Development of New Todame Learning Media to Improve Problem-Solving Skills on Newton's Law for High School Students

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Abstract *- The problem-solving skills of Indonesian students are still relatively low, especially in complex subjects like Newton's law in Physics. Therefore, a learning Media is needed to improve these skills, such as the Tournament-based Truth or Dare Online Card (New Todame) to enhance problem-solving abilities, specifically on Newton's law. This study aims to: (1) gather information about media needs from teachers and students, (2) develop New Todame media, (3) assess the feasibility of the media, (4) gather feedback on user satisfaction, and (5) examine the improvement in problem-solving skills after using the New Todame media. This research is development research (R&D) using the ADDIE design, consisting of Analysis, Design, Development, Implementation, and Evaluation stages. Data collection was done through interviews, preliminary study questionnaires, validation sheets, feasibility questionnaires, and pretest & posttest sheets. The results indicate that New Todame is feasible for use, and there is an improvement in problem-solving skills on Newton's law after using the New Todame media, with an N-Gain score of 0.455, categorized as moderate.*

Keywords*: Truth or Dare Cards; New Todame; Problem-Solving Skills; Newton's law.*

INTRODUCTION

Education in the era of globalization is increasingly important to be continuously developed, especially with the emergence of the 4.0 industrial revolution and society 5.0, which requires humans to survive amidst competition. The 4.0 industrial revolution utilizes artificial intelligence and AI as essential parts of future changes. Meanwhile, society 5.0 is a concept of society that uses technology as a platform for sharing information to lead a better life (Musnaini et al., 2020).

This situation requires human resources to possess skills that cannot be replaced by machines. However, the Global Human Capital Index (2021) reveals that the human capital capabilities in Indonesia are ranked 65th out of 130 countries. One of the essential skills that a person must have in this era is problem-solving ability (Wijaya et al., 2016). Furthermore, according to the Partnership for 21st Century Skills (2017), problem-solving is one of the key skills that must be mastered to achieve success in the workplace. Problem-solving skills may be hindered if there is insufficient education in schools focused on developing these skills (Jarmita, 2018). This lack of focus could make it difficult for students to recognize the problems they face and find appropriate solutions (Mariani & Susanti, 2019).

Therefore, problem-solving skills need to be developed in high school physics education, particularly because it is a part of understanding and applying physics concepts (Aripin et al., 2021). These skills involve students going through several stages, such as understanding the problem, planning a solution, selecting a strategy, implementing the strategy, and evaluating the results (Gagne, 1970).

Based on preliminary interviews with physics teachers, one of the physics topics considered difficult to solve is Newton's law. This finding aligns with the research of

Supeno et al. (2018), which shows that students' problem-solving skills in Newton's laws are still low, especially when it comes to drawing object diagrams, determining coordinate axes, and representing forces. Newton's laws are the foundation of classical mechanics, which are crucial for understanding how objects move and how forces and mass are related (Hermanto et al., 2019). Common difficulties students face in Newton's laws include identifying acting forces and determining the magnitude of force interactions between objects (Fadlli et al., 2019). Additionally, many students provide correct answers but cannot give the proper reasoning (Mufidah et al., 2020).

These difficulties can stem from both environmental and individual factors. Inadequate teaching methods, including the use of inappropriate media, models, methods, and supporting instruments, represent environmental factors (Nurhaniah et al., 2022). Meanwhile, the way students learn and understand the material is an individual factor. These two factors are interconnected since students learn from external stimuli, which are received by the senses and processed by the brain (Mufidah L., 2019).

Several previous studies have concluded that one way to help students solve physics problems is by providing creative and engaging learning methods, such as using educational media (Putra & Hidayusa, 2019). Additionally, research conducted by Cahyani et al. (2019) mentioned that creating a fun and engaging classroom atmosphere is one effort to improve students' problem-solving skills.

Given these challenges, games are one potential solution that can help students. As Kurniawan & Risnani (2021) stated, games are an alternative medium to help students understand and solve problems in classroom learning. Moreover, game-based media are practical and effective when applied to students (Esra Yanti Sinaga et al., 2022). In line with this, a preliminary study conducted by the researcher in a high school in Bandung found that most students preferred game-based learning. Students actively interacted, responded positively, and were enthusiastic during the lessons that used game-based media. This was discovered by distributing preliminary study questionnaires to 11th-grade students. Additionally, the researcher conducted interviews with one of the physics teachers, who mentioned the need for innovative learning media to improve students' problem-solving skills using game-based educational media. This aligns with the students' responses, with 70.6% "strongly agreeing" that learning media made it easier to understand lessons, and 82.4% "strongly agreeing" that online learning media made learning more engaging.

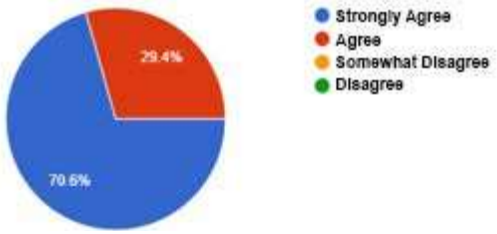


Figure 1. Results of the Agreement Level on the Statement 'The Media Makes It Easier for Students to Understand the Learning Process'

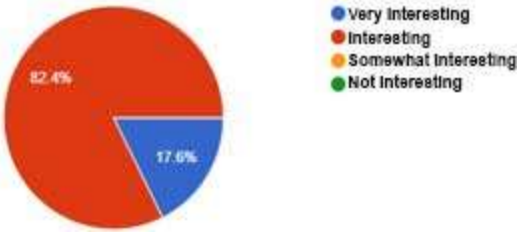


Figure 2. Results of the Agreement Level on the Statement 'Online learning makes the learning process more interesting'

Therefore, the researcher proposes the development of an online Tournament-based Truth or Dare card game (New Todame) as a solution. Media, as a communication component, functions as a messenger from

the communicator to the communicant (Cristicos, 1996). Cards, according to Arsini & Kristiantari (2022), are one form of interactive learning media that can help students acquire the necessary knowledge and skills. The concept of this card game can be adapted to the context of physics learning by designing questions related to Newton's law concepts and creating challenges that require students to solve problems. The cards are divided into two types: Truth cards and Dare cards. The difference between the two lies in the difficulty of the questions. The Truth cards focus on cognitive domain C2 (Understanding), while the Dare cards include questions in domains C3 (Applying) and C4 (Analyzing). The cognitive domains used in the Truth or Dare questions are based on Bloom's taxonomy.

The online Tournament-based Truth or Dare card game (New Todame) is designed to improve problem-solving skills, particularly in Newton's law, and has never been developed before. The development of New Todame serves as formative assessment during the learning process of Newton's law, which helps gather information about students' problem-solving abilities.

RESEARCH METHODS

This study is classified as Research and Development (R&D). According to Sugiyono (2013), R&D is a research method aimed at producing a product. The research design used in this study is the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation).

In the analysis stage, the researcher analyzes the problems and needs faced in a school, both by a high school physics teacher and by 11th-grade science students, regarding the New Todame media. This analysis serves as initial knowledge or information for creating the media in this study. Actions taken include interviews with a physics teacher and the distribution of preliminary study questionnaires to students in a high school in Bandung. The interviews were analyzed descriptively, while the preliminary study questionnaires were analyzed using descriptive statistical methods. The preliminary study questionnaires were presented in Google Forms, containing Likert scale questions with five levels, as well as open-ended questions where students could fill in paragraph responses. Additionally, the researcher analyzed the curriculum used at the school to guide the creation of questions for New Todame. The researcher also analyzed the software that would be used to develop the product.

The second stage, Design, involves planning the product, which is divided into four types: 16 cards containing questions (8 Truth cards and 8 Dare cards), answer keys, rules, and simulation videos. The design process is divided into eight steps:

1. Designing questions related to Newton's law.
2. Creating a scoring rubric.
3. Designing illustrations that match the questions.
4. Creating the rules for the New Todame media.
5. Developing a scenario for the simulation video.
6. Creating a storyboard.
7. Designing a flowchart for website development where all products would be presented.
8. Choosing AI-generated audio for reading the questions.

The development stage (Development) involves combining the questions, illustrations, and instructions for each button with appropriate color and font choices, using Articulate Storyline 3 software.

Afterward, all the designed products are compiled into a website to facilitate the use of the New Todame media by both students and teachers. In addition, the New Todame media includes a simulation video; hence, in this stage, the developer creates a simulation video and integrates it into the New Todame media.

The development stage also includes product feasibility testing. The product is validated through several stages, such as expert judgment by media and question instrument experts, followed by product trials. The evaluation is conducted through product feasibility questionnaires filled out by students. The media trial is conducted in two classes at a public high school in Bandung. The results of the trials are analyzed using SPSS software to assess validity and reliability. Before the trials, the researcher analyzes the validity results from the expert judgments using Aiken's V formula, as shown below:

$$V = \frac{\sum(r - l_0)}{n(c-1)} \quad (1)$$

Description:
V: Aiken's validity coefficient
r: Validity score given by the rater
l_0: Lowest validity score category
c: Total score categories
n: Number of raters

In the fourth stage, (Implementation), the researcher conducts teaching and learning activities with students who have not yet learned Newton's law to assess the improvement of problem-solving skills in Newton's law using pretest and posttest instruments. The results from this stage are analyzed using the N-Gain formula and categorized according to Table 1 (Hake, 1999).

$$g = \frac{(posttest\ score - pretest\ score)}{(maximum\ score - pretest\ score)} \quad (2)$$

Table 1. N-Gain Categories

N-Gain	Categories
g > 0,7	High
0,7 > g > 0,3	Medium
g < 0,3	Low

The final stage, Evaluation, involves making revisions and reflections throughout the previous stages (Analysis, Design, Development, and Implementation). If there are any shortcomings, the researcher can make improvements to ensure that the research objectives are optimally achieved.

RESULTS AND DISCUSSION

Results

The first phase was the analysis stage, including needs analysis and software analysis. Based on interviews conducted with a physics teacher at a public high school in Bandung, the teacher stated the need for educational media that can enhance students' problem-solving skills, particularly on complex topics such as Newton's Laws. The teacher also mentioned that students' problem-solving skills are currently relatively low. The results of the needs analysis questionnaire distributed to the students aligned with the teacher's statement. The software analysis identified several tools for developing the New Todame media, including Canva, Wondershare Filmora 9, Microsoft Word, Articulate Storyline 3, Clue Labs, and Google Sheets.

The results of the second phase (Design) are as follows: (1) A total of 32 questions were designed with cognitive domains of C2, C3, and C4, as shown in the appendix. Out of the 32 questions, the best 16 were validated by experts in the development phase (Development); (2) A scoring rubric was created, considering both the levels of New Todame and the cognitive levels of the 16 questions. The questions in the New Todame media are short-answer types. If students answer incorrectly, they

receive a score of 0, while correct answers earn the following scores:

Table 2. Scores for Each Question in New Todame

L	T	RK	Score of *Truth*		RK	Score of *Dare*	
			P	SUM		P	SUM
	A		1			2	
	B		2			3	
1	C	C2	2	10	C3	3	15
	D		3			4	
	E		2			3	
	1		1			2	
	2		2			3	
2	3	C2	2	11	C3	3	16
	4		4			5	
	5		2			3	
	1		1			2	
	2		2			5	
3	3	C2	2	12	C4	5	24
	4		5			7	
	5		2			5	
	1		1			3	
	2		2			5	
4	3	C2	2	13	C4	5	26
	4		6			8	
	5		2			5	
Total			**46**	**46**		**81**	**81**

Description:
L: Level
T: Phase
RK: Cognitive Level
P: Phase

(3) Illustrations for the questions were created using Canva. These illustrations help visualize the problem presented in the questions.

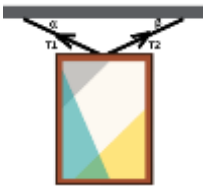


Figure 3. Hanging Frame

Figure 4. A Person Weighing an Item Inside an Elevator

After the Design phase, the Development phase followed. The result of the Development phase was a simulation video integrated into the New Todame media and uploaded to YouTube. Additionally, the slides were merged using Articulate Storyline 3, and the output of the New Todame media was integrated with the Clue Labs website. This platform allows tracking users' access time, the number of users, the devices used, and the location of the users when interacting with the New Todame media.

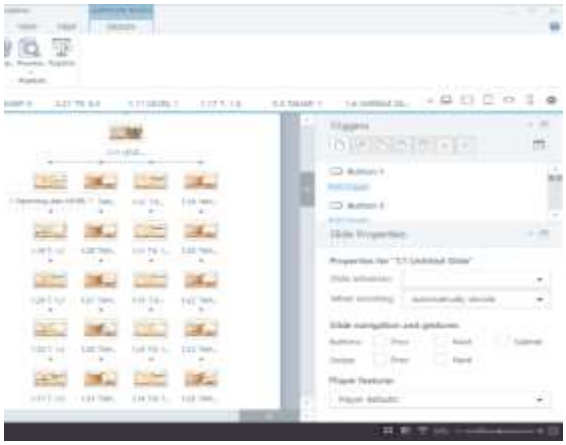


Figure 5. Slide Layout in Articulate Storyline

The Development phase also included the media validation process, conducted by instrument and media experts (judgment experts), followed by product trials. The validation results showed that the New Todame media is "feasible" for testing, with the highest validity score being 0.87 for the test instruments and a minimum score of 0.83, categorizing all test items as "Valid." The visual and software aspects of the New Todame media scored as follows:

Table 3. Expert Validation Scores for New Todame Media

Aspect	Score V	Conclusion
Software	0,81	Valid
Visual	0,84	Valid

The trial phase involved 114 students and confirmed that all test items were valid. The reliability test, based on Cronbach's Alpha, yielded a score of 0.886, indicating that the test instrument is highly reliable. The student satisfaction survey, which evaluated three aspects—software, instructional value, and visual communication—showed high levels

of satisfaction, with a strong agreement across all positive statements, suggesting that the New Todame media is feasible across all three aspects.

The implementation phase showed an improvement in students' problem-solving abilities, with an N-Gain score of 0.455, categorized as "moderate." The N-Gain scores for each problem-solving skill aspect, as outlined by Heller, are shown in Table 4.

Table 4. N-Gain Scores for Each Problem-Solving Aspect

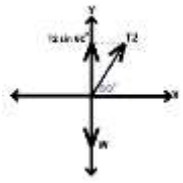
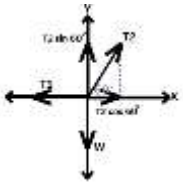
Problem-Solving Aspect	*N-Gain*	Category
Visualize the problem	0,406	Moderate
Describe the problem to physics term	0,545	Moderate
Plan a solution	0,424	Moderate
Execut the plan	0,438	Moderate
Check and evaluate	0,409	Moderate

During the implementation phase, user satisfaction levels were also measured, with 43% of participants stating they were "very satisfied" and 28% saying they were "satisfied" with the New Todame media. Moreover, 92% of students recommended New Todame to others. The following are some of the students' comments after using New Todame:

- The animations are very well done, making it exciting.
- Easy to use.
- Interactive and advanced.
- Very trendy.
- I love New Todame because the game is relaxing and makes physics less intimidating.
- Cool.
- Great color choices.

The final phase was the Evaluation phase, which involved gathering feedback from judgment experts and users. Based on this feedback, several improvements were made to the flowchart, opening sequence, web hosting, and voice-over. Additionally, minor issues like JavaScript scoring and typographical errors were corrected. The Table 5 below highlights the main differences before and after revisions:

Table 5. Differences Before and After Revisions

Before	After
	
The image of the starting point of the normal force vector is not in the correct position.	The image of the starting point of the normal force vector has been adjusted to the correct position.
	
The representation of the vectors on the x and y axes is incomplete.	The representation of the vectors on the x and y axes is more complete.
	
The opening does not adequately present the subject matter.	The opening better presents the subject matter with the addition of a large title and vector directions in several positions.
The web hosting used is 000webhos.com.	The web hosting used is Netlify.com.

Discussion

Based on the results presented above, the analysis phase revealed that both teachers and students require the New Todame media due to students' low problem-solving abilities in Newton's Laws. Similar findings regarding students' low problem-solving skills, particularly in Newton's

Laws, have been reported by Supeno et al. (2018).

Furthermore, New Todame is an online tournament-based educational game, aligning with students' preferences for interactive media in the classroom. This demand is supported by Purwanto et al. (2012), who highlighted the scarcity of accessible educational physics media. The need for such media is further corroborated by Kurniawan & Risnani (2021), who argued that games are an effective alternative for helping students understand and solve classroom learning problems.

In the design phase, the cognitive domains C2, C3, and C4 were selected with the rationale that C2 would be used for the Truth cards, which are easier, while the Dare cards utilized the more challenging domains of C3 and C4. Although C2 is considered easier, the explanation is based on Heller's problem-solving ability framework (1992), ensuring that students can still cover all aspects outlined by Heller. Heller's stages of problem-solving have proven to be relevant for various physics materials. This was demonstrated by researchers who applied these stages in the classroom, as mentioned by Lestari et al. (2019) and Cintami et al. (2024), showing an improvement in problem-solving abilities.

During the design phase, Canva was used to create question illustrations, considering its ease of use and the thousands of graphic elements available on the platform. Canva provides a wide variety of shapes that can be easily combined, and it allows for exporting designs in multiple formats, such as JPG, PDF, SVG, MP4, GIF, and others. These features align with Miftahul Jannah et al. (2023), who described Canva as an innovative and effective platform for creating educational media.

In the development phase, Articulate Storyline 3 and Clue Labs were the key software tools used for the New Todame media. Articulate Storyline 3 allowed the development to follow the flowchart precisely, while Clue Labs enabled tracking of user interactions. The media's feasibility was confirmed as "suitable for implementation" based on expert validation. Winarno (2009) stated that any educational media must be validated for both content and usability before implementation, which aligns with the validation results for New Todame.

During the implementation phase, the media received positive feedback from students, who appreciated the color choices and easy-to-understand features. Additionally, the modern and relaxing nature of the game made learning physics more enjoyable. Students provided feedback such as "great", "amazing", and "cool", reflecting their satisfaction with the New Todame media.

In the final evaluation phase, feedback from both experts and students led to improvements in key areas, such as the flowchart, web hosting, and audio. Significant feedback from multiple validators and users emphasized these aspects, highlighting their importance for ensuring the media's overall quality and user satisfaction. As Setiyowati (2019) noted, multimedia developers should pay close attention to the product's animation, graphics, audio, video, and navigation to enhance user experience.

CONCLUSION

This study concludes that the Truth or Dare Online card-based media, structured as a tournament (New Todame), is highly necessary for both students and teachers to enhance problem-solving skills, specifically regarding Newton's Laws. Interviews with teachers revealed that students' abilities in problem-solving remain low, particularly

concerning Newton's Laws. Teachers expressed the need for engaging and innovative educational media capable of fostering a more enjoyable classroom environment, capturing students' attention, and increasing their motivation to learn. This observation is further supported by 70.6% of students who "strongly agree" that learning media facilitates understanding, and 82.4% who "strongly agree" that online learning media makes lessons more engaging. Expert evaluations of the New Todame media confirmed its suitability for use, with a V score of 0.81 in the software aspect and 0.84 in the visual aspect. Additionally, all test instruments were found to be valid and reliable, categorized as "very high." Therefore, it can be concluded that the New Todame media is appropriate for educational implementation.

The New Todame media was also implemented in the classroom, resulting in a notable improvement in students' problem-solving skills, with an N-Gain score of 0.455, placing it in the "moderate" category based on pretest and posttest results. Consequently, user satisfaction with the New Todame media was exceptionally high, with 43% of students reporting that they were "very satisfied," and 28% indicating that they were "satisfied." Moreover, the quality of the graphics and content was well-received, and 92% of students indicated that they would recommend this media to others.

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