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Development of the UNO Fluid Battles Educational Card Game to Enhance Students' Cognitive Learning Outcomes on the Topic of Fluids

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Abstract: This study aimed to develop the UNO Fluid Battles educational cards to improve students' cognitive learning outcomes in the topic of fluids. This research employed the Research and Development (R&D) method using the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation). The validation process was carried out by material experts with 86.56% feasibility results and media experts with 97.22% results, indicating that the game was highly feasible for use in learning. The effectiveness test using the n-gain method obtained a value of 0.76, which showed an increase in learning outcomes in the high category. In addition, the instrument reliability test using Cronbach's Alpha resulted in a value of 0.72, indicating a high level of reliability. The results of this study proved that UNO Fluid Battles was not only successfully developed as an interactive learning medium but was also proven feasible in improving the cognitive learning outcomes of students of class XI-01 SMAN 1 Jakarta.

Keywords: Educational Game, Fluids, Cognitive Learning Outcomes, ADDIE Model

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A. INTRODUCTION

This Improving the quality of education requires a learning process that is not only effective but also engaging. Teachers, as learning facilitators, play a vital role in designing classroom experiences that encourage students to be active, enthusiastic, and capable of comprehending subject matter deeply. One way to support this is through the integration of appropriate learning media. Learning media can help simplify abstract concepts and foster a more interactive and enjoyable learning atmosphere (Khaulani et al., 2019). Additionally, a well-optimized classroom environment has the potential to enhance student engagement and improve learning outcomes (Dewi Diyantari et al., 2020).

Nevertheless, the teaching of physics in schools continues to face several challenges. Physics is often perceived as difficult due to its abstract and conceptual nature, which is not easily grasped through conventional lecture-based approaches. Consequently, many students become demotivated and struggle to achieve meaningful understanding. Traditional, teacher-centered methods tend to be one-way and do not actively involve students, often resulting in boredom and low academic achievement (Simaremare et al., 2022).

To overcome these issues, innovative learning media are needed to create more enjoyable and meaningful learning experiences. One such innovation is the use of educational card

games, which serve not only as visual aids but also as tools to enhance conceptual understanding and encourage active participation. Educational card games provide a playful yet purposeful environment in which students can develop their critical thinking while engaging with academic content (Astuti et al., 2023; Aulya et al., 2021). This is supported by Raja, who found that educational card games are effective for active learning due to their interactive and enjoyable nature, and are useful in developing students' problem-solving skills.

Among the most well-known and popular games among students is the UNO card game. Based on a needs analysis conducted by the researcher, 100% of 62 students indicated they were familiar with UNO, and 90.7% expressed interest in a version modified to include physics content—particularly on the topic of fluids. They believed that incorporating game elements would not only boost their motivation but also make the learning process more engaging. A follow-up survey of 63 students further confirmed that UNO is widely known and appealing to high school learners.

In response to this, the researcher developed UNO Fluid Battles, an educational card game inspired by the classic UNO game, but enriched with fluid mechanics concepts, illustrations, and questions designed according to cognitive learning levels. Rather than functioning as a complete learning model, this media is intended to be used during reinforcement or evaluation sessions. Its engaging gameplay is expected to enhance students' understanding of fluid concepts and, in turn, improve their cognitive learning outcomes.

According to (Supardi, 2015), cognitive learning outcomes reflect a student's ability to understand, apply, and analyze instructional material. The UNO Fluid Battles game supports the development of these cognitive domains through an enjoyable, competitive format that aligns with learning objectives. The game is structured to guide students in gradually developing higher-order thinking—from recalling basic facts to analyzing complex concepts.

Moreover, in addition to increasing motivation and conceptual understanding, UNO Fluid Battles also fosters students' collaboration and communication skills as they work in teams, strategize, and make joint decisions throughout the game. Educational card games stimulate student engagement by offering opportunities for cooperation and discussion, as highlighted by (Isabela, 2021). This is in line with (Hidayati, 2020), who found that communication and collaboration skills jointly contribute 46.6% to students' cognitive learning achievement. While these skills are not the primary focus of this study, they naturally emerge through gameplay and indirectly support improvements in cognitive learning outcomes. Therefore, the development of UNO Fluid Battles is a relevant response to the need for more engaging and effective learning tools in physics, particularly in mastering fluid concepts. This research is expected to contribute to the development of innovative educational media and support the enhancement of cognitive learning outcomes among high school students.

B. METHOD

This research was a development research (Research and Development) that employed the ADDIE model, which includes five phase: Analysis, Design, Development, Implementation, and Evaluation. The study aimed to develop an educational card game media named *UNO Fluid Battles*, designed to improve students' cognitive learning outcomes in static topic of fluids. The research was conducted at SMAN 1 Jakarta with 36 grade XI students who received physics lessons, in February 2025, using a total sampling technique. In the analysis phase, a needs assessment was conducted through a literature review and student questionnaires to identify learning difficulties and students' interest in the topic of fluids.

During the design and development phase, a prototype of the *UNO Fluid Battles* card game was created. The game consists of concept and question cards based on cognitive indicators, illustrated with engaging visuals, and structured with game mechanics aligned with Bloom's Taxonomy. These cards are categorized into question cards, host cards, strategy cards, and action cards to support the gameplay and enhance cognitive engagement. Research instruments including expert validation sheets, perception questionnaires, and pre- and post-tests were also developed. Feasibility testing was conducted through expert validation:

1. Material Expert Validation assessed content alignment with the curriculum.
2. Media Expert Validation evaluated visual design, readability, and media appeal. Validation results were analyzed using Likert scales and categorized into feasibility levels.

Table 1. Likert Scale

Percentage Range	Category
$75\% \leq x \leq 100\%$	Very Feasible
$50\% \leq x < 75\%$	Fairly Feasible
$25\% \leq x < 50\%$	Less Feasible
$< 25\%$	Not Feasible

In the implementation phase, the validated media was tested on a limited scale. Students were given a pre-test, participated in the learning session using *UNO Fluid Battles*, and then completed a post-test. Teacher and student perception tests were also conducted using questionnaires that measured engagement, clarity, attractiveness, and usability of the media. The evaluation phase focused on determining whether the developed media could improve students' cognitive learning outcomes. This was measured using a normalized gain (n-gain) analysis based on pretest and posttest results. N-Gain test to determine improvements in cognitive learning outcomes.

Table 2. Normalized Gain Scale

Gain Score	Category
$g < 0.3$	Low
$0.3 \leq g < 0.7$	Medium
$g \geq 0.7$	High

C. RESULTS AND DISCUSSION

The needs analysis results revealed that 100% of students were already familiar with the UNO card game, and 90.7% expressed interest in its implementation in physics learning on fluid material. As many as 90.3% of students considered the media to be a fun learning variation, while 83.9% believed that it could enhance their engagement in the learning process. In addition, 82.3% agreed that the media made learning more practical. A total of 96.8% reported that it helped reduce boredom during lessons, and 87.1% believed that the media contributed positively to their learning outcomes. These findings indicate the necessity of developing the UNO Fluid Battles educational card media as an innovative, practical, and enjoyable learning tool that has the potential to improve student engagement and learning outcomes in fluid physics.

In the *Design* phase, the development of the UNO Fluid Battles educational card game began with designing the back of the cards, featuring a cover with the UNO logo as the main visual identity. The cards were then categorized into four types: (1) Question Cards in blue, containing questions based on cognitive learning outcome indicators; (2) Host Cards in red, functioning as game openers or triggers; (3) Strategy Cards in green, used to answer and counter the question cards; and (4) Action Cards, consisting of Reverse, Skip, and Draw One, which serve to control the flow of the game.

Figure 1. The back of the cards

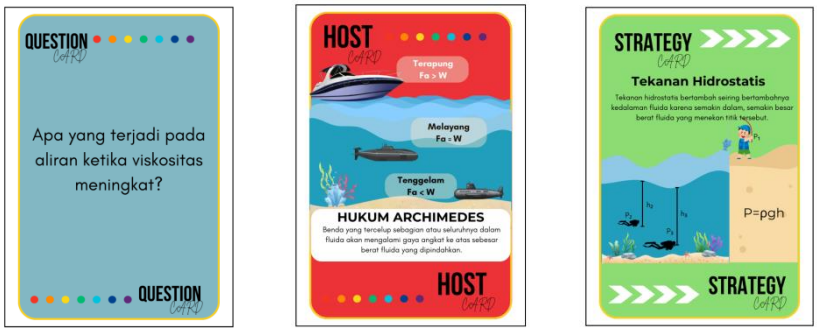

Figure 2. Question cards (left), Host cards (middle), and Strategy cards (right)

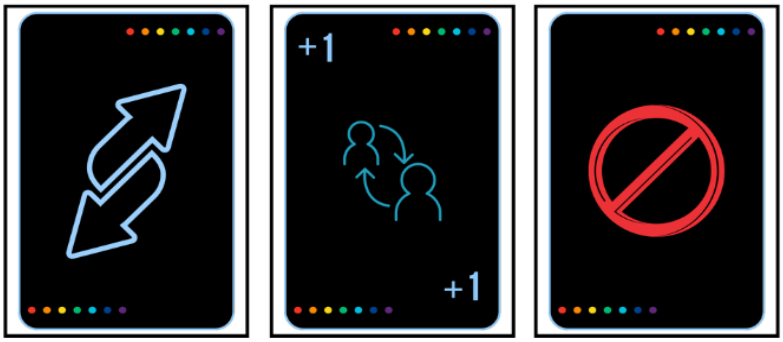

Figure 3. Action Cards, consisting of Reverse (left), Draw One (middle) and Skip (right)

The *UNO Fluid Battles* learning media underwent a feasibility test by two experts: a material expert and a media expert.

1. Feasibility Test by Material Expert

This feasibility test aimed to evaluate the material quality in the *UNO Fluid Battles* educational card game related to fluid topics. The assessment by the material expert covered the scope, presentation, and language. The validation results showed an average score of **86.56%**, categorized as **Very Feasible**, in line with feasibility standards (Sugiyono, 2017; Widodo & Wahyudin, 2018). Expert validation is essential to ensure content relevance and accuracy in educational games (Akçayır & Akçayır, 2018; Filomena & Maria, 2015). The full results from validators are shown in the following table:

Table 3. Feasibility test results by material experts

No	Assesment Aspect	Achievement Percentage	Category
1	Material Coverage	86.67%	Very Feasible
2	Presentation Techniques	88%	Very Feasible
3	Language	85%	Very Feasible
	Average	86.56%	Very Feasible

2. Feasibility Test by Media Expert

The media feasibility test evaluated the visual and technical aspects of the educational card game, focusing on visual design, illustrations, and language use. The validation by the media expert resulted in an average score of 97.22%, categorizing it as Very Feasible. This aligns with prior research emphasizing the importance of well-designed educational media in enhancing student engagement and learning outcomes. Similarly, research by (Rukayah et al., 2021) highlighted the positive impact of visual-based science learning media on junior high school students' engagement and comprehension. These findings underscore the critical role of visual and technical quality in educational media to facilitate effective learning experiences.The full results from validators are shown in the following table:

Table 4. Feasibility test results by media experts

No	Assesment Aspect	Achievement Percentage	Category
1	Visual Design	95%	Very Feasible
2	Illustration	96.67%	Very Feasible
3	Language	100%	Very Feasible
	Average	97.22%	Very Feasible

In the implementation phase, the UNO Fluid Battles learning media was applied in the teaching of fluid physics to gather user perceptions regarding the feasibility of the media. Users—both teachers and students—provided assessments after utilizing the media.

3. Teacher Perception Test

The perception test was conducted at SMA Negeri 1 Jakarta and was given to two physics teachers. This test aimed to evaluate the feasibility of using the developed educational card game media, *UNO Fluid Battles*, based on several assessment aspects. The following is the data obtained from the perception test results:

Table 5. Teacher Perception Results

Assesment Aspect	Achievement Percentage	Category
Material Coverage	92%	Very Feasible
Presenation Techniques	98%	Very Feasible
Illustration	96%	Very Feasible
Language	94%	Very Feasible
Average	95%	Very Feasible

4. Student Perception Test

The perception test was conducted at SMA Negeri 1 Jakarta, involving 36 Grade XI students who specialize in Physics. This test aimed to assess the feasibility of using the developed educational card game media, *UNO Fluid Battles*, based on several evaluation aspects. The following is the data obtained from the perception test results:

Table 6. Student Perception Result

Assesment Aspect	Achievement Percentage	Category
Material Coverage	91.42%	Very Feasible
Presenation Technique	89.11%	Very Feasible
Game Completeness	90%	Very Feasible
Student Engagement	89.56%	Very Feasible
Illustration	91.11%	Very Feasible
Language	89.44%	Very Feasible
Average	89.91%	Very Feasible

Evaluation was carried out during the full implementation stage to determine the extent to which the *UNO Fluid Battles* educational card game media contributed to the

improvement of students' cognitive learning outcomes. The evaluation was conducted through several stages of instrument analysis, including:

a. Gain Test

Table 7. Result of Pre-test and Post-test

Assesment	N	Mean	Minimal	Maximal
Pre-test	36	61	26	90
Post-test	36	89.83	56	100

Based on the N-Gain analysis, the average score obtained was 0.72, which is categorized as high. This result indicates that the use of the UNO Fluid Battles educational card game effectively improved students' cognitive learning outcomes in fluid topics. This finding is supported by (Suyatna et al., 2020), who emphasized that innovative learning media can enhance students' understanding of scientific concepts. In line with this, (Sari & Lutfi, 2015) showed that card-based educational games improve learning outcomes through active student involvement. International studies also support this conclusion; (Clark et al., 2016; Wouters et al., 2013) found that game-based learning significantly contributes to both cognitive gains and student motivation. Therefore, the UNO Fluid Battles media can be considered an effective learning media that promotes meaningful learning and improves student achievement.

b. Item Difficulty Index

Table 8. Item Difficulty Index

Category	Number of Items	Percentage
Easy	22	62.85%
Medium	12	34.29%
Difficult	1	2.86%

The distribution of difficulty levels indicates that most of the questions tend to fall into the low to medium cognitive levels, with fewer items targeting higher-order thinking skills.

c. Discriminating Power

Table 9. Discriminating Power

Category	Number of Items
Poor Discrimination	12
Fair Discrimination	7
Good Discrimination	3
Very Good	13

These results indicate that most of the developed test items have good to excellent discrimination, although some items still require revision to improve the quality of student learning outcome measurements.

d. Product Pearson Moment and Cronbach's Alpha

The validity test using Pearson Product Moment correlation showed that out of 35 items, 17 were declared valid, while 18 items were invalid due to correlation values below the r-table at the 5% significance level. This indicates that most items still require revision to achieve optimal measurement quality. High item validity demonstrates the ability of the questions to accurately measure the intended cognitive aspects.

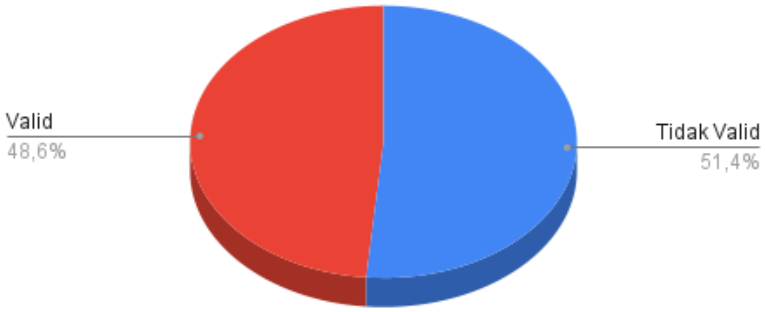

Figure 4. Validity Test Result

Regarding the reliability, test using Cronbach's Alpha produced a value of 0.72, which falls into the high category. This value indicates that the internal consistency among the test items is sufficiently good, making the instrument appropriate for use in learning evaluation. According to the classification proposed by (Sugiyono, 2017; Taber, 2018), an alpha value above 0.7 indicates good reliability and is acceptable for educational research purposes. Thus, although some items require revision, the instrument as a whole meets the requirements for reliability and partial validity, making it suitable as an evaluation tool to assess students' cognitive learning outcomes in fluid mechanics.

The findings of this study reinforce the potential of UNO Fluid Battles as an effective educational tool in the physics classroom. Its integration of conceptual questions, cognitive-level differentiation, and interactive gameplay supports both student engagement and learning retention. One of the main advantages of this educational media lies in its ability to visualize and concretize abstract concepts in fluid mechanics through an interactive card-based system. By integrating these into game mechanics, UNO Fluid Battles allows students to experience physics in a more tangible and engaging way, thus promoting deeper conceptual understanding.

Additionally, the competitive and collaborative elements embedded in the gameplay foster higher levels of motivation and participation (Plass et al., 2015). This aligns with research by (Wouters et al., 2013), which emphasizes that game-based learning environments enhance both cognitive achievement and learner satisfaction. UNO Fluid Battles is also advantageous due to its flexibility and ease of use in various classroom settings, making it suitable for both formative assessment and reinforcement activities. Its visual appeal, structured challenge levels, and student-

centered approach offer an innovative alternative to traditional learning media, particularly in supporting higher-order thinking skills.

D. CONCLUSIONS AND SUGGESTIONS

UNO Fluid Battles has been proven to be a feasible learning medium for teaching fluid topics in physics education. It positively contributes to enhancing students' cognitive learning outcomes by offering an interactive approach that concretely visualizes fluid concepts. With well-structured gameplay and relevant content, UNO Fluid Battles serves as a promising educational media that supports more engaging, meaningful, and student-centered learning experiences.

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