive statistics derived from Likert-scale questionnaire scores. Item analysis was conducted using the Rasch model, encompassing item fit, reliability, Wright map, item measure, person measure, and person fit analyses. The pre-test and post-test data were analyzed to determine media effectiveness by calculating the normalized gain (N-Gain).

RESULTS AND DISCUSSION

Learning media validation results

The content assessment of the media was conducted by two experts with expertise in chemistry subject matter. The validators involved were chemistry lecturers from the Faculty of Mathematics and Natural Sciences (FMIPA), Semarang State University (UNNES). The assessment results obtained from these validators are presented in Table 1.

Table 1. Results of Expert Validation Assessment of Materials

No.	Validator	Total Score	Maximum Score	Criteria
1.	VAMt-1	36	40	Very Good
2.	VAMt-2	35	40	Very Good

Table 2. Results of Media Expert Validation Assessment

No.	Validator	Total Score	Maximum Score	Criteria
1.	VAMd-1	59	64	Very Good
2.	VAMd-2	60	64	Very Good

Based on the results of the validation assessment, it shows that the interactive learning media based on articulate storyline 3 is very valid for use as a learning medium and can be tested on students for small-scale trials.

Learning media validation results

The media expert validator in this study was a chemistry lecturer from the Faculty of Mathematics and Natural Sciences, University of the Netherlands. The assessment was conducted using a questionnaire consisting of several learning indicators, such as the suitability of the questions to the outline, the accuracy of the difficulty level, the suitability of the answer key, and the use of appropriate and easy-to-understand language. The results of the validator's assessment can be seen in Table 3.

Table 3. Question validation results

No.	Validator	Total Score	Maximum Score	Criteria
1.	V-1	26	28	Very Good
2.	V-2	25	28	Very Good

The average assessment score obtained was 59.5 out of a maximum total score of 28, categorized as very valid. This indicates that the developed questions align with the learning objectives and are suitable for use as an evaluation instrument in the next research phase. Some suggestions for improvement are minor, such as adjusting the cognitive level of the questions to the question indicators. Therefore, this instrument is suitable for use without requiring significant changes.

Readability questionnaire results

Table 4. Readability questionnaire results

No.	Rated aspect	Average score	Category
1.	This media design is interesting to use	3.68	Very good
2.	Media appearance can encourage my interest in reading	3.64	Very good
3.	The writing in the media is clearly legible	3.84	Very good
4.	The shape and size of the letters in the media make it easier for me to read	3.80	Very good
5.	Sentences in this media do not give rise to double interpretations.	3.68	Very good
6.	The language used in this media is easy to understand	3.80	Very good
7.	The images presented in the media are clearly visible	3.68	Very good
8.	The available videos are clear (not blurry)	3.84	Very good
9.	Media instructions are easy to follow and understand	3.80	Very good
10.	In this media there is a menu, instructions for use, so that the media presentation is complete	3.60	Very good
11.	This media presents a menu at the beginning which contains parts of the media.	3.64	Very good
12.	This media presents thermochemistry material in a concise manner.	3.80	Very good
13.	This media presents examples of questions and practice questions on thermochemistry material.	3.56	Very good
14.	There are navigation buttons that make it easier for me to use the media	3.84	Very good
15.	Easy to use/operate media	3.80	Very good
16.	This media guides me to be more active in the learning process.	3.80	Very good
	Average	3.73	Very good

Table 4 shown the analysis of the readability questionnaire, the interactive learning media based on articulate storyline 3 received an average score of 3.73, which is considered very good. This indicates that students responded positively to this learning media and that it is suitable for use in large-scale testing.

Large-Scale Test Results

A large-scale trial was conducted after the media, test instruments, and questionnaires were declared valid by experts and revised based on the results of the small-scale trial. The purpose of the large-scale trial was to determine the media's effectiveness in improving students' conceptual understanding and to assess student and teacher responses to the interactive learning media based on articulate storyline 3.

This trial involved 33 grade XI Mathematics and Natural Sciences students. The instruments used were 24 questions selected from the small-scale trial and student and teacher response questionnaires. Data collection involved a pre-test before learning and a post-test after learning using the interactive media, with a time allocation of 120 minutes for each test. The test results can be seen in Table 5.

Table 5. Student test results

No Absent	Pre-test score	Post-test score	Maximum score	N-Gain
1.	22	68	72	0.92
2.	31	66	72	0.8536585
3.	13	70	72	0.9661017
4.	17	59	72	0.7636364
5.	32	68	72	0.9
6.	26	68	72	0.9130435
7.	29	68	72	0.9069767
8.	18	64	72	0.8518519
9.	21	56	72	0.6862745
10.	34	70	72	0.9473684
11.	30	66	72	0.8571429
12.	30	69	72	0.9285714
13.	31	54	72	0.5609756
14.	18	57	72	0.7222222
15.	28	62	72	0.7727273
16.	24	62	72	0.7916667
17.	36	69	72	0.9166667
18.	20	53	72	0.6346154
19.	35	69	72	0.9189189
20.	30	68	72	0.9047619
21.	29	61	72	0.744186
22.	19	63	72	0.8301887
23.	27	63	72	0.8
24.	27	67	72	0.8888889
25.	29	70	72	0.9534884
26.	33	66	72	0.8461538
27.	28	66	72	0.8636364
28.	27	59	72	0.7111111
29.	25	62	72	0.787234
30.	32	69	72	0.925
31.	27	67	72	0.8888889
32.	21	67	72	0.9019608
33.	18	54	72	0.6666667
Average N-Gain of the class				0.8340783

The calculation results show that the individual N-Gain values of students vary, with most being in the moderate to high category . The average class N-Gain value obtained was 0.867 , which is included in the high category (Hake, 1999). This indicates that the interactive learning media used in this study effectively improved students' conceptual understanding of the material being taught. The results of this study are in line with the research of Nur Chuddin (2025) who developed interactive multimedia based on STEM with *articulate storyline 3* , which showed that the media is suitable for use and very well received by students (student response 93%) in learning chemical bonding material. Similarly, Sundari & Silitonga (2022) proved that the use of *articulate storyline media* in chemical bonding material significantly improved student learning outcomes with completeness up to 92%. In addition, research by Khalishah et al. showed the effectiveness of using *articulate storyline* in reaction rate material in increasing student creativity, with an N-Gain of 0.365.

Results of student and teacher response questionnaires

Table 6. Results of student response questionnaire

Indicator Evaluation	Assessment Items	Average score	Category
A. Media display	1. This media view Interesting.	3.90	Very good
	2. This media makes students enjoy learning chemistry.	3.84	Very good
	3. This learning media makes students not bored when learning chemistry.	3.75	Very good
	4. This media supports students in mastering chemistry lessons, especially material on thermochemistry.	3.87	Very good
	5. Illustrations and audio in the media can improve understanding of the material.	3.72	Very good
B. Material	6. The delivery of material in this learning media is related to everyday life.	3.81	Very good
	7. The material presented in this media is easy to understand.	3.84	Very good
	8. There are several sections in the media for students to	3.75	Very good

Indicator Evaluation	Assessment Items	Average score	Category
	discover their own concepts.		
	9. The presentation of material in this chemistry media encourages students to ask questions and discuss.	3.84	Very good
C. Language	10. The quizzes presented are in accordance with the material and can test how far students understand the thermochemistry material.	3.81	Very good
	11. The language and sentences used in the media are clear and easy to understand.	3.90	Very good
	12. The chemical terms used are simple and easy to understand.	3.87	Very good
Average score		3.82	Very good

The table above shows that student responses to the use of this learning media showed an average score of 3.82, which is considered very good. Meanwhile, teacher responses to the use of this learning media showed an average score of 3.00, which is considered good. This indicates that the use of this interactive learning media has met the needs of students and teachers as learning facilitators and is suitable for use as an interactive learning medium in the classroom.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that the interactive learning media based on *Articulate Storyline 3* on thermochemistry material has proven to be very feasible and effective for implementation in learning. The prominent scientific contribution of this work is the media's succes in visualizing thermochemical concepts that have been considered abstract such as enthalphy changes and reaction systems into real and easy to understand simulations through the mini lab and mini game features. The succes of this innovation was empirically confirmed through a significant surge in student understanding category with a high N-Gain score of 0.834.

The practical implication of these findings indicate that the integration of integrative media can transform classroom dynamics, which initially tended to be passsive and dominated by lecture methods, into active and student centered learning environments. As a step forward for the development of educational technology in the future, this study reccomends further exploration by inserting more complex

interactive features, such as hotspots or freeform picks, as well as expanding the aplication of similar media models to other chemistry materials such as acids and bases or other exact science subjects.

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