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Role playing and augmented reality animal structures to support students' joyful learning and argumentation abilities

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Abstract

Joyful learning is a strategy that can increase undergraduate student engagement and motivation in learning. This strategy is important for learning animal structures in biology students who have the potential to cause anxiety caused by treatment that is considered to be hurtful to animals. The use of role-playing and augmented reality (AR) technology in learning can provide a more interactive and interesting learning experience. The purpose of this study was to analyze the effect of role playing and augmented reality in the discovery learning model on joyful learning and students' argumentation skills. This study was a quasi-experimental study with a one-group pretest-posttest design. The research sample is undergraduate students in Biology Education department who are active in the odd semester of the 2025/2026 academic year and are taking the Animal Structure course. This design compared the conditions of joyful learning and argumentation skills before and after being given treatment in the form of learning Animal Structure topic using the discovery learning model, combined with role-playing assisted by augmented reality. The instruments of this study were a joyful learning questionnaire and an argumentation ability test instrument to collect quantitative data on joyful learning and argumentation skills. Data analysis used a nonparametric analysis of the Wilcoxon test because the data were not homogeneous and not normal. The results showed a significance value (Asymp. Sig. 2 tailed) of 0.00 (<0.05). The effect size on joyful learning was 0.87 and argumentation ability was 0.59. These results confirm that the integration of experience-based pedagogical strategies with immersive technology can create enjoyable learning while fostering students' critical thinking and argumentative skills.

Abstrak. *Joyful learning menjadi strategi yang dapat meningkatkan keterlibatan dan motivasi mahasiswa dalam pembelajaran, strategi ini penting untuk pembelajaran struktur hewan pada mahasiswa biologi berpotensi menimbulkan kecemasan. Penggunaan role playing dan teknologi augmented reality (AR) dalam pembelajaran dapat memberikan pengalaman belajar yang lebih interaktif dan menarik. Tujuan penelitian ini untuk menganalisis pengaruh role playing dan augmented reality pada model discovery learning terhadap joyful learning dan kemampuan argumentasi mahasiswa. Penelitian ini merupakan penelitian kuasi eksperimen dengan desain one group pretest-posttest. Sampel penelitian terdiri dari mahasiswa program sarjana di Departemen Pendidikan Biologi yang aktif pada semester ganjil tahun akademik 2025/2026 dan sedang mengikuti mata kuliah Struktur Hewan. Desain ini membandingkan kondisi joyful learning dan kemampuan argumentasi sebelum dan sesudah diberikan perlakuan berupa pembelajaran Struktur Hewan dengan menggunakan model discovery learning yang dikombinasikan dengan role playing berbantuan augmented reality. Instrumen penelitian ini yaitu angket joyful learning dan instrumen tes kemampuan argumentasi untuk mengumpulkan data joyful learning dan kemampuan argumentasi secara kuantiatif. Analisis data menggunakan analisis nonparametrik uji Wilcoxon karena data tidak homogen dan tidak normal. Hasil penelitian menujukkan nilai signifikansi (Asymp. Sig. 2 tailed) sebesar 0,00 (<0,05). Hasil ini menegaskan bahwa integrasi strategi pedagogis berbasis pengalaman dengan teknologi imersif dapat menciptakan pembelajaran yang menyenangkan sekaligus menumbuhkan pemikiran kritis dan keterampilan argumentasi siswa.*

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A. Introduction

Joyful learning is an important principle in modern education (Hernik & Jaworska, 2018). In the deep learning curriculum concept, joyful learning is a strategy that can increase student engagement and motivation in learning (Diputera et al., 2024; Feriyanto & Anjariyah, 2024). A fun learning process can create a comfortable learning environment, increase cognitive engagement, and support the achievement of deeper understanding (Anggraeni et al., 2021; Calp, 2020; Rahmawati et al., 2024). This is in line with efforts to create more meaningful and student-centered learning, including in biology learning.

Learning biology concepts must consider the approaches, models, and strategies used (Siburian & Sadikin, 2024). In learning animal structure, the application of joyful learning is very important, considering that this material is often considered difficult due to its abstract and complex nature (Hoopes et al., 2019; Waterworth, 2020). Students often experience difficulties in understanding animal anatomical structures due to limitations in observing objects directly. Furthermore, learning animal anatomy in biology students has the potential to cause anxiety and increase stress (Niang et al., 2023; Tracy et al., 2022). Therefore, learning methods and media are needed that can provide a more interesting and interactive learning experience so that students can enjoy the learning process and have an impact on their understanding of the material.

Besides joyful learning, argumentation skills are also an important skill for students, especially biology education students. Argumentative skills are part of critical thinking skills and are included in the 21st-century skills that are highly needed in education and the professional world (Amin et al., 2021; Hasmaningsih et al., 2022). Students with good argumentation skills can construct strong arguments, convey opinions logically, and support their thoughts with valid evidence. However, research shows that students' argumentation skills still need to be improved, especially in the context of scientific discussions and evidence-based problem-solving (Amin et al., 2021; Rusmini & Suyono, 2021).

One of the learning models that can support joyful learning is role-playing (Jeet & Pant, 2023; Widyawulandari & Indriayu, 2019). This learning model involves students in an active way through simulation roles that can improve involvement emotional and cognitive they (Anggraini & Putri, 2019; Jamilah, 2019). The use of AR technology in learning can provide a more interactive and interesting learning experience, so it can help students understand abstract concepts better (Arslan et al., 2020; Cahyadi et al., 2022; Yeom, 2011).

Current learning models must also consider a scientific approach. One model with a scientific approach is discovery learning. (Mayasari et al., 2019). The discovery learning model can improve students' argumentation skills because this model invites students to search for information accompanied by scientific evidence and communicate their findings (Sunarto & Amalia, 2022; Halimah et al., 2020). The discovery learning syntax allows for a combination with the use of technology-based media and other relevant approach models so that learning can be more effective and enjoyable (Imamah & Toheri, 2014; Indriyani et al., 2023; Laila et al., 2018; Mardiyanti, 2023; Zahro & Afriza, 2024).

Previous research has only used the syntax of the scientific approach model with the help of technology to improve argumentation skills. The integration of augmented reality and role-playing media in the discovery learning model is expected to support joyful learning and argumentation among students. Research that has been done. Not yet combining role-playing and augmented reality models in learning models discovery learning. Quasi-experiments carried out previously also did not research the influence of the discovery learning model supported by role playing and augmented reality models, which are game-type models and media towards joyful learning. Based on the exposure mentioned, it is necessary to research to explore the implementation role role-playing and augmented reality in the discovery learning model to support joyful learning and improve the ability of argumentative students. This study aims to analyze the effects of using role playing and augmented reality implementation in the discovery learning model on joyful learning and student argumentation in learning the animal structure course.

B. Material and method

This research is a quasi-experimental design with a one-group pretest-posttest design. This design involves a group that is given treatment in the form of learning eye studying Animal Structure using a discovery learning model combined with augmented reality-assisted role-playing. Joyful learning and argumentation skills were measured before (pretest) and after learning (posttest).

The variables in this study are role-playing and augmented reality as independent variables, and joyful learning and students' argumentation skills as dependent variables. The hypotheses in this study are:

1) Hypothesis alternative (Ha): There are influencing variables (role playing and augmented reality) on dependent variables (joyful learning and ability argumentation of students).
2) Hypothesis zero (H0): There is no influence variables (role playing and augmented reality) to variables (joyful learning and ability argumentation of students).

The use of AR in the discovery learning model in this study is in the syntax of data collection. AR is used

to identify the structure of animal tissue, then the results of observations are analyzed to address the identified problems. AR also assists in the processing of collected data. Role play is implemented in the data collection process after using AR where students will simulate the position of each animal tissue and the verification/proof process so that at this stage students can train their argumentation skills.This research will be conducted in the Biology Education Study Program, Lambung Mangkurat University. Data collection will be conducted in the odd semester of the 2025/2026 academic year. The population in this study is all students of the Biology Education Study Program, Lambung Mangkurat University, who are active in the odd semester of the 2025/2026 academic year. The research sample is students who are active in the odd semester of the 2025/2026 academic year and are taking the Animal Structure course. The sampling technique is carried out using a purposive sampling technique, taking into account the available classes for the course. The number of samples in this study is 54 students.

The instrument in this study has been tested for empirical validity and reliability using the Pearson correlation test and Cronbach's alpha. The instruments in this research are:

1) An instrument for measuring joyful learning was developed based on Wolk's (2008) indicators. The indicators and their descriptions are presented in Table 1.
2) Instruments for measuring students' argumentation skills: Argumentation skills tests were developed based on argumentation skills indicators according to Toulmin (2003). The form of the test questions is multiple choice The indicators and their descriptions are presented in Table 2.

Table 1 Joyful learning indicators and their descriptions

No	Indicators	Description
1	Curiosity	Students show a high interest in exploring material, ask questions, and find out more about the phenomenon being studied.
2	Find pleasure in learning.	Students are actively involved in discussions, practices, or learning activities without feeling forced.
3	Self-reflection	Participants are allowed to reflect experience study, so that grow awareness self.
4	Safety and respect	The classroom atmosphere is supportive, free from excessive pressure, so that students feel calm and safe in learning.
5	Collaborate	Students work in groups, help each other, and build a learning fun social.
6	Relevance	Subject matter associated with real life so that students feel what was learned is meaningful.
7	Creativity	Students are encouraged to think creatively, solve problems uniquely, and produce innovative work.
8	Joy and Enthusiasm	Students showed happy, enthusiastic expressions and enjoyed the learning process.

Table 2 Argumentation abilities indicators and their descriptions

No	Indicators	Description
1	Claim	Statements or conclusions put forward as an answer to something problem or a question. Shows the position or opinion main student.
2	Data (Grounds/ evidence)	Information, facts, or evidence used to support a claim. Can be in the form of results observation, theory, or empirical data.
3	Warrant	A logical reasoning that explains the relationship between the data and the claim. Answer the question of why the data support the claim.
4	Backing	An additional basis in the form of theory, concepts, or literature that strengthens the warrant. Used to add credibility argument.
5	Qualifier	An expression that indicates the extent to which a claim is believed to be true. Examples: “most likely,” “mostly,” or “almost certainly.”
6	Rebuttal	Exceptions or conditions that weaken the claim. Demonstrates awareness of counterarguments.

Data analysis was carried out by analyzing the average joyful learning and argumentation ability and its indicators using descriptive statistical analysis. Inferential statistics were used to test the differences in joyful learning and argumentation ability before and after learning with role-playing and AR. The test used was the nonparametric statistic Wilcoxon Test because in the prerequisite test, the data analysis was not homogeneous (sig. value. Levene Test Results 0.000 <0.05) and not normally distributed (sig. value. Kolmogorov-Smirnov Test Results 0.004 <0.05). The effect size calculation was carried out to analyze the influence of the use of role playing and AR on joyful learning and argumentation skills. The analysis was carried out using the SPSS application.

C. Results and discussion

Joyful Learning

The results of the average joyful learning measurement showed an increase from the pre-learning and post-learning measurements using role-playing and augmented reality in the discovery learning model. The average joyful learning score is presented in Figure 1. Average joyful learning scores were also measured per indicator. This was done to analyze which indicators played a significant role in improving joyful learning among students. The average measurement results per indicator are presented in Figure 2. In addition to the average analysis, an inferential statistical analysis was also conducted using the Wilcoxon test to analyze differences before and after learning. The results of the analysis are presented in Table 3, and the results of the analysis of each indicator are presented in Table 4. Based on testing with the Wilcoxon test known that mark Asymp. Sig. (2-tailed) (<0.05), so it can be concluded that there is a difference between before and after learning.

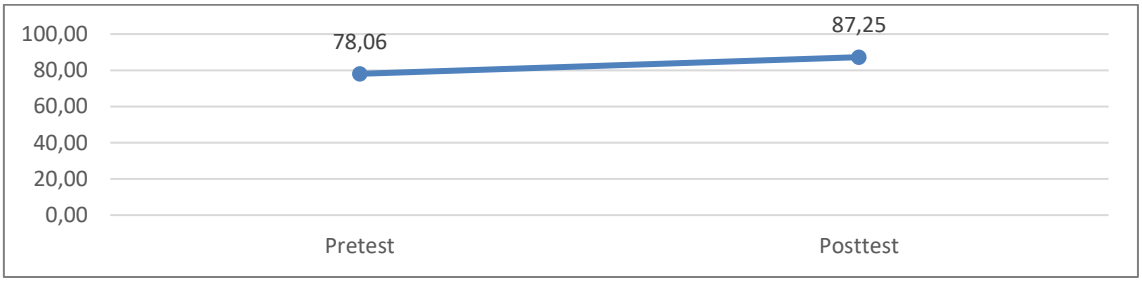

Figure 1 Average value of joyful learning

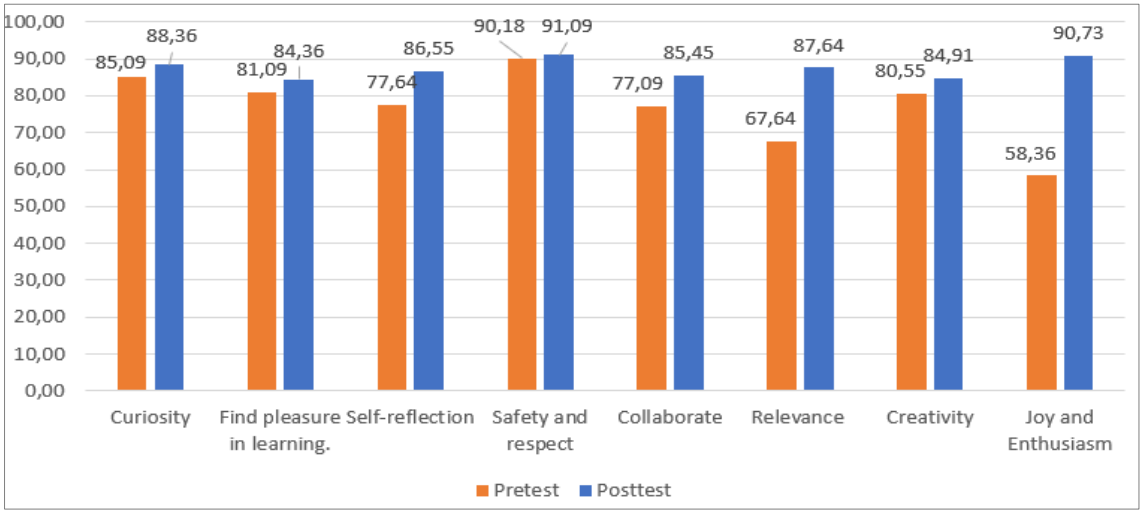

Figure 2 Average joyful learning of each indicator

Table 3 Wilcoxon test results

Test result value	Variables joyful learning
Z	-9,023
Asymp. Sig. (2-tailed)	0,000
r	0,87

Table 4 Results of the wilcoxon joyful learning test of each indicator

Indicator	Asymp. sig. value (2-tailed)	α	Conclusion
Curiosity	0,000	0.05	There is a difference
Find pleasure in learning.	0,000		There is a difference.
Self-reflection	0,000		There is a difference.
Safety and respect	0,000		There is a difference.
Collaborate	0,000		There is a difference.
Relevance	0,000		There is a difference.
Creativity	0,000		There is a difference.
Joy and Enthusiasm	0,000		There is a difference.

The measurement results showed a significant increase in *joyful learning scores* after learning with augmented reality-based role-playing within the discovery learning framework. The average score increased from pre-test to post-test (Figure 1). The Wilcoxon test proved a significant difference (Z = -9.023; Asymp. Sig. = 0.000 < 0.05). The effect size (r) is 0.87, which means that role playing and AR have a large effect on students' joyful learning. Analysis in each indicator showed a significant increase in all aspects of *joyful learning* ($p < 0.05$), namely curiosity, choice, collaboration, relevance, safety & respect, creativity, reflection, and play & humor (Table 4).

The results of this study indicate that the use of *role-playing* and *augmented reality* (AR) in learning significantly increased students' *joyful learning*. This finding aligns with previous research confirming that AR integration in learning increases engagement, motivation, and a pleasant learning experience (Lee et al., 2024; Yu et al., 2022; Zhang et al., 2022). Furthermore, *role-playing* is effective in creating an active and collaborative learning environment (Azhariyah, 2020; Nugroho & Wijaya, 2023). Role playing and AR enhance students' joyful learning by supporting key phases of the learning process, particularly engagement and exploration. Role playing increases emotional involvement and psychological safety by allowing students to express ideas through assumed roles, reducing fear of making mistakes. Meanwhile, AR enhances curiosity and attention by visualizing abstract concepts in an interactive and immersive way. During exploration, both approaches promote active participation and playful learning experiences, enabling students to interact, experiment, and communicate ideas more confidently. As a result, learning becomes enjoyable, meaningful, and motivating for students.

In the curiosity indicator, a significant increase indicates that AR and *role-playing* can foster students' curiosity. AR facilitates immersive visualization of abstract concepts, while *role-playing* creates situations that require students to ask critical questions. Research by Demircioğlu et al. (2023) shows that argumentation-based AR increases curiosity and critical thinking. A similar finding was found by Lai & Cheong (2022), who reported that the application of AR in physics fosters curiosity through virtual experimental exploration. The Find pleasure in learning *indicator* also experienced a significant increase. The freedom to choose role strategies in *role-playing* and exploration paths through AR enhances students' learning autonomy. These results align with (Li et al., 2025), who stated that providing choices in AR design strengthens intrinsic motivation. Research by Suharti et al. (2024) and Erlangga et al. (2024) also confirmed that the use of AR based on *problem-based learning* and personalized learning provides space for students to determine their learning strategies.

In the *collaboration indicator*, students showed significant improvement. *Role-playing activities* require teamwork in carrying out roles, while AR supports collaboration through joint exploration of virtual objects. Kazlaris et al. (2025) in a systematic review found that collaborative AR strengthens communication and the exchange of ideas, while Guillén-Peñafiel et al. (2025) confirmed the effectiveness of *role-playing* in building social cooperation. The *relevance indicator* also increased because students felt the connection of the material to real contexts. AR connects academic concepts with everyday phenomena, while *role-playing* places students as actors in relevant situations. Studies by Marini et al. (2022) and Yatri & Sismulyasih (2024) proved that AR can increase relevance by presenting learning experiences close to students' lives.

In terms of *safety and respect*, improvements occurred due to the interaction rules in *role-playing* that ensure a safe learning environment, as well as the use of AR that minimizes risks. The improvements can be explained through the lens of psychological safety and experiential learning. Structured interaction rules in role-playing reduce social risk by clarifying expectations and protecting learners from negative evaluation, while AR minimizes physical and cognitive risk by enabling safe exploration of complex situations. Together, these conditions support active engagement and deeper learning. Boysen et al. (2023) showed that game-based learning activities increase students' confidence to participate without fear, while Steube (2024) revealed that *role-playing* encourages persuasive interactions while maintaining communication ethics. *Creativity indicators* experienced significant improvements. AR gives students the opportunity to manipulate objects visually, while *role-playing* requires improvisation of ideas. Research (Huang & Musah, 2024) states that AR strengthens divergent thinking, and Voulgari et al. (2024) confirm that *role-playing games* can stimulate students' creativity.

Self-Reflection indicators were supported by the opportunity for debriefing in *role-playing* and the recording or re-visualization features in AR. Improvement in self-reflection is observed when students engage in metacognitive processes such as monitoring understanding, evaluating learning strategies, and acknowledging errors without fear. Joyful learning environment supports these processes by reducing anxiety and encouraging openness, enabling students to reflect more effectively on their learning experiences. Ucar-Longford et al. (2024) reported that online scaffolding improved students' critical reflection, while Lottero-Perdue et al. (2023) found that *chat-based role-playing* was effective in training prospective teachers' reflection. In the Joy and Enthusiasm *indicator*, the improvement occurred due to the fun game elements in *role-playing* and gamification in AR. This is consistent with research by

Boysen et al. (2023) and Sonjaya et al. (2024), which stated that the integration of games and AR reduced awkwardness and increased students' emotional engagement.

The results indicate that a joyful learning environment plays a significant role in encouraging students' courage to engage in debate. When learning activities are perceived as enjoyable, supportive, and non-threatening, students tend to feel psychologically safe to express their opinions, question ideas, and challenge differing viewpoints. This sense of comfort reduces anxiety and fear of making mistakes, which are common barriers to active participation in debates. Moreover, joyful learning fosters positive emotional engagement, allowing students to view debates not as confrontational situations but as opportunities for collaborative thinking and idea exchange. As a result, students become more willing to articulate arguments, respond to counterarguments, and participate actively in academic discussions.

Argumentation Abilities

The results of the average argumentation ability measurements showed an increase from the pre-learning and post-learning measurements using role-playing and augmented reality in the discovery learning model. The average argumentation ability scores are presented in Figure 3.

Average argumentation ability measure-ments were also conducted per indicator. This was done to analyze which indicators played a significant role in improving students' argumentation skills. The average measurement results per indicator are presented in Figure 4.

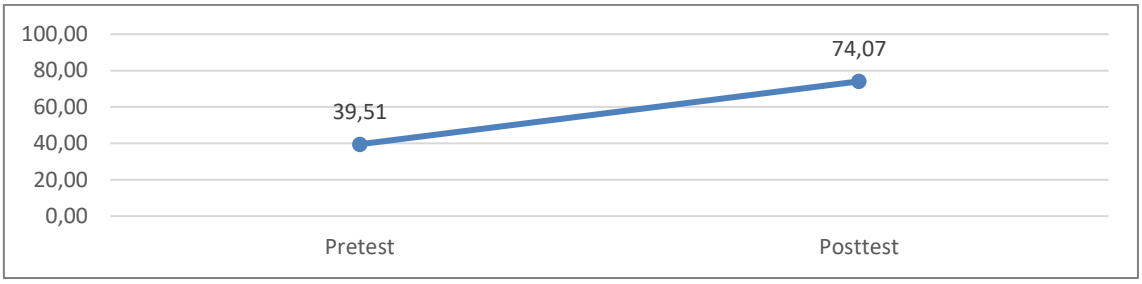

Figure 3 Average value of argumentation ability

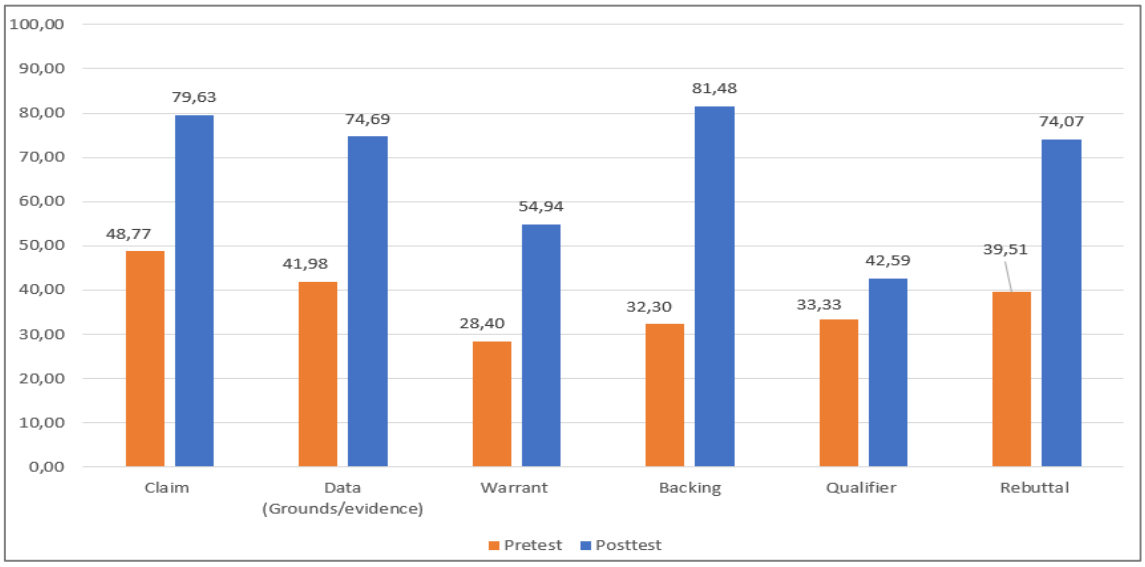

Figure 4 Average argumentation ability of each indicator

Table 5 Wilcoxon test results

Test result value	Variables joyful learning
Z	-6,097
Asymp. sig. (2-tailed)	0,000
r	0,59

Table 6 Results of the Wilcoxon ability test argumentation per indicator

Indicator	Asymp. sig. value(2-tailed)	α	Conclusion
Claim	0,000	0.05	There is a difference
Data (Grounds/evidence)	0,000		There is a difference.
Warrant	0,000		There is a difference.
Backing	0,000		There is a difference.
Qualifier	0,000		There is a difference.
Rebuttal	0,000		There is a difference.

In addition to the average analysis, an inferential statistical analysis was also conducted using the Wilcoxon test to analyze differences before and after learning. The results of the analysis are presented in Table 5, and the results of the analysis per indicator are presented in Table 6. Based on testing with the Wilcoxon test, it is known that the Asymp. Sig. (2-tailed) The value is (<0.05), so it can be concluded that there is a difference between before and after learning.

The results showed that the average argumentation ability score increased from pre-test to post-test (Figure 3). The Wilcoxon test results showed a significant difference (Z = -6.097; Asymp. Sig. = 0.000 < 0.05). The effect size (r) is 0.59, which means that role playing and AR in the discovery learning model have a large effect on students' argumentation abilities. Analysis in each indicator also showed a significant increase ($p < 0.05$) in the claim, data/evidence, warrant, backing, qualifier, and rebuttal indicators (Table 6).

In terms of argumentation skills, the claim indicator improved as students became accustomed to conveying statements in their roles, reinforced by AR visualizations that supported claims. Demircioglu et al. (2023) showed that AR-based argumentation improved the quality of students' claims. The data (Grounds/evidence) indicator also improved because AR presented concrete visual evidence, and role-splaying encouraged students to use evidence to defend their positions. Mohamed and Shaaban (2023) found that AR improved students' ability to link data to text, while Vapalahti and Marttunen (2020) confirmed the effectiveness of role-playing in encouraging the use of factual reasoning. Improvements in warrant indicator indicate that students are more skilled at establishing causal relationships between claims and data. Ruwe and Mayweg-Paus (2023) demonstrated that providing feedback on arguments improves reasoning quality, while Muslim et al. (2024) found that VR-based role-playing improves logical thinking in language learning. The backing indicator improved as students became accustomed to using additional sources to support claims. This is supported by research (Ucar-Longford et al., 2024), which emphasizes the importance of online scaffolding to strengthen the use of evidence.

In the qualifier indicator, improvements were seen because students learned to express claims with specific nuances through discussion practice. Steube, (2024) revealed that role-play encouraged students to construct arguments more carefully and persuasively. The final indicator, rebuttal, also improved because students were accustomed to refuting opposing arguments in role-playing and testing claims with the help of AR. Lottero-Perdue et al. (2023) stated that role-play-based exercises significantly strengthened rebuttal skills.

Overall, the findings of this study confirm that the integration of role-playing and AR not only creates enjoyable learning but also strengthens students' argumentative skills. These findings provide several important implications for the development of learning in the digital era. The integration of role-playing and augmented reality has been proven to create a fun learning atmosphere and increase student motivation. This suggests that educators need to consider the use of AR-based immersive technology combined with active learning strategies to strengthen joyful learning. In practice, lecturers or teachers can design contextual role-playing scenarios, then enrich the experience with AR visualizations to increase students' emotional and cognitive engagement.

The improvement in all argumentative ability indicators confirms that this combination of methods has implications for strengthening higher-order thinking skills. Students are not only encouraged to convey claims but also trained to use data, reasoning, and rebuttals in academic discussions. The implication of these findings is the need for educators to integrate argumentation-based activities into AR-assisted learning designs, for example, by including open-ended question prompts, analyzable virtual data, or role-playing scenarios that require students to provide logical arguments. These findings are in line with international studies that emphasize the importance of integrating immersive technology and experience-based pedagogical strategies to improve the quality of 21st-century learning (Demircioglu et al., 2023; Kazlaris et al., 2025; Lee et al., 2024; Yu et al., 2022; Zhang et al., 2022).

The implementation of augmented reality (AR) and role playing in teaching animal structure is constrained by technical readiness and time management. AR relies heavily on device availability, application performance, and stable connectivity, while role playing requires careful coordination and sufficient instructional time. These technical demands may limit the consistency and effectiveness of learning activities. Although technical limitations were

identified, they did not influence the research findings because they were systematically anticipated and managed. Prior to implementation, device readiness, application functionality, and instructional timing were carefully prepared and monitored. This proactive management ensured stable learning conditions and allowed the intervention to be implemented consistently, thereby maintaining the validity of the results.

D. Conclusion

The results of this study indicate that the application of *role playing* and *augmented reality* in the *discovery learning model* in the Animal Structure course has a positive and significant effect on improving students' *joyful learning* and argumentation skills. All indicators of *joyful learning* from *curiosity* to Joy and Enthusiasm increased significantly, as did indicators of argumentation skills, including *claim*, *data*, *warrant*, *backing*, *qualifier*, and *rebuttal*. These results confirm that the integration of experience-based pedagogical strategies with immersive technology can create enjoyable learning while fostering students' critical thinking and argumentative skills.

E. References

Amin, A. M., Adiansyah, R., & Hujjatusnaini, N. (2021). Students' argumentation quality and argumentation skill biology education student. *Jurnal Bioedukatika*, *9*(2), 84-92. DOI: https://doi.org/10.26555/bioedukatika.v9i2.20675

Anggraeni, M. D., Sunarno, W., & Suparmi, S. (2021). The implementation of joyful learning strategies using experimental and project methods in terms of students' creativity and self-discipline. *Jurnal Pendidikan Indonesia (JPI)*, *10*(2), 256–267. DOI: https://doi.org/10.23887/jpiundiksha.v10i2.30110

Anggraini, W., & Putri, A. D. (2019). Penerapan metode bermain peran (role playing) dalam mengembangkan kognitif anak usia 5-6 tahun. *JECED : Journal of Early Childhood Education and Development*, *1*(2), 104–114. DOI: https://doi.org/10.15642/jeced.v1i2.466

Arslan, R., Kofoğlu, M., & Dargut, C. (2020). Development of augmented reality application for biology education. *Journal of Turkish Science Education*, *17*(1), 62–72. DOI: https://doi.org/10.36681/tused.2020.13

Azhariyah, A. (2020). Penerapan metode role play dalam meningkatkan kemampuan berbicara dan kualitas pembelajaran bahasa inggris. *Fitrah: International Islamic Education Journal*, *2*(2), 81–103. DOI: https://doi.org/10.22373/fitrah.v2i2.699

Boysen, M., Lund, O., Jørnø, R., & Skovbjerg, H. M. (2023). The role of expertise in playful learning activities: A design-based self-study within teacher education aimed at the development of tabletop role-playing games. *Teaching and Teacher Education*, *128*, 104128. DOI: https://doi.org/10.1016/j.tate.2023.104128

Cahyadi, D. D., Asfarian, A., Novelina, S., Setijanto, H., & Agungpriyono, S. (2022). Virtual reality-based animal anatomy model: A new possible approach for veterinary education in Indonesia. *ARSHI Veterinary Letters*, *6*(1), 11–12. DOI: https://doi.org/10.29244/avl.6.1.11-12

Calp, Ş. (2020). Peaceful and happy schools: How to build positive learning environments. *International Electronic Journal of Elementary Education*, *12*(4), 311- 320. DOI: https://doi.org/10.26822/iejee.2020459460

Demircioglu, T., Karakus, M., & Ucar, S. (2023). Developing students' critical thinking skills and argumentation abilities through augmented reality–based argumentation activities in science classes. In *Science and Education*, *32*(4), 1165–1195 Springer Netherlands. DOI: https://doi.org/10.1007/s11191-022-00369-5

Diputera, A. M., Eza, G. N., Guru, P., Anak, P., Dini, U., Pendidikan, F. I., Medan, U. N., Kebidanan, A., & Husada, M. (2024). Memahami konsep pendekatan deep learning dalam pembelajaran anak usia dini yang meaningful, mindful dan joyful: Kajian melalui filsafat pendidikan. *Bunga Rampai Usia Emas (BRUE)*, *10*(2), 108–120. DOI: https://doi.org/10.24114/jbrue.v10i2.65978

Erlangga, E., Mukhlis, R., Wihardi, Y., & Raflesia, S. P. (2024). Augmented reality in STEM using personalized learning to promote students' understanding. *Computer Engineering and Applications Journal*, *13*(2), 50-59. DOI: https://doi.org/10.18495/comengapp.v13i2.473

Feriyanto, F., & Anjariyah, D. (2024). Deep learning approach through meaningful, mindful, and joyful learning: A library research. *Electronic Journal of Education. Social Economics and Technology*, *5*(2), 208– 212. DOI: https://doi.org/10.33122/ejeset.v5i2.321

Guillén-Peñafiel, R., Hernández-Carretero, A. M., & Sánchez-Martín, J. M. (2025). Role-playing as a didactic strategy for teaching intangible heritage: an intervention with trainee teachers. *Heritage*, *8*(3), 1- 29. DOI: https://doi.org/10.3390/heritage8030090

Halimah, A. N., Harlita, H., & Dwiastuti, S. (2020). Discovery learning disertai pertanyaan divergen untuk meningkatkan keterampilan argumentasi siswa pada pembelajaran biologi. *Edusains*, *12*(1), 1– 8. DOI: https://doi.org/10.15408/es.v12i1.12762

Hasmaningsih, L., Karnan, K., & Handayani, B. S. (2022). Level of scientific argumentation ability of students in biology learning. *Jurnal Pijar Mipa*, *17*(6), 717–722. DOI: https://doi.org/10.29303/jpm.v17i6.4242

Hernik, J., & Jaworska, E. (2018). The effect of enjoyment on learning. *Proceedings of INTED2018 Conference*, *1*(May), 508–514. DOI: https://doi.org/10.21125/inted.2018.1087

Hoopes, K., Colver, M., Thurston, T., E. Wadsworth-Anderson, Lewis, M., & Robl, N. (2019). Pedagogical enhancements to animal anatomy and physiology: maintaining and improving student academic performance in the discipline. *NACTA Journal*, *64*(2), 360– 369. Retrieved from https://www.researchgate.net/publication/353373398

Huang, L., & Musah, A. (2024). The influence of augmented reality on creativity, student behavior, and pedagogical strategies in technology-infused education management. *Journal of Pedagogical Research*. *8*(2), 260–275. DOI: https://doi.org/10.33902/JPR.202425376

Imamah, F. U., & Toheri, T. (2014). Pengaruh penggunaan kombinasi metode pembelajaran discovery learning dan brain storming terhadap kemampuan pemecahan masalah pada pokok bahasan himpunan. *Eduma : Mathematics Education Learning and Teaching*, *3*(1), 120–137. DOI: https://doi.org/10.24235/eduma.v3i1.12

Indriyani, D., Muhfahroyin, M., & Santoso, H. (2023). Pengaruh discovery learning berbasis augmented reality terhadap hasil belajar siswa. *Biolova*, *4*(2), 107– 113. DOI: https://doi.org/10.24127/biolova.v4i2.4032

Jamilah, S. (2019). Pengembangan sosial-emosional anak melalui metode role playing (bermain peran) di kelompok B anak usia dini. *PELANGI: Jurnal Pemikiran Dan Penelitian Islam Anak Usia Dini*, *1*(1), 83– 101. DOI: https://doi.org/10.52266/pelangi.v1i1.282

Jeet, G., & Pant, S. (2023). Creating Joyful experiences for enhancing meaningful learning and integrating 21st century skills. *International Journal of Current Science Research and Review*, *06*(02), 900–903. DOI: https://doi.org/10.47191/ijcsrr/v6-i2-05

Kazlaris, G. C., Keramopoulos, E., Bratsas, C., & Kokkonis, G. (2025). Augmented reality in education through collaborative learning: a systematic literature review. *Multimodal Technologies and Interaction*, *9*(9), 94. DOI: https://doi.org/10.3390/mti9090094

Lai, J. W., & Cheong, K. H. (2022). Educational opportunities and challenges in augmented reality: Featuring implementations in physics education. *IEEE Access*, *10*, 43143–43158. DOI: https://doi.org/10.1109/ACCESS.2022.3166478

Laila, E. N., Karyanto, P., Suciati, S., & Purwaningsih, A. N. (2018). Pengaruh penerapan model discovery learning disertai media augmented reality (ECO-AR 1-3) terhadap penguatan aspek pengetahuan dalam literasi lingkungan. *Jurnal Ilmiah Pendidikan*, *15*(1), 209–213. Retrieved from https://jurnal.uns.ac.id/prosbi/article/view/28298/19398

Lee, L.-K., Wei, X., Chui, K. T., Cheung, S. K. S., Wang, F. L., Fung, Y.-C., & Hao, T. (2024). A systematic review of the design of serious games for innovative learning: Augmented reality, virtual reality, or mixed reality? *Electronics*, *13*(5), 890. DOI: https://doi.org/10.3390/electronics13050890

Li, G., Luo, H., Chen, D., Wang, P., Xin, Y., & Zhang, J. (2025). Augmented reality in higher education: A systematic review and meta-analysis of the literature from 2000 to 2023. *Education Sciences*, *15*(6), 678. DOI: https://doi.org/10.3390/educsci15060678

Lottero-Perdue, P. S., Rillero, P., Liebars, C., Goldberg, A., & Reich, J. (2023). Chat-based role-play for preservice teachers to practice eliciting students' arguments. *Innovations in Science Teacher Education*, *8*(3), 91-104. Retrieved from https://innovations.theaste.org/index.php/iste/article/view/393

Mardiyanti, L. (2023). Pengaruh model discovery learning dipadu lesson study terhadap hasil belajar mahasiswa pendidikan biologi. *Biodik*, *9*(3), 71-77. DOI: https://doi.org/10.22437/biodik.v9i3.28514

Marini, A., Nafisah, S., Sekaringtyas, T., Safitri, D., Lestari, I., Suntari, Y., & Iskandar, R. (2022). Mobile augmented reality learning media with metaverse to improve student learning outcomes in science class. *International Journal of Interactive Mobile Technologies (IJIM)*, *16*(07), 99–115. DOI: https://doi.org/10.3991/ijim.v16i07.25727

Mayasari, D. D., Wardianti, Y., & Febrianti, Y. (2019). Pengaruh pendekatan saintifik terhadap motivasi dan hasil belajar biologi siswa. *BIOEDUSAINS: Jurnal Pendidikan Biologi dan Sains*, *2*(2), 93–103. DOI: https://doi.org/10.31539/bioedusains.v2i2.861

Mohamed, A. M., & Shaaban, T. S. (2023). Exploring the effectiveness of augmented reality technology on reading comprehension skills among early childhood pupils with learning disabilities. *Journal of Computers in Education*, *10*(4), 711–731. DOI: https://doi.org/10.1007/s40692-023-00269-9

Muslim, A. H., Setyosari, P., Kuswandi, D., & Widiati, U. (2024). Impact of virtual reality-assisted role-play on learning styles and english performance. *Jurnal Teknologi Pendidikan*, *26*(1), 370–385. DOI: https://doi.org/10.21009/jtp.v26i1.49848

Niang, M. M., Nyemb, P. M. M., Yattara, H., Ndiaye, A., Gaye, M., & Ndiaye, A. (2023). A study of stress factors during the learning of anatomy in Gaston Berger University of Saint-Louis. *Indian Journal of Clinical Anatomy and Physiology*, *9*(4), 257–262. DOI: https://doi.org/10.18231/j.ijcap.2022.054

Nugroho, T., & Wijaya, A. (2023). Penerapan teknik role play untuk mengembangkan keterampilan komunikasi anak usia dini. *Jurnal Pendidikan Bahasa dan Anak Usia Dini*, *1*(2), 1-8. DOI: https://doi.org/10.61132/jupenbaud.v1i2.44

Rahmawati, I. Y., Wulansari, B. Y., Rusdiana, N. I.,

Pujiati, A., & Bariyah, S. K. (2024). Joyful learning approach in increasing motivation to learn english in middle school students of san fabian, Philippines. *Elite : English and Literature Journal*, *11*(1), 63–73. DOI: https://doi.org/10.24252/elite.v11i1.46175

Rusmini, R., & Suyono, R. A. (2021). Profile of argumentation ability of undergraduate students in chemistry education based on non-routine problems. In *E3s web of conferences* (Vol. 328, p. 06007). EDP Sciences. DOI: https://doi.org/10.1051/e3sconf/202132806007

Ruwe, T., & Mayweg-Paus, E. (2023). "Your argumentation is good", says the AI vs humans – The role of feedback providers and personalised language for feedback effectiveness. *Computers and Education: Artificial Intelligence*, *5*, 100189. DOI: https://doi.org/10.1016/j.caeai.2023.100189

Siburian, J., & Sadikin, A. (2024). Biology learning models based on higher order thinking skills ; A book research and development. *Jurnal Penelitian Pendidikan IPA*, *10*(11), 8827–8836. DOI: https://doi.org/10.29303/jppipa.v10i11.8858

Sonjaya, I., Husnaini, A. N., & Saepullah, S. (2024). Enhancing blended learning through augmented reality and gamified strategies in modern teaching. *The Journal of Academic Science*, *7*(1), 12–22. DOI: https://doi.org/10.59613/xbdmd750

Steube, M. (2024). Does role play manipulate students? Persuasive effects of role-play. *Science Education*, *108*(3), 655– 672. DOI: https://doi.org/10.1002/tea.21910

Suharti, P., Asyari, A., & Wikanta, W. (2024). Augmented reality integrated education game using problem-based learning model to improve critical thinking skills. *Research and Development in Education (RaDEn)*, *4*(1), 320–336. DOI: https://doi.org/10.22219/raden.v4i1.32026

Sunarto, M. F., & Amalia, N. (2022). Penggunaan model discovery learning guna menciptakan kemandirian dan kreativitas peserta didik. *BAHTERA: Jurnal Pendidikan Bahasa dan Sastra*, *21*(1), 94–100. DOI: https://doi.org/10.21009/bahtera.211.07

Toulmin, S. E. (2003). The uses of argument: Updated edition. In *The Uses of Argument: Updated Edition*. DOI: https://doi.org/10.1017/CBO9780511840005

Tracy, C. B., Driessen, E. P., Beatty, A. E., Lamb, T., Pruett, J. E., Botello, J. D., Brittain, C., Ford, Í. C., Josefson, C. C., Klabacka, R. L., Smith, T., Steele, A., Zhong, M., Bowling, S., Dixon, L., & Ballen, C. J. (2022). Why students struggle in undergraduate biology: Sources and solutions. *CBE Life Sciences Education*, *21*(3), ar48. DOI: https://doi.org/10.1187/cbe.21-09-0289

Ucar-Longford, B., Hosein, A., & Heron, M. (2024). Improving pre-service teachers' argumentation skills: A holistic online scaffolding design approach. *Journal of Digital Learning in Teacher Education*, *40*(2), 76– 96. DOI: https://doi.org/10.1080/21532974.2024.2320440

Vapalahti, K., & Marttunen, M. (2020). Collaborative argumentation through role-play by students on a degree programme in social services. *Social Work Education*, *39*(4), 552–566. DOI: https://doi.org/10.1080/02615479.2019.1663164

Voulgari, N., Panagopoulos, M., & Garneli, V. (2024). A systematic review of augmented reality in mathematics education: Fostering learning through art integration. *Arts & Communication*, *3*(2), 4446. DOI: https://doi.org/10.36922/ac.4446

Waterworth, P. (2020). Creating joyful learning within a democratic classroom. *Journal of Teaching and Learning in Elementary Education (Jtlee)*, *3*(2), 109– 125. DOI: https://doi.org/10.33578/jtlee.v3i2.7841

Widyawulandari, R. S., & Indriayu, M. (2019). Implementation of joyful learning approach in providing learning motivation for elementary school student. *Advances in Social Science, Education and Humanities Research*, *277*(Steach 2018), 54– 58. DOI: https://doi.org/10.2991/steach-18.2019.12

Wolk, S. (2008). Joy in school. *Educational Leadership*, *66*(1), 8–15. Retrieved from https://eric.ed.gov/?id=EJ809289

Yatri, N. D., & Sismulyasih, N. (2024). Developing augmented reality-based learning media in improving young learners' short story listening skills. *Journal of Languages and Language Teaching*, *12*(3), 1379– 1391. DOI: https://doi.org/10.33394/jollt.v12i3.11546

Yeom, S. J. (2011). Augmented reality for learning anatomy. *ASCILITE 2011 - The Australasian Society for Computers in Learning in Tertiary Education*, *December 2011*, 1377–1383. DOI: https://doi.org/10.14742/apubs.2011.1786

Yu, J., Denham, A. R., & Searight, E. (2022). A systematic review of augmented reality game-based learning in STEM education. *Educational Technology Research and Development*, *70*, 1169–1194. DOI: https://doi.org/10.1007/s11423-022-10122-y

Zahro, A. F., & Afriza, E. F. (2024). Penerapan model pembelajaran discovery learning berbantuan media augmented reality terhadap hasil belajar. *COSMOS: Jurnal Ilmu Pendidikan, Ekonomi Dan Teknologi*, *2*(1), 46– 57. Retrieved from https://cosmos.iaisambas.ac.id/index.php/cms/article/view/209

Zhang, J., Li, G., Huang, Q., Feng, Q., & Luo, H. (2022). Augmented reality in k–12 education: A systematic review and meta-analysis of the literature from 2000 to 2020. *Sustainability (Switzerland)*, *14*(15), 1-17. DOI: https://doi.org/10.3390/su14159725