Jurnal Penelitian dan Pengkajian Ilmu Pendidikan: e-Saintika
https://journal-center.litpam.com/index.php/e-Saintika/index

July 2024 Vol. 8, No. 2
e-ISSN: 2615-6881
pp. 198-218

Virulent Attack: Role-Playing Learning Media to Enhance Student's Cognitive Learning Outcomes

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Received: March 2024; Revised: May 2024; Published: July 2024

Abstract

The cognitive learning outcomes of 10th-grade students at SMA Islam Malang regarding the concept of viruses are low. This is due to the perception among students that the virus concept is difficult to grasp, and the learning methods employed tend to be monotonous. Consequently, the aim of this study is to develop and assess the effectiveness of 'Virulent Attack' - a role-playing learning media adapted from the popular game Werewolf - in improving the cognitive learning outcomes of high school students in understanding the virus concept. Following the ADDIE development model, the study involved 29 X-D students from SMA Islam Malang who had no prior knowledge of the virus concept. The validation test was conducted by three experts (one material expert, one media expert, and one biology teacher) using a validation sheet questionnaire. The practicality test was carried out by students during the trial stages, and one educational practitioner provided feedback through a response questionnaire. The effectiveness test was evaluated by comparing students' pretest and posttest scores on cognitive learning outcomes, which were analyzed using the N-Gain score criteria. The findings indicate that 'Virulent Attack' is highly valid (material expert: 100%, media expert: 94.64%, biology teacher: 96.68%), practical (average score: 90.58%), and moderately effective in improving cognitive outcomes (N-Gain score: 0.66, effectiveness: 66.55%). Importantly, the game provided a positive learning experience, increased motivation, and facilitated a deeper conceptual understanding, suggesting its potential application in real-world educational contexts. These findings not only highlight the value of role-playing games in educational settings but also have practical implications for incorporating such media into biology curricula to enhance engagement and understanding.

Keywords: Virulent Attack; Learning Media; Role-playing; Cognitive Learning Outcomes

How to Cite: Zahrah, N. A., Setiawan, D., & Zubaidah, S. (2024). Virulent Attack: Role-Playing Learning Media to Enhance Student's Cognitive Learning Outcomes. Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika, 8(2), 198–218. https://doi.org/10.36312/esaintika.v8i2.1851

https://doi.org/10.36312/esaintika.v8i2.1851

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INTRODUCTION

Cognitive learning outcomes refer to behavioral changes that occur within the cognitive domain. This domain encompasses various levels, including remembering, understanding, applying, analyzing, assessing, and creating (Anderson & Krathwohl, 2001). These outcomes play a significant role in education and learning as they contribute to students' academic achievements. Low cognitive learning outcomes have detrimental effects on students' future career prospects (Saarinen et al., 2019). Furthermore, they hinder students' ability to comprehend, retain, and apply knowledge in real-world contexts (Fooladvand, 2017).

Based on the findings from preliminary studies conducted with students and a biology teacher at SMA Islam Malang, it has been reported that the development of cognitive learning outcomes holds significance for students. This is attributed to the fact that achieving high cognitive learning outcomes, particularly in biology, enables students to enhance their critical thinking skills (Hacisalihoglu et al., 2018), reasoning abilities (Guerra-Carrillo et al., 2017), problem-solving skills, and collaboration skills (Weir et al., 2019). These diverse skills are deemed crucial in preparing students to meet the challenges of the future.

However, the cognitive learning outcomes of students in the field of biology remain relatively low. As a result, there is a need to develop a new learning approach that can better support students in achieving the necessary competencies. This need for improvement is further substantiated by the findings of a preliminary study conducted at SMA Islam Malang, which revealed that students' cognitive learning outcomes in biology, particularly in the concept of viruses for 10th grade students, were still categorized as low. The passing grade set for 10th grade biology is 75, and the test results indicate that a significant number of students have not met this criterion. Out of the six observed classes, only two had a minimum passing grade percentage above 50%. The average percentage of students who scored above the minimum passing score was 63% for class 10 MIPA 1, 24% for class 10 MIPA 2, 42% for class 10 MIPA 3, 24% for class 10 IPS 1, 51% for class 10 IPS 2, and 17% for class 10 IPS 3.

The low cognitive learning outcomes observed among students regarding the concept of viruses suggest that this concept can be classified as difficult. This finding is supported by previous research conducted by Fauzi et al. (2021), Firmanshah et al. (2020), and Hadiprayitno et al. (2019). Specifically, these studies have highlighted that many students encounter challenges when learning about viruses due to misconceptions regarding their classification as either prokaryotic or eukaryotic organisms (Simon et al., 2017). Additionally, students face difficulties in distinguishing the structural characteristics of viruses from those of other living organisms (Firmanshah et al., 2020), as well as in understanding their microscopic structure. Furthermore, it has been noted that the lack of adequate learning resources to facilitate the observation of viruses further hinders students' comprehension of this concept (Khan & Read, 2018).

The preliminary analysis revealed that 66.7% of students encountered significant challenges when learning the virus concept. Building upon the previous paragraph (Firmanshah et al., 2020; Khan & Read, 2018; Simon et al., 2017), it was further found that students struggled with the memorization of the material and displayed a tendency to forget the content easily. Moreover, students attributed their difficulties in understanding virus concepts to the utilization of monotonous and ineffective learning media.

The concept of viruses is considered crucial in the field of biology and should be included in school curricula (Bracko & Simon, 2022; Davies et al., 2017; de Souza et al., 2020; Doornekamp et al., 2017; Hoffer et al., 2022). This is because it has direct relevance to real-world scenarios. By learning about viruses, students will gain an understanding of the significance of vaccinations, become more aware of preventive measures against virus-related diseases, and acquire knowledge to effectively combat current and future pandemics. Conversely, if students have limited cognitive learning

outcomes due to a lack of understanding of this concept, it can have repercussions for both themselves and those around them in terms of efforts to prevent virus-related diseases.

The low cognitive learning outcomes of students at SMA Islam Malang may be attributed to several factors. Firstly, the occurrence of boredom during pre-dismissal learning sessions. According to the analysis conducted in October 2023, lessons held before school dismissal resulted in a lack of interest among students. This is evident from their behavior, which shows indifference towards the subject being taught. Some students are observed playing online games, chatting, and eating during class. Learning interest significantly influences learning outcomes (Riawan et al., 2020). When students lack interest in learning, they encounter difficulties in the learning process. Consequently, they become disengaged with the learning process (Harefa et al., 2023). Secondly, the implementation of monotonous teaching methods. Preliminary studies indicate that students find monotonous learning uninteresting. Continuous exposure to monotonous teaching methods leads to passivity among students (Zaki et al., 2021) and results in boredom and reduced attention towards the lessons presented (Ramadhan et al., 2023). These issues directly contribute to poor learning outcomes among students (Astuti et al., 2021).

In light of the issues arising from suboptimal cognitive learning outcomes among students studying the concept of viruses, efforts were made to identify potential solutions. The initial investigation revealed that students expressed a preference for engaging learning materials. Within this context, game-based learning media emerged as a type of media that students found intriguing. Students reported that the integration of games into the learning process can enhance their overall learning experience by introducing diversity and enjoyment, alleviating boredom, promoting comprehension of the subject matter, adding an extra layer of appeal, and reducing the likelihood of becoming lethargic during learning sessions.

Game-based learning media were chosen as a solution because of the notable influence that educational games have on improving cognitive abilities in individuals skills (Hardy et al., 2019). This choice is substantiated by the capacity of game elements to actively engage students and stimulate their motivation to learn (Alt, 2023). Moreover, studies conducted by Luttikhuizen (2018) and Stokes & Selin (2016) provide additional support for the idea that educational games can effectively immerse students in the learning process, even when dealing with intricate and intricate concepts.

In accordance with Garris et al., (2002), it has been argued that games with engaging features and a repetitive cycle can lead to increased student engagement in the learning process, thereby resulting in more substantial learning outcomes. Drawing on Garris' game model, the game's features are purposefully designed to actively immerse students in the learning experience. Throughout the game cycle, students are provided with motivation, perseverance, and feedback from the game system, ultimately leading to the acquisition of cognitive, affective, and psychomotor learning outcomes.

One intriguing type of game-based learning media is Werewolf, also known as the Mafia game. Werewolf is a role-playing activity in which villagers strive to eliminate Werewolf characters before falling prey to their attacks (Thompson, 2015). The game incorporates characters such as Werewolf, Villager, Doctor, and Seer. This

role-playing approach has been utilized as an instructional tool in diverse academic disciplines, including social studies (Zare et al., 2023; Wang et al., 2018) and language learning (Norhaidi et al., 2019).

The utilization of role-playing in a multitude of disciplines has demonstrated promising outcomes, specifically with regards to student involvement and enhanced learning achievements (Barrera et al., 2021; Yang et al., 2023; Zhong, 2022a). Students' perspectives following the implementation of role-playing in educational settings indicated favorable reactions, aligned with the findings of Lu & Lien (2020), which suggested that role-playing facilitates students' acquisition of new knowledge.

In order to align the game mechanism with the context of learning biology concepts related to viruses, several modifications were implemented. These modifications encompassed the adjustment of names, characters, and game mechanics themselves. Specifically, the original game title "Werewolf" was altered to "Virulent Attack," a name that directly alludes to the notion of viruses assaulting humans and is better suited for effectively conveying the desired concept to students. Furthermore, the primary character was transformed from a Werewolf to a character named "Virulent," and a new game mechanic was introduced in the form of an additional session where players are required to answer questions pertaining to virus concepts.

The use of role-playing as a learning medium has been explored by various researchers in multiple domains. However, there is currently a limited number of studies that investigate the correlation between role-playing and the development of cognitive learning outcomes among students, particularly in the context of the virus concept in biology. Therefore, the aim of this study is to develop a valid, practical, and effective role-playing learning medium called "Virulent Attack" to enhance the cognitive learning outcomes of 10th grade high school students on the virus concept. It is important to note that this research does not propose replacing main textbooks with role-playing learning media. Rather, it aims to provide new insights and approaches to teaching in order to address the gaps that exist in biology education, specifically in relation to the virus concept. In light of this, the research will focus on two key questions:

1. What are the outcomes of the Virulent Attack role-playing learning media development?
2. How does the implementation of the Virulent Attack role-playing learning media influence students' cognitive learning outcomes?

METHOD

Research Type

The type of research conducted in this study is Research and Development (R&D) employing the ADDIE development model, as proposed by Branch (2010). The ADDIE model encompasses five distinct stages, namely, Analyze, Design, Develop, Implement, and Evaluate, as illustrated in Figure 1. The decision to utilize the ADDIE model in this study is rooted in its numerous advantages in facilitating the creation of instruction that is both more effective and efficient, while remaining relevant, through an iterative design process (Trust & Pektas, 2018). The subsequent paragraphs provide detailed descriptions of each stage of the ADDIE model.

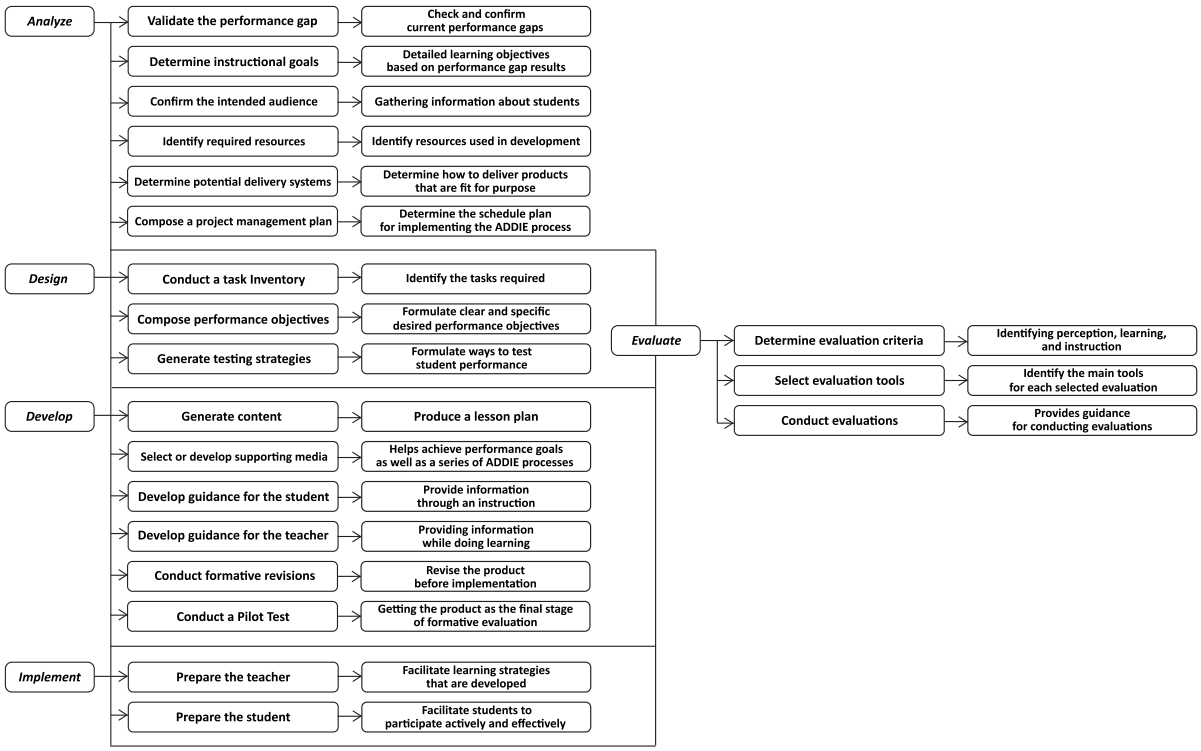

Figure 1. The research methods through ADDIE stages

Analyze

The purpose of this stage is to identify the suitability and necessity for developing learning media. This stage involves collecting data by administering questionnaires to students of XI IPA 2 and conducting interviews with the biology teacher of SMA Islam Malang to determine the requirements and components needed for effective learning media development. The students of XI IPA 2 class were chosen as they are considered representative of all 11th grade students or classes that have covered the virus concept in 10th grade. This stage is also carried out by establishing learning objectives based on the performance gap analysis results and compiling a schedule and plan to execute a series of ADDIE processes. The research schedule details are as follows: all stages of the ADDIE model will be conducted during the 'Asistensi Mengajar' Program. The performance gap analysis activities will be conducted in September 2023, while the implementation stage will be carried out in October 2023.

Design

The objective of the design stage is to generate storyboards for the creation of educational media. This stage includes the organization of the content, layout, and format of the educational media, which is informed by the analysis conducted in the analyze stage. The specifications for media content and learning concepts are developed based on the Merdeka Curriculum in Phase E, as it aligns with the curriculum used at SMA Islam Malang. Through the design stage, teachers can ensure that the content meets the students' requirements and learning goals. The design stage establishes the foundation for the development and implementation of high-quality educational media that enhance the learning process.

Develop

The development stage involves the provision of learning content to help students achieve their learning objectives. In this stage, the previously created storyboard is brought to life using Adobe Photoshop CS6 software. This software was chosen for its suitability and user-friendliness in creating character illustrations. The development stage also includes the testing of the validity and practicality of the learning media that has been created. For the validity test, a validation sheet questionnaire was distributed to one media expert, one material expert, and one biology teacher, all of whom had more than five years of teaching experience. The practicality test involved collecting data on student responses to the developed media through a student response sheet questionnaire. Further details about the trial stages with students can be found in Table 1.

Table 1. Description of the Stages of the Learning Media Trial

Stages	Purpose	Respondent requirements
One-on-one trial	Collect initial feedback and identify and rectify any errors in the created media from participants with varying cognitive abilities.	1. Three students 2. The respondents exhibit a range of cognitive abilities, including low, medium, and high levels 3. Having examined the concept of the virus
Small trial	Determine the efficacy and feedback pertaining to the revised educational media.	1. 8 to 20 students 2. Respondents exhibit a range of cognitive abilities, including low, medium, and high levels 3. The concept of the virus has been considered
Field trial	Assessing the suitability of the developed learning media for implementation.	1. One class (more than 25 students) 2. Respondents exhibit a range of cognitive abilities, including low, medium, and high levels 3. The concept of the virus has been considered
Conduct pilot test	Collect student responses as the concluding phase.	1. One class (more than 25 students) 2. Respondents exhibit a range of cognitive abilities, including low, medium, and high levels 3. Have not yet fully grasped the concept of the virus 4. The participants were excluded from the research sample

In addition to the input provided by students, the involvement of teachers as field practitioners is crucial in the enhancement of the developed media. The ultimate step in the development process is to classify the validation results provided by validators, as well as the practicality results offered by students and teachers, based

on the criteria established by Aka et al. (2018). The criteria for media validity and practicality can be found in Table 2.

Table 2. Criteria for validity or practicality of media

Percentage (%)	Criteria
x = 100	Very valid/practical, can be used without revision
80 ≤ x < 100	Valid/practical, can be used with minor revisions
60 ≤ x < 80	Less valid/practical, moderate revision
40 < x < 60	Not valid/practical, major revision, not recommended for use
20 < x < 40	Not very valid/practical, not used

Adapted from Aka et al., (2018)

Implement

The implementation stage involves the application of the media in an authentic setting, specifically among 29 students from the X-D class in October. The implementation process comprised three meetings. During the first meeting, a pretest on cognitive learning outcomes regarding the virus concept was administered. Subsequently, the learning concept was introduced through student and teacher discussions and presentations. The third meeting consisted of implementing the learning media using the Teams Games Tournament (TGT) model. The selection of the TGT model was based on its proven effectiveness in enhancing student comprehension (Salam et al., 2015; Wyk, 2011), promoting student involvement and accountability, and facilitating social learning and active participation in the classroom (Silva et al., 2021).

The TGT model consists of five stages, namely class presentation, teams or groups, games, tournaments, and team recognition. The class presentation is conducted by the teacher, who explains the procedures for the game. The second stage involves forming teams or groups, in which the teacher divides the students into six groups based on the division made in the previous meeting, in order to provide learning opportunities for the students. The third stage consists of a game, which is facilitated through the use of learning media. The fourth stage is a tournament, where matches are held between two teams, each represented by two students. The final stage involves team recognition, which is carried out by calculating the scores obtained by each team in the game and tournament stages. The learning activities conclude with a posttest to assess the cognitive learning outcomes of the students regarding the concept of viruses. The implementation stage is followed by measuring the effectiveness of the developed media on the students' cognitive learning outcomes.

Evaluate

Data collection for the effectiveness test on cognitive learning outcomes was conducted using pretest and posttest sheets on the concept of viruses administered before and after the application of the learning media. In this study, data analysis techniques employed both quantitative and qualitative descriptive analysis. Qualitative data was gathered from suggestions and comments provided by material experts, media experts, biology teachers, and students. On the other hand, quantitative data was obtained from validation scores, as well as pretest and posttest scores measuring students' cognitive learning outcomes. The score calculation used in

this study is based on a formula adapted from Akbar (2013), which is presented in Equation 1. The variables used in the formula are as follows: v (final score), Tse (total empirical score), and TSh (total expected score).

$$v = \frac{Tse}{Tsh} x\ 100 \quad \text{(I)}$$

Quantitative data were analyzed using IBM SPSS Statistic 23 in order to assess the normality and significance of the data. The normality test for the data was conducted using the Shapiro-Wilk test, as the number of data points in the study was less than 50. The significance test for the data was conducted using either parametric or non-parametric statistical tests, depending on the normality results that were previously tested with the significance criteria of t count < t table (0.05). The criteria indicates that H0 is rejected and H1 is accepted. The hypothesis presented in this study revolves around the notion that the utilization of Virulent Attack role-playing learning media has the potential to enhance the cognitive learning outcomes of 10th grade high school students, particularly in relation to the concept of viruses.

Data on the efficacy of learning media is also analyzed utilizing N-gain criteria. The utilization of N-Gain is warranted as it allows for the assessment of the effectiveness of the developed media by measuring the disparity between students' cognitive learning outcomes scores prior to and subsequent to the implementation of the learning media. Subsequently, the data is classified based on both N-Gain value and efficacy, which are presented in Table 3 and Table 4 (Hake, 1999), respectively.

Table 3. N-Gain score division categories

N-Gain Score	Criteria
$g > 0.70$	High
$0.30 \leq g \leq 0.70$	Medium
$g < 0.30$	Low

Table 4. Categories of N-Gain effectiveness interpretation

Percentage (%)	Criteria
< 40	Ineffective
40 – 55	Less effective
56 – 75	Quite effective
> 76	Effective

Ethical Considerations

This study was carried out in accordance with ethical standards, with permissions obtained from the subject teachers and the principal of SMA Islam Malang. The research was conducted from August to November during the odd semester of the academic year 2023/2024 and included the participation of students from classes X-A, X-D, X-E, XI IPA 1, and XI IPA 2. Prior to conducting the research, all participants gave their consent and willingly agreed to be part of the study. The findings of this investigation are intended solely for academic and educational purposes, while also respecting the rights and interests of the participants and the institutions involved.

RESULTS AND DISCUSSION

Virulent Attack role-playing learning media development and validation results

The final outcome of this development is the Virulent Attack learning media, comprising the main component in the form of game cards. Figure 2(a) depicts a character card assigned to each player. Figure 2(b) represents the virus card, which displays the names of viruses that will be randomly selected by the game guide or Moderator prior to the start of the game. The selected virus card will trigger an outbreak in a village, aligning with the game narrative. Figure 2(c) illustrates the hint card, which is associated with the previously chosen virus card. This card contains information about the virus's characteristics and the traits of individuals affected by the virus attack. Students are expected to provide answers related to the virus name based on the given instructions. Figure 2(d) displays the question card, comprising a variety of questions pertaining to virus concepts, including characteristics, replication cycles, and the positive and negative roles of viruses. The clue card and question card serve as assessment tools. If students provide the correct answers, they will earn a special opportunity to win the game in accordance with the applicable rules.

(a) (b) (c) (d)

Figure 2. Examples of cards, (a) character card; (b) virus card; (c) clue card; (d) question card

To evaluate the validity of the developed learning media, a validation process was conducted with experts including a material expert, a media expert, and a biology teacher. The purpose of this validation was to ensure the alignment of the learning media with the learning objectives and to assess the benefits it provides to students. By involving experts from diverse fields, the strengths and weaknesses of the learning media could be thoroughly evaluated, allowing the developers to make necessary improvements in accordance with the suggestions and comments received.

The first validation was conducted by a materials expert, and the results can be seen in Table 5. The purpose of the validation by the materials expert is to evaluate the accuracy of the content and learning aspects (Niswah et al., 2024). According to the validation results, the validity of the material in the learning media obtained a percentage of 100%, indicating that the content of the material in the developed learning media is very valid and does not require revision. Feedback from the materials expert indicates that the learning media can be used in the learning activity due to its accuracy in terms of material scope, material suitability, and linguistics. The accuracy of information contained in the learning media itself must meet the

standards of accuracy in order to prevent misunderstandings among students when they digest and interpret any provided information (Mawaddah et al., 2019; Munawaroh et al., 2023).

Table 5. Results of validation by material expert

No.	Assessment Aspect	Percentage of Validity (%)	Criteria
1.	Material scope	100.00	Very valid
2.	Material suitability	100.00	Very valid
3.	Linguistics	100.00	Very valid
Average of all aspects		100.00	Very valid

The next stage of validation involves the evaluation of the learning media by an experienced validator in the field of learning media. According to Chrisyarani & Yasa (2018), the purpose of conducting validation by media experts is to assess the level of suitability of the developed product as a learning media. The results of the validation conducted by the media expert on the developed learning media are presented in Table 6. Based on these results, the learning media developed is deemed valid with a percentage of 94.64%. The assessor described the idea used in the Virulent Attack learning media as unique, dynamic, and interesting. Furthermore, the idea has been translated into a product design that is applicable, practical, and aesthetically appealing. The validator suggested improving some of the images in the learning media, specifically the virus cards, in order to enhance the variation of the media. Varied images in the learning media are likely to create a positive first impression and motivate students to read or engage in learning activities (Darnawati et al., 2021). These suggestions and feedback have been incorporated to improve the quality of the learning media and support the learning process. Consistent with Fatmawati (2016), a gradual and continuous development process is necessary to produce high-quality products.

Table 6. Results of validation by media expert

No.	Assessment Aspect	Percentage of Validity (%)	Criteria
1.	View	90.00	Valid
2.	Graphics	100.00	Very valid
3.	Contents	88.57	Valid
4.	Language	100.00	Very Valid
Average of all aspects		94.64	Valid

The final stage of validation was conducted by biology teachers. Table 7 presents the results of the validation conducted by the biology teachers, which indicate a media validity percentage of 96.98%. This percentage suggests that the developed media is valid for use with minor revisions. Generally, feedback from the biology teachers indicates that the learning media is highly effective and innovative, supported by an appealing design display. The biology teachers have recommended adding a storage box to each card to enhance the appearance of the learning media, making it neater and more attractive. It is important to present the learning media in an appealing and improved manner in order to foster students' enthusiasm for independent learning

(Herayanti et al., 2017). The various suggestions and inputs provided by the biology teachers have been incorporated to enhance the learning media, ensuring its effectiveness in influencing students' learning process. Consistent with Efendi et al., (2023), higher quality learning media have a greater impact on students' learning outcomes. Based on evaluations by various experts, the Virulent Attack role-playing learning media has been deemed valid and suitable for implementation in the classroom. In accordance with Wenno et al., (2022) when a learning tool is considered valid and meets high qualifications, it can be used in real classroom settings.

Table 7. Results of validation by biology teacher

No.	Assessment Aspect	Percentage of Validity (%)	Criteria
1.	Appropriateness of the material	96.67	Valid
2.	Readability of questions	94.28	Valid
3.	Suitability in testing research variables	100.00	Very Valid
	Average of all aspects	96.68	Valid

To assess the efficacy of the developed media, a trial phase was conducted to obtain firsthand feedback from both students and teachers who served as users. The trial outcomes, as reported by the students and teachers, are summarized in Table 8. The aspects evaluated based on the feedback encompassed media content, teacher involvement, and student engagement.

Table 8. Media practicality results from student and teacher response questionnaires

No.	Respondent	Percentage of Validity (%)	Criteria
1.	One-to-one Trial	85.64	Practical
2.	Small Trial	85.84	Practical
3.	Field Trial	89.35	Practical
4.	Conduct Pilot Test	95.17	Practical
5.	Teacher respond	96.92	Practical
	Average of all aspects	90.58	Practical

Based on the findings of the response questionnaire, it is evident that the overall average score received by both students and teachers in relation to the various aspects measured was positive, amounting to 90.58%. This implies that the developed media is practical and can be effectively implemented for educational purposes. This finding aligns with the research conducted by Fitriani & Indriaturrahmi (2020), which states that once a product development has been deemed suitable based on multiple trial stages, it can be utilized as a valuable learning resource in real classroom settings. In order to evaluate the enhancement of students' cognitive learning outcomes, a normality test was initially conducted on the pretest and posttest scores, employing the Shapiro-Wilk test. The outcomes of the Shapiro-Wilk test are presented in Table 9.

Based on the outcomes of the Shapiro-Wilk normality test presented in Table 9, it can be deduced that the data pertaining to students' cognitive learning outcomes before and after the pretest are not distributed normally. Consequently, non-

parametric inferential statistics, specifically the Wilcoxon Test, were employed as shown in Tables 10 and 11.

Table 9. Shapiro-Wilk normality test results

	Test type	Shapiro-Wilk		
		Statistic	df	Sig.
Cognitive learning outcomes	Pretest	0.845	29	0.001
	Posttest	0.880	29	0.003

In Table 10, the results revealed that none of the students exhibited a decrease in scores from the posttest to the pretest (as indicated by the absence of negative ranks, which equated to 0). Conversely, all participants observed an increase in scores from the pretest to the posttest, with an average rise of 15.00 (as indicated by the presence of positive ranks). As a result, no students attained the same scores on both the pretest and posttest, which is consistent with the Ties indicator displaying a value of 0.

Table 10. Result of Wilcoxon Signed-Rank Test

		N	Mean Ranks	Sum of Ranks
Pretest and posttest students' cognitive learning outcomes	Negative Ranks	0	0.00	0.00
	Positive Ranks	29	15.00	435.00
	Ties	0		
	Total	29		

Table 11 demonstrates a notable disparity in the pretest and posttest scores pertaining to students' cognitive learning outcomes concerning the virus concept. The statistical analysis reveals a significance level of 0.000 for both tests, indicating a rejection of the null hypothesis (H0) and acceptance of the alternative hypothesis (H1). Consequently, this suggests a substantial distinction in the average scores observed between the pretest and posttest of students' cognitive learning outcomes. Thus, the implementation of role-play-based learning media exhibits the potential to enhance students' comprehension of the virus concept.

Table 11. Result of Wilcoxon Signed Test

	Pretest and posttest students' cognitive learning outcomes
Z	-4.704
Asymp. Sig. (2-tailed)	0.000

Based on the analysis, it is evident that students have made significant progress in their understanding of the concept of the virus. This finding aligns with the outcomes observed in other studies that utilized role-play-based learning materials, which generally yielded satisfactory learning outcomes (Bring & Lyon, 2019; Chen & Wu, 2023; Kluver et al., 2018; Wang, 2020; Zhong, 2022b).

To determine the effectiveness of the developed learning materials in enhancing students' cognitive learning outcomes regarding the virus concept, an analysis was conducted using the N-Gain score guidelines. Based on the N-Gain test results presented in Table 12, the average N-Gain score obtained was 0.66, which falls within the medium category. The average percentage of N-Gain, which serves as a measure

of the effectiveness of the designed learning materials, reached 66.55%. This proportion meets the criteria for being quite effective, indicating that the Virulent Attack role-playing learning materials have been proven to be quite effective in improving students' cognitive learning outcomes in relation to the virus concept.

Table 12. N-Gain calculation of students' cognitive learning outcomes

	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain score	29	0.33	0.89	0.66	0.17
N-Gain (%)	29	32.93	89.47	66.55	17.22
Valid N (listwise)	29				

In relation to the students as users, a selection of student representatives were included in the interview to articulate their learning experience following the utilization of the Virulent Attack role-playing learning medium. The following quotations from the students provide insights into their respective experiences, with the codes "B" denoting male students and "G" denoting female students.

> *G1: I finally learned about the explanation of the vaccine concept because these learning media helped me to understand the concept more easily.*
>
> *B1: Not only the character cards with special abilities or the delivery of fun learning media, the question cards in this game have questions that are weighty enough to be able to facilitate understanding of the concept presented which in turn is able to encourage myself to always find out what the right answer is to the question.*
>
> *B2: I can understand the concept thoroughly starting from the types of viruses, the impacts caused by different types of viruses, the forms of viruses and many more.*

Findings derived from interviews conducted with students G1 and B2 indicate that their participation in the Virulent Attack role-playing game has enhanced their comprehension of learning concepts. The mechanism employed in the Virulent Attack role-playing learning media, which entails peer discussions, has the potential to enhance students' comprehension due to the fact that engaging in discussion activities necessitates the exchange of viewpoints from diverse individuals, thereby training students to identify solutions that they perceive as optimal and aligned with the objectives at hand. This finding aligns with the research conducted by Emerson et al., (2023), which demonstrated that role play can foster the development of problem-solving strategies in students. Additionally, student B1 reported feeling actively engaged in answering questions in order to secure victory in the game, as depicted in Figure 3. This can be attributed to the ability of role-playing activities to stimulate active interaction and collaboration among students, thereby rendering the learning process more active (Lu & Chang, 2016) and student-centered (Coleman & Money, 2020; Wang et al., 2018), consequently enhancing their motivation to learn (Zourmpakis et al., 2023b).

Figure 3. Students' participation to answer the question cards in the game

Students' perspectives on Virulent Attack role-playing learning media

Finally, interviews were conducted with students to elicit their perceptions and lived experiences during their engagement with the Virulent Attack role-playing learning media. The findings from these interviews are presented in the subsequent summary.

> *G1: This lesson was my first experience in using role play. I also felt more interested when applying these learning media.*
>
> *B2: I find the learning media very helpful for me in learning because the mechanics in the game provide a new learning experience while playing for me.*
>
> *B3: I had a very enjoyable learning experience because I did not feel bored in learning. Even some of my friends who are quite lazy enjoy learning when applying these learning media.*

Student B2 stated that the game mechanics provided a valuable learning experience as it aided in their comprehension of the presented concept. In-game mechanics are a crucial aspect of gamification applications. As Tsai et al., (2020) assert, the mechanisms within a game have the potential to impact students' experiences and learning outcomes. This is due to the fact that the use of well-structured game mechanics can enhance students' concentration and enjoyment (Wang et al., 2016). Thus, a thorough understanding of game mechanics can greatly contribute to students' learning processes. Conversely, students G1 and B3 expressed that the Virulent Attack role-playing learning media provided an unforgettable learning experience. Games, by their very nature, can offer an enjoyable learning environment, fostering increased engagement and motivation (Pesare et al., 2016). Students G1 and B3 found this experience more favorable compared to traditional learning methods. In conclusion, the Virulent Attack role-playing learning media not only delivers an enjoyable learning experience but also enhances students' overall motivation to learn and facilitates a deeper understanding of the concept for real-world application.

Based on the presented research findings, it is crucial to emphasize that the development of game-based learning media requires teachers to have an understanding of individual students' needs, provide appropriate learning materials, and consistently evaluate the entire learning process (Zourmpakis et al., 2022). As

pointed out by Jääskä & Aaltonen (2022), teachers play a significant role in game-based learning as it enhances student engagement. Moreover, if teachers fail to facilitate the integration of games into learning, students may not achieve the intended outcomes (Zourmpakis et al., 2023a). Therefore, the creation of learning media integrated with games must be tailored to the learning context, encompassing pedagogical and psychological aspects, learning strategies, and student characteristics to foster knowledge acquisition.

When considering the limitations of this study, it is imperative to emphasize a number of crucial factors. Firstly, it is essential to recognize that the materials utilized in these learning media exclusively focus on the concept of viruses in biology. Consequently, the generalizability of the findings is inherently limited to other fields of study beyond virology. Secondly, the pedagogical approach employed to implement this learning resource is specifically centered on the utilization of the TGT learning model. Furthermore, the practical application of the learning media is restricted to a single group consisting of 29 students.

CONCLUSION

The Virulent Attack role-playing learning media developed has been found to be highly valid (material expert: 100%, media expert: 94.64%, biology teacher: 96.68%), practical (average score: 90.58%), and effective in improving students' cognitive learning outcomes (N-Gain score: 0.66, effectiveness: 66.55%). Students responded positively to their learning experience while using these role-playing learning media, reporting increased understanding and motivation to learn. Therefore, these games have the potential to support biology learning and serve as new learning media. Based on these findings, it is recommended that biology teachers in schools incorporate role-playing games to provide a positive and enjoyable learning experience for students.

The validation process carried out in this study was comprehensive, following the stages outlined in the ADDIE model. Particularly in the practicality testing stage of the learning media, we conducted three trials and one pilot test, involving one biology teacher to gather feedback on the practicality of the media from the perspective of students and teachers as users. However, despite these advantages, this research does have certain limitations, such as the specific topics covered in biology, the scope of the research, and the sample size used.

RECOMMENDATION

Virulent Attack role-playing learning media can be utilized to enhance students' cognitive learning outcomes in biology, particularly in the concept of viruses. In order to assess the effectiveness of these developed media in a more comprehensive learning context, we propose several recommendations that can be implemented by teachers, developers, or further researchers. Firstly, teachers can incorporate these role-playing activities into classes of varying sizes or with more diverse subjects. This approach will enable students to develop a deeper understanding, thereby facilitating their active participation in class and enhancing their motivation to learn in an optimal educational environment. Secondly, teachers can employ these role-playing activities across different student abilities, educational contexts, and other disciplines to evaluate its effectiveness from various perspectives. Thirdly, it is advisable to create similar role-playing learning media that focus on different learning concepts, ensuring

the accuracy of the content developed. This will help determine the applicability of such games in other fields of study. Lastly, it is crucial to investigate the long-term effects of game-based learning media on students' retention of complex biology concepts. Additionally, it is worthwhile to explore the role of teachers in facilitating the effectiveness of game-based learning, particularly in the context of role-playing games.

Author Contributions
All authors have sufficiently contributed to the study and agreed with the results and conclusions.

Funding Information
This research has been supported by the LPPM (Research and Community Service Institute) of State University of Malang, under Decree Number 5.4.1/UN32/KP/2023.

Acknowledgment
Thank you to the Principal of SMA Islam Malang, the biology teachers, friends of the 'Asistensi Mengajar' Program, and the students in classes X-A, X-D, X-E, XI IPA 1, and XI IPA 2 who have actively contributed to this research.

Conflict of Interests
The researchers declare no conflict of interests.

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