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Research Article

Developing a Physics Educational Game Using Construct 3 on Fluids to Improve Student Learning

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ABSTRACT

This study aimed to develop an Android-based educational game for teaching Static Fluid concepts using Construct 3 software and to evaluate its feasibility, attractiveness, and effectiveness in improving the learning outcomes of Grade XI students at MAN Kota Lhokseumawe. The study employed a Research and Development (R&D) approach based on the 4-D model, consisting of Define, Design, Develop, and Disseminate stages, with 20 students serving as research subjects. Data were collected through material and media expert validation sheets, teacher and student response questionnaires, and pre-test and post-test instruments. The material expert validation resulted in a validity index of 0.84, while the media expert validation obtained an index of 0.915, indicating that the developed educational game was highly feasible for use in physics learning. Teacher responses yielded a mean score of 3.66 with a feasibility index of 0.825, while student responses achieved a mean score of 3.97 with an index of 0.99, both indicating a very high level of attractiveness and positive acceptance. Furthermore, the analysis of learning outcomes showed an N-Gain value of 0.78, which was categorized as high, demonstrating a substantial improvement in students' understanding of Static Fluid concepts after using the educational game. Overall, the findings indicate that the Construct 3-assisted Android educational game is valid, practical, attractive, and effective as an interactive learning medium. Its integration of game-based activities and physics content provides students with an engaging learning experience while supporting conceptual understanding and improved learning achievement
.

Keywords: Educational Game; Construct 3; Static Fluid; Learning outcomes; R&D 4-D model

1. INTRODUCTION

The advancement of digital technology has created significant opportunities for transforming educational practices in the modern era (Sakdiah, 2022). Mobile devices based on Android are now widely owned by students, making their utilization as learning media worth optimizing. Conventional teaching approaches need to shift toward more dynamic methods that stimulate motivation and active student engagement (Cahaya et al., 2022). Physics as a natural science discipline is often perceived as difficult (Suparno, 2013), especially on topics requiring deep conceptual reasoning such as Static Fluid material for grade XI. Concepts like hydrostatic pressure, Pascal's principle, buoyancy, and Archimedes' law require visualization and contextual understanding that cannot be adequately conveyed through verbal instruction alone (Suparno, 2019). This demands the availability of learning media that can present the material concretely, attractively, and accessibly.

Preliminary observations at grade XI MAN Kota Lhokseumawe revealed that physics learning remained dominated by a teacher-centered approach using textbooks and simple presentation slides. Student engagement tended to be passive. The average student score on Static Fluid material only reached 65, below the Minimum Competenci Criteria (KKM) of 75, Static fluids material is abstract and cannot be directly seen (Rahayu et al., 2025). Many students reported that verbal content delivery felt tedious and unmotivating (Mardhiyah et al., 2021). While students greatly enjoyed game-based learning (Sugiyarto et al., 2018). Various approaches are needed to enable students to learn in more interactive and enjoyable ways (Sakdiah & Unaida, 2025) .

One innovative solution with strong potential is the development of educational games as learning media (Afidah & Subekti, 2024). Educational games are designed with pedagogical goals, providing an enjoyable play experience while reinforcing conceptual understanding. Multiple studies have demonstrated that educational game implementation increases motivation, active participation, and student learning outcomes(Purnawati et al., 2022).

Construct 3 is an HTML5-based software tool that allows two-dimensional game development without requiring mastery of complex programming languages(Ramadani et al., 2025). Construct 3 is a program for creating HTML5-based games or applications specifically for 2D platforms, containing images, sound, animation, video, and other supporting

components (Ratu Amala & Suprijono, 2024). Its user-friendly interface and ability to export to the Android platform make it a suitable choice for developing mobile-based educational games that can be distributed through various file-sharing platforms (Ardi Ramdani & Sari Susanti, 2024).

Based on the background above, this study aimed to: (1) develop an Android-based physics educational game assisted by Construct 3 on Static Fluid material that meets feasibility criteria according to material and media experts; and (2) analyze improvements in learning outcomes for grade XI students at MAN Kota Lhokseumawe after using the media in instructional activities.

2. RESEARCH METHOD

This study employed a Research and Development (R&D) approach using the 4-D model proposed by Thiagarajan (Eny Winaryati et al., 2021), encompassing four systematic stages: Define, Design, Develop, and Disseminate. This model was selected because its linear and structured nature yields a learning product that has undergone thorough testing and refinement.During the Define stage, curriculum analysis, formulation of learning objectives, student characteristic analysis, and identification of core Static Fluid concepts were carried out. Initial analysis revealed that grade XI students exhibited diverse cognitive abilities and varying learning motivation that needed to be facilitated through adaptive and engaging media. Core concepts analyzed included density, hydrostatic pressure, Pascal's law, and Archimedes' law. The Design stage involved the preparation of pre-test/post-test instruments, media selection, determination of display format, and initial draft design of the learning product. The game was designed with a side-scrolling concept that integrates adventure elements with critical thinking-based questions across five game levels aligned with the 2013 curriculum competencies. In the Develop stage, the initial product was validated by two material expert validators and two media expert validators using a 1-4 Likert scale assessment sheet. Feasibility was analyzed using Content Validity Ratio (CVR) and Content Validity Index (CVI). After revision, the product was field-tested with 20 grade XI students at MAN Kota Lhokseumawe. Teacher and student response data were collected via questionnaires, while learning improvement was measured through 15 multiple-choice pre-test/post-test items. Data analysis utilized three approaches: (1) validator assessments using CVR/CVI; (2) user responses using the Student Response Score percentage based on the Likert scale; (3) learning improvement using Normalized Gain (N-Gain) with categories of high ($g \geq 0.7$), moderate ($0.3 \leq g < 0.7$), and low ($g < 0.3$). The Disseminate stage was carried out by distributing the final product to grade XI physics teachers for use as an alternative learning medium.

3. RESULTS AND DISCUSSION

3.1 Expert Validation Results

The developed product is an Android-based physics educational game developed using Construct 3. The game consists of a loading page, main menu containing profile, instructions, material, and game features, and five game levels each containing two critical thinking-based multiple-choice questions. Static Fluid material is presented in the form of text, images, and video.

Figure 1. Main menu

Material expert assessment covered four aspects: content feasibility (mean 3.25; index 0.81), material accuracy (mean 3.50; index 0.88), presentation clarity (mean 3.38; index 0.84), and language use (mean 3.25; index 0.81). The overall mean validation score from material experts was 3.34 with a feasibility index of 0.84, categorized as highly feasible.

Table 1. Material expert validation results

No.	Aspects Assessed	Average per aspect	Feasibility index	Criteria
1.	Content Appropriateness	3,25	0,81	Very worthy
2.	Material Accuracy	3,50	0,88	Very worthy
3.	Clarity	3,38	0,84	Very worthy
4.	Language Usage	3,25	0,81	Very worthy
	The average sum of all scores	3.34	0,84	Very worthy

Meanwhile, media expert validation covered software engineering aspects (mean 3.65; index 0.91) and visual communication (mean 3.67; index 0.92), yielding an overall mean of 3.66 with an index of 0.915, also categorized as highly feasible.

Table 2. Media expert validation results

No.	Assessment aspect	Average per aspect	Feasibility index	Criteria
1.	Software Aspects	3,65	0,91	Very worthy
2.	Visual Communication Aspects	3,67	0,92	Very worthy
	The average sum of all scores	3,66	0,915	Very worthy

3.2 Teacher and Student Response Results

The teacher response questionnaire administered to the grade XI physics teacher showed an overall mean score of 3.66 with a feasibility index of 0.825, categorized as highly feasible. Aspects of content quality, time allocation, media characteristics, evaluation, and interest/motivation were all categorized as highly feasible. Language quality obtained an index of 0.75, still categorized as feasible. Student responses from 20 students indicated all assessment aspects in the highly attractive category. Cognitive, affective, and conative aspects each received an index of 0.99 with an overall mean score of 3.97. Based on the results of the teacher response questionnaire presented in Table 3, it can be concluded that the developed learning media received a very positive response from teachers. This is indicated by an overall average score of 3.66 with a feasibility index of 0.825, which falls into the very feasibility category.

Table 3. Teacher response questionnaire results

No.	Assessment aspect	Average per aspect	Feasibility index	Criteria
1.	Content Quality Aspect	3,75	0,91	Very worthy
2.	Time Allocation Aspect	3,44	0,88	Very worthy
3.	Character Aspect	4,20	0,94	Very worthy
4.	Evaluation Aspect	3,50	1,00	Very worthy
5.	Grammar Aspect	2,20	0,75	Very worthy
6.	Interest and Motivation Aspect	4,88	0,47	Very worthy
	The average sum of all scores	3,66	0,825	Very worthy

The cognitive aspect achieved an average score of 3.96 with a feasibility index of 0.99, the effective aspect achieved an average score of 3.95 with a feasibility index of 0.99, and the third aspect achieved an average score of 3.99 with a feasibility index of 0.99. Overall, the average score for all aspects was 3.97 with a feasibility index of 0.99. This score falls within the 3.26–4.00 range, making it categorized as very interesting. Therefore, it can be concluded that the developed media/product received a very positive response from students and is suitable for use in the learning process, as seen in the **Table 4**.

Table 4. Student response questionnaire results

No.	Assessment aspect	Average per aspect	Feasibility index	Criteria
1.	Cognitive Aspect	3,96	0,99	Very worthy
2.	Affective Aspect	3,95	0,99	Very worthy
3.	Conative Aspect	3,99	0,99	Very worthy
The average sum of all scores		3,97	0,99	Very worthy

3.3 N-Gain Learning Improvement Analysis

The N-Gain test was used to determine the improvement in student learning outcomes after being given treatment in the form of pretest and posttest assessments. The administration of pretest and posttest questions was intended to identify students' prior knowledge, particularly in answering the questions provided before and after conducting learning activities. The posttest questions were used to obtain learning results. To determine whether or not student learning outcomes improved after using the Construct 3-assisted physics educational game as a learning medium, the posttest questions used were identical to the pretest questions. Both the pretest and posttest consisted of 15 multiple-choice questions, with a maximum score of 6.7 per question. The test was completed by grade XI students of MAN Kota Lhokseumawe with a time allocation of 60 minutes.

Table 5. Pretest Postest and N-Gain results

No		Pre test	Post test	Post-Pre	Score Ideal (100-Pre)	N-Gain Score	N-Gain Score (%)
1	Alqaira amanda	33,5	93,8	60,3	66,5	0,91	90,68
2	Alya zikrina	33,5	80,4	46,9	66,5	0,71	70,53
3	Annisatul maida	33,5	73,7	40,2	66,5	0,60	60,45
4	Azzahra qaulia nisa	40,2	73,7	33,5	59,8	0,56	56,02
5	Chalisa najla safira	46,9	73,7	26,8	53,1	0,50	50,47
6	Fildzah nur shafara	40,2	67	26,8	59,8	0,45	44,82
7	Hasdiana azila	46,9	80,4	33,5	53,1	0,63	63,09
8	Intan amalia	40,2	80,4	40,2	59,8	0,67	67,22
9	Khaira niswati	33,5	87,1	53,6	66,5	0,81	80,60
10	Maulizana	33,5	80,4	46,9	66,5	0,71	70,53
11	Musyqiran ariza	40,2	87,1	46,9	59,8	0,78	78,43
12	Naisya syifa	26,8	87,1	60,3	73,2	0,82	82,38
13	Nayla annisa fariha	60,3	100	39,7	39,7	1,00	100,00
14	Nayla safira	40,2	87,1	46,9	59,8	0,78	78,43
15	Nazwa alfira	40,2	93,8	53,6	59,8	0,90	89,63
16	Rauzatul jannah	33,5	100	66,5	66,5	1,00	100,00
17	Salwa azzahra	53,6	93,8	40,2	46,4	0,87	86,64
18	Saqya rahmatillah	46,9	100	53,1	53,1	1,00	100,00
19	Sasqia maulidya	53,6	100	46,4	46,4	1,00	100,00
20	Sayyida nafisa zuhra	26,8	87,1	60,3	73,2	0,82	82,38
Average		40,2	86,33	46,13	59,8	0,78	77,61

Learning improvement was analyzed using N-Gain through IBM SPSS based on the comparison of pre-test and post-test scores. Calculations yielded an N-Gain value of 0.78, falling in the high category ($g \geq 0.7$). This result indicates a meaningful improvement in students' mastery of Static Fluid concepts following the use of the Android-based educational game.

Table 6. N-Gain results

N-Gain	**Criteria**
0,78	High

3.4 Discussion

The research findings consistently demonstrate that the Android-based physics educational game developed with Construct 3 is feasible, attractive, and effective as a learning medium for Static Fluid material. Product feasibility was confirmed by expert validator assessments placing all aspects in the highly feasible category, both from the perspective of material substance and media presentation. The high material feasibility index (0.84) indicates that the game content aligns with curriculum competencies, is conceptually accurate, and is systematically structured. Material presented

through text, images, and video helps students understand the relationships between concepts without the risk of misconception. This is consistent with (Zain & Jumadi, 2018), who affirmed that contextual physics learning through android media enhances critical thinking skills. The media feasibility index of 0.915 demonstrates that the technical and visual aspects of the game are well designed, supporting ease of use and visual appeal that sustains student attention. Positive teacher responses with an index of 0.825 indicate this educational game is practical to use in class, aligns with time allocation, and encourages learning motivation.

The very high student responses (mean 3.97; index 0.99) reflect the success of the game design in accommodating adolescent characteristics. Gamification elements such as level systems, scoring, and immediate feedback proved effective in enhancing students' cognitive and affective engagement. This finding is consistent with (Luki et al., 2023), who affirmed that Android-based media creates a more practical and enjoyable learning experience for the digital generation. The strongest evidence of effectiveness came from the N-Gain value of 0.78 in the high category. This value demonstrates that using the educational game significantly improved conceptual mastery compared to initial conditions. This improvement is possible because the game facilitates repeated learning, immediate feedback, and application of concepts through structured challenges. These results reinforce (Sakdiah et al., 2022), who stated that games designed as learning tools promote creative thinking and academic achievement. An additional advantage of this product lies in its flexibility: it can be operated online or offline, installed on various Android devices, and distributed through diverse platforms without complex procedures, making it suitable for broader development across other physics topics.

4. CONCLUSION

This development research produced an Android-based physics educational game assisted by Construct 3 on Static Fluid material that proved valid, practical, and effective. Material expert validation yielded a feasibility index of 0.84 and media expert validation yielded 0.915, both in the highly feasible category. Teacher responses (index: 0.825) and student responses (index: 0.99) showed very positive reception. The N-Gain value of 0.78 in the high category confirmed significant improvement in student learning outcomes. Future research is recommended to expand material coverage, involve larger samples, and integrate different learning models for more optimal generalization of results.

RECOMMENDATIONS

Based on the research findings, it is recommended that physics teachers at the senior high school level adopt educational game-based media, particularly for abstract and conceptually challenging topics. Future developers are encouraged to incorporate wider material scope, integrate collaborative learning features, and conduct longitudinal studies to assess the sustained impact of game-based physics learning on student achievement.

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AUTHOR'S CONTRIBUTIONS

[1]Ravi Ralika, [2]Halimatus sakdiah, [3]Syarifah Rita Zahrah, [4]Muliani, [5]Safriana, conceived the study, developed the educational game product, conducted all validation procedures, analyzed the data, and wrote the complete manuscript.

CONFLICT OF INTEREST

The author declares that there are no competing interests related to this research.

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