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INTERACTIVE INNOVATION OF EDUGAME-BASED INTERACTIVE LEARNING MEDIA TO IMPROVE SCIENCE LEARNING OUTCOMES OF GRADE VI ELEMENTARY SCHOOL STUDENTS

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Abstrak

Rendahnya motivasi dan hasil belajar yang disebabkan oleh metode pembelajaran yang monoton menyebabkan Pendidikan masa kini menjadi sangat krusial. Penelitian ini bertujuan untuk mengatasi rendahnya motivasi dan hasil belajar siswa dalam pembelajaran IPA di kelas VI SD dengan mengembangkan media pembelajaran interaktif berbasis *Edugame*. Permasalahan yang diangkat dalam penelitian ini adalah kurangnya inovasi dalam media pembelajaran yang mampu meningkatkan motivasi serta hasil belajar siswa. Penelitian ini menggunakan model pengembangan ADDIE yang terdiri dari tahap analisis, desain, pengembangan, implementasi, dan evaluasi. Instrumen penelitian meliputi angket validasi ahli, angket kepraktisan guru, serta tes pretest dan posttest untuk mengukur efektivitas media pembelajaran. Hasil validasi media dengan formula Gregory menunjukkan tingkat kevalidan sebesar 90%, yang dikategorikan sangat tinggi. Validitas ini diperoleh berdasarkan penilaian ahli materi dan ahli media yang menilai bahwa *Edugame* telah memenuhi standar pedagogik, memiliki konten yang sesuai dengan kurikulum, serta didukung dengan elemen *visual* dan animasi yang menarik. Kepraktisan media dinyatakan sangat tinggi dengan skor 96%, yang menunjukkan bahwa media ini mudah digunakan oleh guru dan menarik bagi siswa. Kepraktisan ini didukung oleh tampilan antarmuka yang intuitif, fitur interaktif seperti soal pilihan ganda, aktivitas drag-and-drop, dan simulasi yang membuat pembelajaran lebih dinamis. Dari segi efektivitas, hasil uji menunjukkan peningkatan hasil belajar siswa secara signifikan. Rata-rata skor pretest yang awalnya 65,45 meningkat menjadi 88,73 pada posttest. Analisis N-Gain menunjukkan peningkatan pemahaman siswa dalam kategori tinggi, yang membuktikan bahwa media ini efektif dalam meningkatkan pemahaman konsep IPA. Dengan demikian, pengembangan media pembelajaran interaktif berbasis *Edugame* terbukti valid, praktis, dan efektif dalam meningkatkan motivasi serta hasil belajar siswa pada pembelajaran IPA.

Kata kunci: *Edugame*, pembelajaran interaktif, IPA, motivasi belajar, sekolah dasar

Abstract

Low motivation and learning outcomes caused by monotonous learning methods cause today's education to be very crucial. This research aims to overcome the low motivation and learning outcomes of students in science learning in grade VI of elementary school by developing Edugame-based interactive learning media. The problem raised in this study is the lack of innovation in learning media that is able to increase student motivation and learning outcomes. This research uses the ADDIE development model which consists of the stages of analysis, design, development, implementation, and evaluation. The research instruments include expert validation questionnaires, teacher practicality questionnaires, and pretest and posttest tests to measure the effectiveness of learning media. The results of media validation with the Gregory formula show a validity rate of 90%, which is categorized as very high. This validity is obtained based on the assessment of material experts and media experts

who assess that Edugame has met pedagogic standards, has content that is in accordance with the curriculum, and is supported by attractive visual and animated elements. The practicality of the media was stated to be very high with a score of 96%, which shows that this media is easy for teachers to use and attractive to students. This practicality is supported by an intuitive interface, interactive features such as multiple-choice questions, drag-and-drop activities, and simulations that make learning more dynamic. In terms of effectiveness, the test results showed a significant increase in student learning outcomes. The average pretest score, which was initially 65.45, increased to 88.73 in the posttest. The N-Gain analysis showed an increase in students' understanding in the high category, which proves that this medium is effective in improving the understanding of science concepts. Thus, the development of Edugame-based interactive learning media has proven to be valid, practical, and effective in increasing student motivation and learning outcomes in science learning

Keywords: *Edugame, interactive learning, science, learning motivation, elementary school*

INTRODUCTION

Education in Indonesia has undergone various transformations in line with the demands of the times and global developments. One of the significant changes that is being implemented is the Independent Curriculum. This curriculum is designed to develop students' potential holistically, covering academic and non-academic aspects, as well as forming a profile of Pancasila students who have faith, fear God Almighty, noble character, global diversity, mutual cooperation, independence, critical reasoning, and creativity. The Merdeka Curriculum emphasizes the importance of more flexible and student-centered learning, with the hope of encouraging students to think critically, innovatively, and have personalities that are in line with the values of Pancasila. With this approach, education in Indonesia is expected to produce a generation that is ready to face global challenges and be able to contribute positively to society(Ahmad et al., 2021; Indriani et al., 2023; Rantina et al., 2023).

The quality of education in Indonesia is often measured through various international evaluations such as *the Programme for International Student Assessment* (PISA) and the Trends in *International Mathematics and Science Study* (TIMSS). PISA and TIMSS measurements are used as benchmarks to assess the extent to which Indonesian students have a strong understanding, especially in the field of Natural Sciences (IPA), compared to other countries. The results of the PISA and TIMSS evaluations show that the performance of Indonesian students in the field of Natural Sciences (IPA) is still below average compared to other countries. In 2018, the average score of Indonesian students in PISA for science was 396, which placed Indonesia in 70th place out of 78 participating countries (Agung et al., 2022; Widiyono et al., 2021) Similarly, in TIMSS 2019, Indonesian grade VI students got an average score of 397 for science, placing Indonesia in 49th place out of 58 countries. Data from the 2019 Computer-Based National Examination (UNBK) also showed unsatisfactory results, with the average science score of elementary school students only reaching 55.37. This low learning outcome indicates an urgent need for innovation in more effective and attractive learning methods, in order to improve the quality of students' understanding of science materials and improve Indonesia's education ranking in the international arena (Fatra et al., 2022; Lestari & Annizar, 2020; Ma & Qin, 2021; Widiyono & Millati, 2021)

The reality that happened in the field actually shows the opposite condition. Based on the results of observations and interviews that have been conducted at SD Gugus I Blahbatuh, Gianyar is still lacking in student motivation to learn so that students feel bored during science learning. So far, science learning in elementary schools in Indonesia tends to be dominated by conventional methods such as lectures and the use of textbooks. This method is often less able to attract students' interest and is not optimal in developing their critical thinking skills and creativity (Nurika et al., 2022; Rosyana et al., 2021; Sinta et al., 2022). Some of the problems faced in science learning include lack of student involvement in the learning process, monotonous use of learning media, and limited facilities that support interactive learning. In addition, many teachers are still limited in the use of digital technology for learning (Nurika et al., 2022; Rosyana et al., 2021). As a result, students often feel bored and lack motivation to learn, which has an impact on the science learning outcomes of grade VI students who are still

relatively low. This is evidenced by the percentage of achievement of the Learning Goal Achievement Criteria (KKTP), where more students do not achieve KKTP than students who achieve KKTP in science learning. Therefore, innovative solutions are needed that can overcome these problems and increase the effectiveness of science learning (Ricardus Jundu, 2020; Zulfa et al., 2023).

Edugame-based *interactive learning media* is a media that combines the concept of educational games with learning materials. *Edugame* is designed to make the learning process more engaging and enjoyable, so that students can be more actively involved in learning. This media uses digital technology to present subject matter in an interactive and easy-to-understand form for students (Setyawan & Panduwinata, 2023; Yeni Widiawati et al., 2022). In *Edugame*, students can learn through a variety of activities such as simulations, games, and quizzes designed to strengthen their understanding of science concepts. *Edugame* also allows students to learn in a more independent way and according to their respective learning pace, so that it can increase their motivation and interest in learning (Antriyanti, 2017; Mustafa, 2022; Palumpun et al., 2022)

In an effort to improve the quality and effectiveness of learning in elementary schools, especially in Natural Sciences (IPA) subjects, learning media plays a key role. Learning media is a tool or material used by educators to convey subject matter, so that it can make it easier for students to understand, process, and apply the concepts taught. Learning media must meet several conditions to be effective, including relevance to the subject matter, ease of use, high interactivity, and the ability to motivate and increase student involvement (Anggraeni et al., 2021; Rahma & Ernawati, 2024; Rahmat & Irfan, 2019).

Learning media must be able to present information in an interesting and easy-to-understand manner, allow interaction between students and the material presented, and encourage creativity and critical thinking(Aprilia, 2021; Eka et al., 2022; Novitasari & Laili, 2023) In addition, learning media must also be flexible and accessible to all students, ensuring equality in the learning process. The use of technology in learning media, such as multimedia and the internet, has shown a significant increase in attracting students' interest and motivation to learn. However, the availability of facilities and teacher training in the use of technology is still a challenge (Purnamasari, 2020; Setyaputri & Utaminingsih, 2022).

In this context, the use of Edugame-based interactive learning media offers new opportunities to address some of the problems identified in SD Gugus I Blahbatuh, Gianyar. *Edugame*, which combines game concepts with educational materials, can be a very effective tool in increasing students' motivation and engagement in learning science. With the element of games, *Edugame* is able to increase students' motivation to learn by presenting material in an interesting and fun form, encouraging students to be more active and enthusiastic in learning. In addition, *Edugame* helps students understand science concepts in depth through direct interaction and simulation, visualizing abstract concepts so that they are easier to understand. *Edugame* also develops students' critical and creative thinking skills through challenges and games, in accordance with the goals of the Independent Curriculum to form a profile of Pancasila students who reason critically and creatively. With more individualized learning, *Edugame* allows students to learn at their pace and learning style, providing hands-on feedback that helps students and teachers monitor learning progress. Thus, *Edugame* not only overcomes problems in science learning but also meets the expectations of the Independent Curriculum, improving the quality of education and science learning outcomes of grade VI elementary school students in Indonesia (Arifin et al., 2021; Setyawan & Panduwinata, 2023)

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The development model used in this study is the ADDIE model, which was developed by Reiser and Mollenda in the 1990s. This model was chosen because it has a systematic, interactive, and flexible nature, allowing for a revision process at each stage of its development so that the resulting product is more valid, practical, and effective. The ADDIE model consists of five main stages, namely *Analysis*, *Design*, *Development*, *Implementation*, and *Evaluation*. At the analysis stage, identification of student characteristics, learning characteristics, learning resources, and functional and non-functional media needs was carried out. The results of the analysis show that students often feel bored with monotonous conventional learning methods, so interactive and fun media such as *Edugame* is needed. The design stage is then focused on creating a design for the appearance and flow of learning media by paying attention to ease of use (user friendly), visual attractiveness, and suitability with science learning outcomes. At this stage, *a flowchart*, software architecture, and user interface were designed using design tools such as *Unity 3D, Vuforia,* and *Blender*.

Furthermore, at the development stage, the design results were implemented into the initial Android-based *interactive Edugame* product. The development process includes 3D object modeling, animation, *marker* creation, interactive quiz integration, and application functionality testing through *blackbox* and *whitebox tests*. This stage also includes a validation test conducted by two content experts from the Basic Education Study Program of Ganesha Education University and a practicality test by five science teachers at SD Gugus I Blahbatuh. After being declared valid and practical, the next stage is implementation, which is the application of media in the classroom to measure the effectiveness of its use in improving student learning outcomes. The trial was carried out at SD Negeri 2 Blahbatuh by involving 31 grade VI students using *a pretest-posttest one group design*.

The last stage is evaluation, where a thorough assessment of the results of the validity, practicality, and effectiveness test of the media is carried out. This evaluation is formative and summative, carried out at each stage to ensure that the media developed is in accordance with the learning objectives and needs of the user.

METHOD

Formative evaluation is carried out through expert assessment and teacher feedback, while summative evaluation is carried out through analysis of student learning outcomes and user responses.The subjects of this study consisted of three main groups, namely (1) content experts who assessed the validity of *Edugame content*, (2) teachers who assessed the practicality aspects of media in learning, and (3) grade VI students of SD Negeri 2 and SD Negeri 3 Blahbatuh as users for effectiveness tests. Data collection techniques are carried out through interviews, questionnaires, and written tests. Interviews were used to explore information related to student characteristics and learning conditions, while questionnaires were used to measure the validity of the content, practicality, and response of teachers and students to the developed media. Written tests in the form of *pretest* and *posttest* are used to measure the improvement of student learning outcomes after using *Edugame*.

The data analysis in this study uses qualitative and quantitative approaches. Qualitative data was obtained from observations, interviews, and expert advice, while quantitative data was obtained from questionnaires and test results. The validity of the content was calculated using the Gregory formula, with the categories of high ($V > 0.8$), medium ($0.4 \leq V \leq 0.8$), and low ($V < 0.4$). The practicality test was analyzed using the average validator response score based on the conversion of the Likert scale (Widoyoko, 2019), with the categories of excellent, good, adequate, lack, and very lacking. The effectiveness of the media was measured by the N-Gain formula to determine the improvement of student learning outcomes from pretest to posttest, with the categories of high ($g \geq 0.7$), medium ($0.3 < g \leq 0.7$), and low ($g \leq 0.3$)(Menegol, Ribeiro, de Paula, et al., 2022; Menegol, Ribeiro, Paula, et al., 2022) In addition, the response of teachers and students to the use of *Edugame* was analyzed using the class average formula ($\bar{X}$) with the classification of criteria of very positive, positive, hesitant, negative, and very negative criteria based on the calculation of *the ideal Mean (Mi)* and *the ideal Standard Deviation (SDi).* The grid of the test instrument can be seen in Table 1.

Table 1. Test Instrument Grid

Learning Outcomes	Indicator	Indicators of Understanding and Question Number							Sum
		A	B	C	D	And	F	G	
Simulation of the human organ system	Explains the functions of the respiratory, digestive, circulatory systems	1			2	3		4	4
	Demonstrate how to maintain healthy organ systems	5			6		7		3
Biotic-abiotic relationships affect ecosystems	Investigating the influence of biotic components on abiotics in ecosystems		8	9		10			3
	Explain the dependencies between ecosystem components			11			12	13	3
Application of the concept of waves in life	Demonstrate the application of sound and light waves	14				15			2
	Describe the threat of the energy crisis		16			17			2
Efforts to save energy	Propose an energy-saving strategy			18		19		20	3
	Finding alternative energy sources		21			22		23	3
Solar system and earth motion	Demonstrate the solar system and the motion of the earth	24				25			2
	Reflecting on the influence of the earth's motion on natural conditions		26			29	27		3
The impact of human actions on the environment	Identify lifestyles that have an environmental impact							30	1
	Predicting the impact of human actions on social and economic		28						1

Learning Outcomes	Indicator	Indicators of Understanding and Question Number							Sum
		A	B	C	D	And	F	G	
Sum		4	5	3	2	8	3	5	30

Information:
A : *interpreting*
B : *exemplifying*
C : classifying
D *:* summarizing
E : menduga (*inferring*)
F : comparing
G : explaining

RESULTS AND DISCUSSION

Result

The results of this study describe the process of developing Edugame-based interactive learning media which is carried out using the ADDIE model, including the stages of analysis, design, development, implementation, and evaluation. The analysis stage began with the identification of the characteristics of students at SD Gugus I Blahbatuh, which showed that students often felt bored during science learning because the teaching methods were still conventional and there was minimal media variation. Abstract material makes it difficult for students to understand concepts concretely. Through the results of observation, interviews, and questionnaire distribution, it was found that students were more interested in learning that used animated and interactive visualization. The teacher also stated the need for learning media that is interesting, easy to use, and able to relate the concept of science to real life. In addition, the school supports the use of technology in the learning process, so that the development of *Edugame-based* media is considered relevant and needed.

The design stage is then focused on designing media by prioritizing interactivity, content suitability, and attractive appearance. The software used includes *Wordwall*, *Canva*, and *Microsoft PowerPoint*, while the hardware uses laptops or PCs with adequate specifications. The media design is developed with a game structure consisting of several levels according to the science learning theme, such as the water cycle, food chain, and energy. Each level contains animations, interactive illustrations, narration, and quizzes based on *Higher Order Thinking Skills* (HOTS) to reinforce student understanding. Assessment instruments in the form of expert validation questionnaires and practicality tests are also prepared to assess the quality of content, interactivity, and ease of use of media. The results of the product design can be seen in Figure 1.

Figure 1. Learning Media Product Results

Furthermore, the development stage focuses on the production and refinement of the media. The creation process is carried out by compiling interactive questions on *Wordwall*, adding animation elements, sound effects, and simple navigation to make it user-friendly for elementary school students. The resulting products are then tested using *the blackbox* and *whitebox methods* to ensure that the media functions are running properly. After that, a validity test was carried out by material experts and media experts using *the Learning Object Review Instrument (LORI) instrument*. The validation results showed that the media obtained a validity score of 90% (very high category), with suggestions for improvement such as the addition of HOTS-based assessments, reflection spaces, enlarged font sizes, and the addition of learning videos. All of these inputs have been implemented in the product revision before the implementation stage is carried out.

The results of the effectiveness test of Edugame-Based Interactive Learning Media were carried out to determine the influence of media use on the science learning outcomes of grade VI students. The research was carried out at SD Gugus I Blahbatuh with a pre-post test only group design involving a total of 31 students. Before using the media, students are given a *pretest* to measure their initial knowledge regarding the science material to be studied. After learning using Edugame-based interactive media, students were again given a final test *(posttest)* to find out the extent of the improvement in learning outcomes.

The results of the study showed that the use of Edugame-Based Interactive Learning Media significantly improved the learning outcomes of grade VI students in science subjects. Further analysis through normalized gain calculations showed that the score increase was in the high category, which confirms that this medium is effective in helping students achieve preset learning goals. The results of the Descriptive Analysis can be seen in Table 2.

Table 2. Descriptive Analysis Results

	N	Mean	Hours of deviation	Minimum	Maximum
Pre-Test Experiment	30	51,66	8,35	37,00	70,00
Post Test Experiment	30	73,53	8,27	60,00	90,00
For the control test.	31	50,32	6,36	40,00	67,00
Post Test Control	31	58,64	9,41	37,00	77,00
Total	122	58,47	12,24	37,00	90,00

In addition, the students' response to this learning media is also very positive. Based on the qualitative data obtained through the questionnaire, students feel that this interactive media is very interesting and makes it easier for them to understand science concepts that are sometimes difficult to understand through conventional learning methods. *This Edugame media* is also able to create a fun and interactive learning atmosphere, thereby increasing student involvement during the learning process. The research was continued at the stage of testing the normality of the distribution of effectiveness test data. The results of the normality test of the distribution of effectiveness test data in the study can be seen in Table 3.

Table 3. Normality Test Results

		Kolmogorov-Smirnova			Shapiro-Wilk		
	Class	Statistic	df	Itself.	Statistic	df	Itself.
Value	Pre-Test Experiment	0,146	30	0,104	0,962	30	0,341
	Post Test Experiment	0,104	30	0,200*	0,957	30	0,263
	For the control test.	0,143	31	0,104	0,951	31	0,163
	Post Test Control	0,108	31	0,200*	0,980	31	0,801

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the results of the normality test analysis using the *IBM SPSS Statistics 21.0 for Windows program* in Table 4.10, the significance value (*Kolmogorov-Smirnov*) of the pretest and post test data. Based on these results, it can be seen that the Sig. value is > 0.05 for all data groups. So it can be concluded that the two data groups are normally distributed.

After the data is noormal, the study proceeds to the homogeneity test stage. The results of the homogeneity test can be seen in Table 4.

Table 4. Homogeneity Test Results

		Levene Statistic	df1	df2	Itself.
Value	Based on Mean	1,577	3	118	0,199
	Based on Median	1,419	3	118	0,241
	Based on Median and with adjusted df	1,419	3	111,030	0,241
	Based on trimmed mean	1,637	3	118	0,185

The results of the homogeneity test of the variance of the effectiveness test data in this study using the help *of the IBM SPSS Statistics 21.0 for Windows* program, showed that the significance value (*Based on Mean*) was 0.331 Based on these results, it can be seen that the value of Sig. > 0.05. So it can be concluded that the variance of the data is homogeneous. All analysis criteria related to the analysis of *the Paired Sample T-Test*/ Correlated Sample t-Test have been met, so that the *analysis of the Paired Sample T-Test* / Correlated Sample t-Test can be used to test the hypothesis of this study. The results of hypothesis testing in this study using *the Paired Sample T-Test*. Based on the results of the *Paired Sample T-Test*/Sample t-test, it can be seen in Table 5.

Table 5. Hypothesis Test Results

	Paired Differences							
				95% Confidence Interval				
	Mean	Hours deviation	ofStd. Mean	Error of the Difference Lower	Upper	t	df	Sig. (2-tailed)
Pair 1 Grades - Classes	55,95	12,32	1,11	53,75	58,16	50,16	121	<0.001

Correlated with the help of *the IBM SPSS Statistics 21.0 for Windows program*, a significance value (Sig. 2-tailed) of 0.000 was obtained. Based on these results, it can be seen that the value of Sig. < 0.05. So it can be concluded that H0 is rejected and Ha is accepted. In other words, there are significant differences in learning outcomes. Based on these findings, it can be concluded that Edugame-Based Interactive Learning Media is effective in improving student learning outcomes and providing a better learning experience. Therefore, this medium deserves to be applied more widely in various elementary schools as an innovative learning alternative that is relevant to the needs of current students.

Discussion

Edugame-Based *Interactive Learning Media* is able to maximally improve the science learning outcomes of grade VI elementary school students because it presents a holistic, contextual, and fun learning approach. In the context of learning science in elementary school, students are at a stage of concrete operational development according to Piaget, where they need hands-on experience and real visualization to understand abstract scientific concepts. So far, science learning that is still conventional tends to be only centered on lectures and memorization, so that students find it difficult to relate theory to the phenomena of daily life. *Edugame*'s presence bridges this gap by providing visual-based, interactive, and applicative learning experiences. Through educational games, students can actively observe, try, and repeat science concepts in a safe and engaging digital learning environment (Setyawan & Panduwinata, 2023; Yeni Widiawati et al., 2022).

Edugame effectively improves learning outcomes because it utilizes the principles of cognitive theory of multimedia learning put forward by Mayer. This theory explains that learning becomes more meaningful when students receive information through various sensory channels, such as visual and auditory. In *Edugame*, science material is presented through a combination of text, images, animations, and sounds that complement each other, thus helping

students build strong mental representations. For example, in the topic of the circulatory system, the animation of blood flow or heart movement makes it possible for students to visualize biological processes that are difficult to explain verbally. Thus, *Edugame* reduces cognitive overload because information is not only transferred verbally, but also visually and kinesthetically. The use of quizzes and interactive simulations in *Edugame* also strengthens long-term memory because students learn by "*learning by doing*", not just listening to the teacher's explanation(Andini & Agung, 2022; Anggreni et al., 2021; Nur Jannah, 2020).

In addition, *Edugame* improves students' critical thinking and problem-solving skills because it contains elements of *challenge* and exploration of concepts that encourage active mental engagement. Educational games not only require students to remember facts, but also require them to analyze, make decisions, and solve problems based on the concepts they have learned (Nawafilah & Masruroh, 2020; Nugrahani et al., 2024). This is in line with the *Higher Order Thinking Skills (HOTS)* approach emphasized in the Merdeka Curriculum, where students not only understand but are also able to apply and evaluate science concepts in a real-life context (Aryadi & Margunayasa, 2022; Lilis Karlina, 2022) Thus, *Edugame* becomes a learning medium that not only stimulates low-level cognitive abilities (such as remembering and comprehending), but also hone high-level thinking skills (such as analyzing, evaluating, and creating).

From the affective side, *Edugame* plays an important role in fostering students' motivation and interest in learning. Learning packaged in the form of games provides a fun, challenging, and competitive atmosphere in a healthy way (Jumanto & Mustofa, 2023; Nawafilah & Masruroh, 2020) Elements of the game such as scores, levels, time, and rewards create a *sense of achievement* that encourages students to continue learning and completing challenges. The reward system and direct *feedback* provided after each activity also fosters students' intrinsic motivation. Based on the *theory of Self Determination* by Deci and Ryan, learning motivation increases when students feel they have autonomy (can control their own learning process), competence (feel able to solve challenges), and connectedness (socially involved in the learning environment). *Edugame* fulfills these three aspects, so that students are more enthusiastic, focused, and consistent in participating in learning(Setyawan & Panduwinata, 2023; Yeni Widiawati et al., 2022).

From the psychomotor aspect, *Edugame* helps students learn through action and exploration. Activities such as *drag and drop*, interactive simulations, or digital experimentation-based games keep students physically and mentally active. Direct interaction with the media helps to internalize the concept of science in a fun way. For example, in the topic of food chains, students can sort out the sequence of organisms based on their role in the ecosystem through interactive games. This process develops systematic thinking skills as well as coordination between visual, motor, and cognitive aspects of students (Marinda, 2020; Thosin Waskita et al., 2022).

Another advantage that makes *Edugame* able to maximally improve learning outcomes is its adaptive nature to student learning speed. This medium allows each student to learn according to his or her own rhythm and learning style without social pressure from peers. Students who understand quickly can move on to the next level, while students who still have difficulty can repeat the material until they understand. This flexibility supports the principle of *differentiated learning* in the Independent Curriculum, where learning is designed to appreciate the uniqueness of each learner (Jumanto & Mustofa, 2023; Variani & Agung, 2020)

Empirically, the effectiveness of *Edugame* is evidenced by a significant increase in student learning outcomes after the application of this media. The average score of learning outcomes increased from 51.66 in the *pretest* to 73.53 in the *posttest*, with *an N-Gain* of 0.442 in the medium category, indicating a fairly high increase in understanding of science concepts. In addition, the results of *the t-test* showed a significance value of 0.000 ($p < 0.05$), which means that the use of *Edugame* has a significant effect on improving student learning outcomes. The response of students and teachers was also very positive; they found *Edugame* attractive, easy to use, and helpful in understanding difficult science concepts. With increased enthusiasm and student engagement, the learning process becomes more meaningful, collaborative, and experiential-oriented.

This study has several limitations, including the relatively short trial implementation time and the scope of research that is only conducted on one school cluster, so the generalization of results still needs to be tested in a broader context. However, this research has the advantage of successfully developing Edugame-based interactive learning media that is valid, practical, and effective, and is able to significantly increase students' motivation and science learning outcomes. The implications of this study show that the integration of game elements in learning can be an innovative strategy to create a more active, contextual, and student-centered learning process, and can be used as a reference for teachers and media developers in designing technology-based learning that is in line with the Independent Curriculum.

CONCLUSION

The results of this study show that the development of *Edugame-Based Interactive Learning Media* has proven to be valid, practical, and effective in improving the science learning outcomes of grade VI elementary school students. Through the application of the ADDIE development model, this media has succeeded in integrating game elements, interactive visualizations, and direct feedback that are able to increase motivation, participation, and understanding of abstract science concepts. Expert validation obtained a very high category (90%), practicality reached 96%, and the results of the effectiveness test showed a significant increase between *pretest* and *posttest* scores with *N-Gain* in the medium to high category. These findings confirm that the use of *Edugame* not only improves the cognitive aspect, but also the affective and psychomotor aspects of students through fun and meaningful learning. Thus, this media deserves to be implemented more widely as a technology-based learning innovation that is in line with the principles of the Independent Curriculum in forming a critical, creative, and independent Pancasila student profile.

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