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EXPLORING VIRTUAL REALITY APPLICATION IN VETERINARY MEDICINE: ENHANCING EDUCATION, DIAGNOSIS, AND TREATMENT

By

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A RESEARCH PAPER SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF DOCTOR OF VETERINARY MEDICINE

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ABSTRACT

An abstract of the research paper presented to the Faculty of Veterinary Medicine, Universiti Malaysia Kelantan, in partial requirement of the course DVT 55204 – Research Project.

This study explores the effectiveness of virtual reality (VR) technology in enhancing veterinary students' comprehension of feline anatomy and physiology. A total of 30 veterinary students from the first to fifth year participated. Prior to the VR session, all students underwent an anatomy and physiology quiz. During the VR session, the students were allowed to engage with an interactive 3D model of a feline patient. The VR session aimed to provide a dynamic and interactive learning experience. Pre- and post-quiz scores were compared to acknowledge the impact of both sessions on knowledge retention and understanding. The results indicated a significant improvement in post-quiz scores within all sessions. This study suggests that VR technology can be effectively utilized in veterinary education. Participants also expressed satisfaction with the VR experience, highlighting its potential as a supplementary teaching method. These findings could contribute to the growing body of literature on the benefits of VR in enhancing learning outcomes in veterinary education.

Keywords: Virtual Reality (VR), Veterinary Medicine, Feline Musculoskeletal System

ABSTRAK

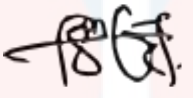
Abstrak kertas penyelidikan yang dibentangkan kepada Fakulti Perubatan Veterinar, Universiti Malaysia Kelantan, dalam keperluan sebahagian daripada kursus DVT 55204 – Projek Penyelidikan.

Kajian ini meneroka keberkesanan teknologi realiti maya (VR) dalam meningkatkan kefahaman pelajar veterinar tentang anatomi dan fisiologi kucing. Seramai 30 pelajar veterinar dari tahun satu hingga lima telah mengambil bahagian dalam kajian ini. Sebelum sesi VR, semua pelajar telah menjalani kuiz anatomi dan fisiologi. Semasa sesi VR, pelajar dibenarkan melibatkan diri dengan model 3D interaktif pesakit kucing. Sesi VR bertujuan untuk menyediakan pengalaman pembelajaran yang dinamik dan interaktif. Markah sebelum dan selepas kuiz dibandingkan untuk mengakui kesan kedua-dua sesi terhadap pengekalan dan pemahaman pengetahuan. Keputusan menunjukkan peningkatan ketara dalam markah selepas kuiz dalam semua sesi. Kajian ini mencadangkan bahawa teknologi VR boleh digunakan secara berkesan dalam pendidikan veterinar. Para peserta juga menyatakan kepuasan dengan pengalaman VR, menonjolkan potensinya sebagai kaedah pengajaran tambahan. Penemuan ini boleh menyumbang kepada peningkatan kesusasteraan tentang faedah VR dalam meningkatkan hasil pembelajaran dalam pendidikan veterinar.

Kata kunci: Realiti Maya (VR), Perubatan Veterinar, Sistem Muskuloskeletal Kucing

CERTIFICATION

This is to certify that we have read this research paper entitled **'Exploring Virtual Reality Application in Veterinary Medication: Enhancing Education, Diagnosis and Treatment'** by **Nur Shahirah Sofea binti Azmi**, and in our opinion, it is satisfactory in terms of scope, quality, and presentation as partial fulfillment of the requirements for the course DVT 55204 – Research Project.



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DEDICATIONS

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CHAPTER 1

1.0 INTRODUCTION

The method of obtaining knowledge differs from one individual to another. There are a total of four acknowledged methods of learning. It can be visual, auditory, read/write, and kinesthetic. However, it has been proven that 65% of the global population are visual learners. Visual learners can face difficulty in studying because their preferred learning style may not align with traditional teaching methods. Visual learners typically like to learn through visual aids such as diagrams, charts, and videos, rather than through verbal instructions or written text alone. This means that they may need help to retain information presented in a non-visual format and may find it difficult to focus or engage with material that does not cater to their learning style. Additionally, visual learners have been proven to require a longer processing period to internalize obtained knowledge, as these learners must visualize concepts before comprehension.

Virtual reality (VR) technology has been proven to improve learning outcomes for visual learners. As further technological development persists, VR has emerged as a valuable tool to achieve satisfying educational results. The justification behind this is the ability of VR to provide visual learners with a more engaging and effective learning experience. This project aims to investigate the impact of VR on visual learners, identify best practices for integrating VR into educational settings, and explore the potential benefits and challenges of using VR as a learning tool.

1.1 RESEARCH PROBLEM STATEMENT

Veterinary students face difficulty in acquiring practical skills and clinical knowledge, and traditional teaching methods may not always effectively address these challenges. (Mahdi, 2022). Veterinary anatomy can present unique challenges when studied through traditional teaching methods (Mejia, 2022) The subject demands a strong grasp of 3-dimension (3D) spatial structures, which can be hard to visualize and understand from 2-dimension (2D) images or textbook explanations alone. Students are often required to mentally map complex, layered structures like muscles, organs, bones, and systems, each of which varies significantly between different animal species. This variability means students must not only master general anatomical principles but also understand the unique anatomical details of multiple animals, adding to their cognitive load.

Traditional teaching methods such as dissections and textbook-based learning also offer limited interactivity, which can hinder a student's ability to connect theoretical knowledge with practical application in clinical settings. Additionally, anatomy labs require considerable resources and are often time-restricted, limiting students' opportunities to review and reinforce their understanding. Newer tools, like VR, offer promising solutions to these limitations by enabling immersive, interactive learning environments, where students can repeatedly explore anatomy in three dimensions at their own pace, bridging the gap between theoretical learning and clinical application.

By acknowledging the inefficiency of this long-established pedagogical approach, inventive learning methods must be implemented to ensure future generations of competent veterinarians.

1.2 RESEARCH QUESTIONS

1.2.1 Can VR aid visual learners in obtaining a comprehensive understanding of conceptual courses such as Veterinary Anatomy and Physiology?

1.2.2 Would veterinary students of Universiti Malaysia Kelantan (UMK) prefer VR study sessions compared to conventional teaching methods?

1.2.3 What are other potential VR applications in veterinary medicine?

1.3 RESEARCH HYPOTHESIS

1.3.1 VR will help visual learners obtain a comprehensive understanding of conceptual subjects such as Veterinary Anatomy and Physiology.

1.3.2 Veterinary students of UMK would prefer VR study sessions compared to conventional teaching methods

1.3.3 VR may become a comprehensive platform for veterinary students to gain practical experience in surgical procedures before applying them in real-life scenarios

1.4 RESEARCH OBJECTIVES

1.4.1 General Objectives

To identify the ability of VR to assist veterinary students in expanding their Veterinary Anatomy and Physiology knowledge while investigating potential applications of VR in enhancing Veterinary Medicine.

1.4.2 Specific Objectives

1. To demonstrate VR's ability to improve UMK veterinary students' understanding of conceptual subjects such as Veterinary Anatomy and Physiology.
2. To determine the veterinary students' preferred method of learning between VR and conventional teaching methods.
3. To identify potential VR applications within Veterinary Medicine.

CHAPTER 2

1.0 LITERATURE REVIEW

1.1 Type of Learners

Various learner categories have been extensively examined and analyzed in the education sector (Papavlasopoulou et al., 2017). Multiple theories and models have been suggested to classify learners according to their favored learning styles or modalities. A well-known method of categorizing learners is grouping them based on the sensory modalities they utilize to learn. Dunn and Dunn's model categorizes learners into four distinctions: visual, auditory, kinesthetic, and tactile. Visual learners favor learning by utilizing visual tools like charts, diagrams, and images. Their ability to comprehend and recall information depends on their visual perception. Auditory learners, conversely, favor learning through the sense of hearing. Their most preferred pedagogical approach occurs through attending lectures, participating in discussions, and listening to audio recordings. Those who are kinesthetic learners, also known as tactile learners, thrive when they engage in hands-on tasks and physical movement. Tactile learners excel in learning through physical touch and interaction. They gain advantages by utilizing manipulatives, encountering real-life situations, and participating in interactive activities (Sarudin et al., 2019).

1.2 Visual Learning

The terminology, Visual learning, has been defined as the adsorption of information from visual formats, such as simulations, graphs, slide shows, posters, and more. (Charbia, 2016). Visual learners, constituting a significant portion of the population, have distinct learning preferences that influence how they acquire and retain information.

These learners excel when visual stimuli are prevalent, such as learning via diagrams, charts, maps, and written instructions. They tend to remember information more efficiently when it is presented visually, utilizing techniques like color coding, mind mapping, and graphic organizers to organize and comprehend complex concepts.

It was also claimed that visual learners often prefer to sit in the front of the lecture halls to better see the teacher's visual aids. Furthermore, this may benefit from watching demonstrations or videos to reinforce learning. By engaging these learners with visually stimulating materials and activities, educators can capitalize on their strengths and enhance their learning experiences. This form of learning comprises more than half of the global population and is known for its endless benefits. (AlKhasawneh, 2024.) This type of learning is fruitful for the educators and the students. Regarding educators, Visual aids help provide information through visual and audible cues to facilitate learning. They help to make learning practice more authentic, dynamic, and essential by helping to materialize the available knowledge. (GC University Faisalabad, 2015)

Additionally, catering to visual learners can improve overall classroom engagement and participation, as they are more likely to be actively involved in visual-based activities. By addressing the needs of visual learners, educators can create a more inclusive learning environment that caters to diverse learning styles. This, in turn, can lead to increased academic success and a more positive learning experience for all students

1.3 Development of Virtual Reality Applications

New techniques and systems that were earlier potentially implementable but virtually could not be applied can now be employed due to the ever-improving computer and information technology.

Virtual environment technologies are one example of such a development, one of them being virtual reality. VR is a simulation that has affected several sectors such as entertainment, social, medical, and learning among others. (Cvetkovic, 2021) This type provides the user with an illusion of an actual three-dimensional world built by computer power. Such environments can be viewed through VR headsets and or through other devices, and it is a seemingly real world whereby users can maneuver around and experience the AVs as they go. These include the graphic display, sound familiarization along with the body movements of people within the virtual environment. (Cvetkovic, 2021)

From gaming and entertainment applications to training simulations, medical procedures, and architectural visualization, virtual reality has diverse applications. It holds promise for enhancing learning, therapy, and entertainment experiences. As VR technology continues to evolve and become more accessible, its impact on various aspects of society is poised to grow exponentially.

1.4 Implementation of Virtual Reality (VR) in Education

VR in the recent past has received a lot of attention due to its ability to revolutionize virtual learning. VR technology has gained a lot of traction in different fields such as the Education and Medicinal Industry (Yaaghobi, 2018). Another benefit of virtual reality in veterinary education is the fact that it presents a realistic environment for the practice of various skills by the students. Furthermore, virtual reality can also provide veterinary students with practical experience in scenarios that are challenging or improbable to encounter in real life (Al-Gindy, 2020). This includes a wide range of scenarios that may include wildlife restraint, conducting operations on uncommon animal species, and even basic surgical procedures such as castration (Yaaghobi, 2018).

VR has been proven to improve social interaction among students. (Bayram & Çalışkan, 2022). In a study conducted by Hou et al. (2019), virtual reality-based collaborative learning activities successfully foster teamwork and communication skills. Furthermore, VR Simulations provides a platform for students to practice procedures, techniques, which might include dissection or some surgical intervention, in controlled conditions. This can assist in the development of student's confidence and competency before working with real animals (Ruthenbeck & Reynolds, 2015). Lastly, VR also allows for distance learning. Veterinary students would be able to access educational resources and participate in interactive lectures, and simulations from anywhere, thus eliminating the need for physical presence in a traditional classroom setting (Ruthenbeck & Reynolds, 2015).

In summary, virtual reality has been scientifically proven to be an advantageous tool for virtual learners and/or veterinary students studying veterinary anatomy and physiology. This modernized tool enhances learning experiences by providing an immersive environment, allowing for continuous practice and experimentation in a safe setting. Spatial understanding and visualization of complex concepts can be achieved by integrating VR into veterinary education.

CHAPTER 3

3.0 MATERIALS AND METHODS

A virtual reality intervention module was developed to strengthen veterinary students' learning ability. This developmental process involves an HP Laptop, Apple Smartphone, Oculus Quest 2, Autodesk Maya 3D Graphics Software, Studio 3Max, and Unity 3D. To ensure the modules' accuracy, the modules were validated by experts in the relevant field of veterinary medicine.

3.1 Study Population

The study population for this research involves UMK veterinary students spanning from the first to the fifth year. These students were selected based on specific criteria, notably having completed and/or currently pursuing their Veterinary Anatomy I and Veterinary Physiology I courses. The justification behind this selection criterion is to ensure that participants have a satisfying fundamental knowledge of veterinary anatomy and physiology, which are crucial to understanding the subject under investigation. By targeting students across different stages of their veterinary education, it captures a diverse range of perspectives and experiences.

The sampling method is conducted to ensure that non-biased results are produced. First, the study population was stratified according to their year of study, and second, a simple random sampling was employed to enroll the participants. The selection of the sample was achieved by distinguishing the students according to their year of study. A total of six students were randomly selected from each stratum to participate in this study actively.

3.2 Measurement Tool

Two sets of questionnaires were developed following an extensive literature search and subjected to content and face validation. Prepared questionnaires then were delivered using Google Forms. The assessment included socio-demographic information, expectations and perceptions towards Virtual Reality (VR), and academic questions about Veterinary Anatomy and Veterinary Physiology. The questionnaire was distributed among the participants before and after the intervention. Each individual is given five (5) minutes to complete the quiz.

3.3 Development of the Virtual Reality Application

The VR application was made based on a high-end photorealistic 3D model of a feline musculoskeletal system from Turbosquid. The model was selected based on its anatomical features, component clarity, cost, and suitability. This model is then redefined on the Autodesk Maya 3D Graphics Software and 3D Studio Max. Once the 3D Model is of highest satisfaction, it is further processed via Unity 3D. In Unity 3D, the project required 636 lines of code (LOC) to create interactive elements for a virtual anatomical model. These lines were developed to facilitate interaction with six distinct muscles and four skeletal components. Each muscle and skeletal structure were coded to respond upon hovering, triggering the display of an accurate anatomical image along with descriptive information. The descriptive information attached to each skeletal and muscular component was inspired by multiple, trustable Veterinary Resources, such as the Veterinary Information Network (VIN).

```
void Start ()
{
    footbonetext.SetActive (false);
    backlimbtext.SetActive (False);
    forelimbtext.SetActive (False);
    EXTtxt.SetActive (False);
    Biceptext.SetActive (False);
}
```

Figure 1: Line of Codes (LOC)

3.4 Implementation of the Intervention Module

The newly developed module was tested with each participant individually. To accommodate the students' demanding schedules, all research sessions were scheduled on separate dates and times, allowing for flexibility while ensuring effective module completion.

Firstly, the participating students were given a pre-intervention questionnaire to ascertain their level of knowledge before the activity. Total privacy was ensured during the completion of the questionnaires, and the students were reminded to not disseminate answers among themselves. The students were given five minutes to answer the given Google Form. The form includes academically appropriate content areas, such as organ anatomical descriptions, and physiological functions.

Subsequently, the participants proceeded to undertake the 10-minute of VR session. In the course of the session, the student manipulates the 3D model, examines the morphology, and learns about physiology in a virtual environment. To determine the impact of the VR session, students took another questionnaire at the end of the session. This set includes academic questions and their perceptions of VR in Education.

A comparison of the results obtained from the assessment conducted after the completion of the VR session with the results obtained before the session were compared. This demonstrated whether the VR session had any effect on the knowledge of the students about feline anatomy and physiology. Moreover, this allowed us to distinctly compare whether conventional or innovative methods of learning affect students' ability to retain information. The general flow of this research can be understood by the inserted flowchart (Diagram 1).

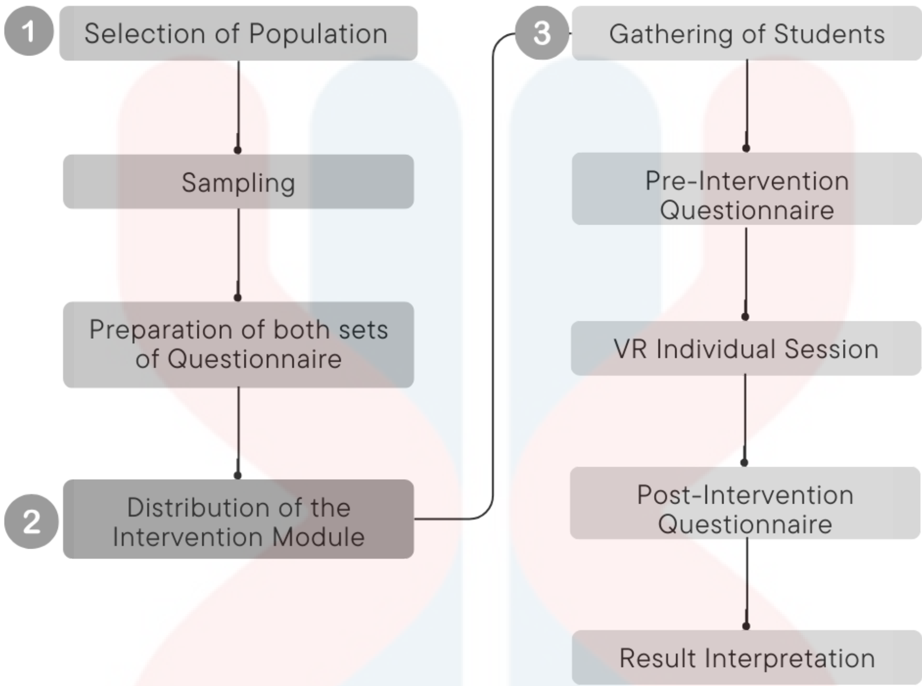

Diagram 1: *The Process Flow implemented for this study.*

CHAPTER 4

4.0 RESULTS

4.1 Comparison of Pre and Post Intervention Scores

Based on the findings shown in Tables 1 and 2, the Z-value of -4.470 indicates a notable skew in rank differences, suggesting consistent variation between the two groups. The level of significance (P-value). value of <0.01 confirms that this variation is statistically significant, meaning the observed differences are unlikely due to chance.

The analysis strongly supports a meaningful change or effect between the conditions studied (pre-test vs. post-test), providing concrete evidence for the effectiveness or impact of the intervention or variable in question. This result successfully signifies the contribution of the intervention in enhancing the students' knowledge of feline Anatomy and Physiology.

Tables 1 and 2 *Statistical Analysis of the Comparison between Pre and Post Intervention scores*

•		N	Mean Rank	Sum of Ranks
POST-TEST - PRE-TEST	**Negative Ranks**	1[a]	4.50	4.50
	Positive Ranks	26[b]	14.37	373.50
	Ties	2[c]		
	Total	**29**		

a. POSTTEST < PRETEST
b. POSTTEST >PRETEST
c. POSTTEST = PRETEST

TEST STATISTICS[a]	
	POST-TEST - PRE-TEST
Z	-4.470[b]
Asymp. Sig (2-Tailed)	**<.001**

a. Wilcoxon Signed Ranks Test
b. Based on Negative Ranks

4.2 Students' Preferences for Integrating VR into Educational Curricula

As shown in Tables 3 and 4, a strong positive perception of VR among veterinary students as an educational tool was achieved. Specifically, 46.70% of participants believed that VR should be well-integrated as a core part of the curriculum. This affirmative result suggests the students' significant acknowledgment of VR's potential in enhancing veterinary education. A slightly larger proportion (53.30%) appreciated VR's benefits but preferred it as a complement rather than replacing traditional pedagogical methods. Surprisingly, none of the respondents had considered VR as unnecessary (0%) or in need of further development (0%).

These responses highlight the students' understanding and appreciation of VR's advantages while reflecting a balanced perspective on its role in education. These results suggest educators focus on integrating VR in ways that complement traditional methods, while fully prioritizing students' learning needs and expectations.

Tables 3 and 4 *Statistical Analysis of the Students' Preferences for Integrating VR into Educational Curriculum*

	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
Preferences for Integrating VR into Educational Curricula	30	85.70%	5	14.30%	3	100.00%

a. Dichotomy group tabulated at value

		Responses		
		N	Percent	Percent of Cases
Preferences for Integrating VR into Educational Curricula	Yes, it should be a core part of the curriculum	14	46.70%	46.70%
	Yes, but only as a supplementary tool	16	53.30%	53.30%
	No, It is unnecessary	0	0	0
	No, It requires further development	0	0	0
Total		30	100.0%	100.0%

a. Dichotomy group tabulated at value

4.3 Potential VR Applications in Vet Medicine

As shown in Tables 5 and 6, the participants showcased a wide-ranged preference for VR application in diverse educational and practical scenarios. The highest endorsement went to Training in Surgical Techniques and Diagnostic Procedures. These two had received a total of 24 responses each (27.30% of the total responses), representing a staggering 85.70% of the cases. This particular result portrays the positive interpretation of VR's capability in providing hands-on, immersive learning experiences in complex procedures of veterinary medicine.

Immersive client communication scenarios had received substantial support, with 21 responses, reflecting 75% of the case. This result indicates the students' recognition of VR's potential in enhancing their soft skills. Simulating animal handling and restraining practices had gathered significant attention as well, with a total of 19 responses, establishing 67.90% of cases.

These results were interesting as they suggest that VR has been successfully recognized as a useful educational tool among students. It advocates the perceived usefulness of VR in various domains of Veterinary Education, including surgical training, diagnostic practice, animal handling, and client communication. This result highlights VR's potential to enhance both technical and interpersonal skills.

Further research should be constructed based on these insights by developing advanced VR modules that are tailored to the learning needs of veterinary students. These modules can be directed toward highly interactive, realistic experiences, allowing students to boost their theoretical knowledge while sharpening practical skills in a risk-free environment. By establishing such an impeccable model, confident and competent veterinary professionals can be fostered.

Tables 5 and 6: *Statistical Analysis of the Potential VR Application in Veterinary Medicine*

	Valid		**Cases Missing**		**Total**	
	N	**Percent**	**N**	**Percent**	**N**	**Percent**
Potential VR Applications in Vet Medicine	28	80.00%	7	20.00%	35	100.00%

b. Dichotomy group tabulated at value 1

		Responses		
		N	**Percent**	**Percent of Cases**
Potential VR Applications in Vet Medicine	Training in surgical techniques and procedures	24	27.30%	85.70%
	Simulating animal handling and restraint practices	19	21.60%	67.90%
	Immersive client communication Scenarios	21	23.90%	75.00%
	Practice in diagnostic procedures such as X-Ray	24	27.30%	85.70%
Total		**88**	**100.00%**	**314.30%**

a. Dichotomy group tabulated at value

4.4 Association of Scores and Year of Study

The Kruskal-Wallis test results revealed no statistically significant difference in the mean ranks of change scores across the five-year groups. Based on Tables 7 and 8, Year 1 had a mean rank of 16.75, Year 2 was 19.08, Year 3 was 14.25, Year 4 was 14.42, and Year 5 was 13.00. The test statistic $H = 1.908$, with 4 degrees of freedom, and a p-value of 0.753, exceeds the conventional threshold of 0.05 for significance. These findings suggest that differences in the year of study do not significantly impact the observed change scores. While there is slight variability in the ranks, the high p-value indicates that these differences are likely due to chance rather than a meaningful relationship. This lack of significant variation highlights the consistency of change scores across all groups, irrespective of their academic progression. Further analysis with larger sample sizes might better assess subtle group differences.

Tables 7 and 8: *Statistical Analysis of the Correlation of Scores and Year of Study*

Ranks			
	Year of Study	**N**	**Mean Rank**
MEAN	1.00	6	16.75
	2.00	6	19.08
	3.00	6	14.25
	4.00	6	14.42
	5.00	6	13.00
	Total	**30**	

Test Statistics[a,b]	
	Mean
Kruskal-Wallis H	1.908
df	4
Asymp. Sig.	.753

a. Kruskal Wallis Test, b. Grouping Variable: Year_Code

4.5 Pre Intervention Expectation Towards Virtual Reality

The pre-test survey results indicate that participants perceive several benefits of VR in veterinary medicine. As indicated by the tabulated results (Tables 9 and 10), the most frequently cited advantage was the ability to practice without using live animals, reported by 28.6% of respondents. Other significant responses include providing instant access to learning materials (23.1%), making learning more engaging (27.5%), and reducing the need for traditional learning settings (20.9%). The total percentage of cases exceeds 100%, reflecting the possibility of multiple responses per participant. These findings highlight the diverse ways in which VR could enhance veterinary education.

Tables 9 and 10: *The Pre-intervention Expectations Towards Virtual Reality*

	Valid		**Cases Missing**		**Total**	
	N	**Percent**	**N**	**Percent**	**N**	**Percent**
Pre_Improvement Frequency[a]	30	90.90%	3	9.10%	33	100.00%

b. Dichotomy group tabulated at value 1

		Responses		
		N	**Percent**	**Percent of Cases**
Pre_ Improvement Frequency[a]	By allowing practices without using live animals	26	28.60%	86.70%
	By providing instant access to learning materials	21	23.15%	70.00%
	By making learning more fun and engaging	25	27.50%	83.30%
	By reducing the need for traditional learning settings	19	20.90%	63.30%
Total		**91**	**100.00%**	**303.30%**

b. Dichotomy group tabulated at value 1

4.5 The Challenges of Virtual Reality

The results of the post-test survey highlight key challenges faced by participants during the VR experience. As shown in Tables 11 and 12, the most common issue was difficulty navigating the VR interface, reported by 44.2% of respondents. Physical discomfort followed at 20.9%, while a lack of anatomical accuracy was noted by 11.6%. Interestingly, 23.3% of participants indicated no significant challenges. These findings emphasize the need for improvements in interface usability and comfort, while anatomical accuracy was a less frequent concern. The total case percentage exceeds 100%, reflecting multiple responses per participant.

Tables 11 and 12: *The Challenges of Virtual Reality*

Post-Test: Challenges of VR				
		Responses		
		N	**Percent**	**Percent of Cases**
Post-Test: Challenges of VR[b]	Difficulty navigating the VR Interface	19	44.20%	63.30%
	Physical Discomfort	9	20.90%	30.00%
	Lack of Detailed Anatomical Accuracy	5	11.60%	16.70%
	No Significant Challenges	10	23.30%	33.30%
Total		**43**	**100.00%**	**143.30%**

c. Dichotomy group tabulated at value 1

Case Summary						
	Valid		**Missing Cases**		**Total**	
Post-Test: Challenges of VR[b]	N	Percent	N	Percent	N	Percent
	30	90.90%	3	9.10%	33	100.00%

b. Dichotomy group tabulated at value 1

4.6 Suggestions For Future Virtual Reality Applications

The results show that participants have diverse suggestions for improving the VR experience. The highest percentage (67.7%) of respondents (N=21) favored adding more real-world scenarios to the VR application, followed by providing more guidance throughout the simulation (64.5%, N=20). Improving the clarity and precision of anatomy models and enhancing user interaction and control both received 61.3% (N=19) support. These findings highlight the importance of enhancing user experience through more realistic content, guidance, and interactivity. With a total response rate of 254.8%, it suggests that multiple improvement areas were emphasized by the participants.

Tables 13 and 14: *Suggestions for Future Virtual Reality Applications*

Post-Test: Potential Improvements for VR				
		Responses		
		N	**Percent**	**Percent of Cases**
Post-Test: Potential Improvements for VR[c]	Adding more real-world scenarios	21	26.6%	67.70%
	Improving the clarity and precision of anatomy models	19	24.1%	61.30%
	Enhancing user interaction and control	19	24.1%	61.30%
	Providing more guidance throughout the simulation	20	25.30%	64.50%
Total		**43**	**100.00%**	**143.30%**

d. Dichotomy group tabulated at value 1

Case Summary						
	Valid		**Missing Cases**		**Total**	
Post-Test: Potential Improvements for VR[c]	N	Percent	N	Percent	N	Percent
	31	93.9%	2	6.1%	33	100.00%

c. Dichotomy group tabulated at value 1

CHAPTER 5

5.0 DISCUSSION

The study results successfully provide significant insights into the use of Virtual Reality (VR) in veterinary education, emphasizing its benefits and areas for improvement. A comparative analysis of pre-test and post-test scores revealed a marked improvement in participants' understanding of feline musculoskeletal anatomy, demonstrating the VR application's effectiveness as a learning tool. This result is influenced by VR's capability to offer students an interactive experience, allowing the change to virtually explore, extract, and dissect the layers of muscles and bones - which is simply unachievable through traditional textbooks. This particular result should be a motivational factor for future VR Integration in Veterinary Medicine. VR can also be further integrated into vast sectors of Veterinary Medicine, this is inclusive of Surgical Preparation, Comparative Anatomy, Restraining Methods, and more.

Upon consideration of the financial aspect of the VR module used in this research, it remains a cost-effective investment for veterinary students. The module offers features that provide realistic, interactive, anatomical, and physiological scenarios which makes it an invaluable tool. While the cost may initially appear as a moderate expense, the long-term benefits of VR integration in education outweigh the win. Given the practical and educational advantages, it provides, integrating VR into veterinary education is a well-justified and forward-thinking investment.

Statistical analysis was conducted to evaluate the relationship between the year of study and change scores, defined as the difference between post-intervention and pre-intervention scores. The analysis revealed no statistically significant impact of the year of study on change scores, suggesting uniformity in outcomes across academic levels.

Nevertheless, the results prove the effectiveness of the intervention module in enhancing students' medicinal understanding, as all academic years demonstrated positive improvements in change scores. This highlights the module's capacity to benefit learners consistently across different stages of study.

The pre-test findings portray the students' perception that VR has significant potential to enhance veterinary education. Key benefits identified include enabling practice without the use of live animals, increasing student engagement, and providing instant access to educational resources. Most participants highlighted VR's value in reducing reliance on live subjects for practical learning, emphasizing its role as a supplementary tool rather than a replacement.

This approach allows students to acquire procedural knowledge in a safe, controlled environment, ensuring skill development while lowering errors during real-life applications. By simulating practical tasks, VR enhances confidence and competence, preparing students for hands-on experiences with live subjects. These findings reflect an acknowledgment of VR's ability to bridge theoretical knowledge with practical skills, addressing ethical concerns associated with traditional methods while maintaining high educational standards. Additionally, the results emphasize the adaptability of VR to cater to various learning styles, making veterinary education more accessible and inclusive. This demonstrates its potential to revolutionize traditional teaching methods while maintaining a balance between technological innovation and practical experience. Overall, the pre-test findings reinforce the promising role of VR as a preparatory and ethical educational platform in veterinary training.

The post-test findings revealed key challenges encountered by participants, particularly with navigating the VR interface and experiencing physical discomfort. Most participants reported confusion in using the technology, an issue anticipated in this study. To address this, an Educational Poster was provided to all participants, outlining step-by-step instructions for navigating the VR hand controllers. This proactive approach aimed to reduce uncertainty and improve user interaction during the intervention, ensuring a smoother and more accessible experience for all participants. Interestingly, a significant portion of participants did not perceive any major challenges, which reflects positively on the user-friendliness of the application. Nonetheless, the identified barriers suggest areas that need refinement, including improving interface design and mitigating physical strain during use.

For future VR application development, participants highlighted the need for enhancements, such as incorporating real-world scenarios, improving anatomical model clarity, and enriching user interactivity. To address these priorities, conducting surveys among veterinary students to identify preferred scenarios—such as operating theaters, client consultations, or animal restraint techniques—could provide targeted insights. These proposals underscore the importance of creating immersive and tailored experiences that meet educational goals. By integrating such feedback, developers can better align VR tools with the evolving needs of veterinary training.

Overall, the study illustrates the promise of VR in veterinary education while highlighting key areas requiring further attention. Addressing challenges such as physical discomfort and interface complexity and integrating user-driven improvements could enhance the application's impact. These findings provide a robust foundation for future research and development of VR applications tailored to the educational needs of veterinary professionals.

CHAPTER 6

6.0 CONCLUSION AND RECOMMENDATION

Based on the findings of this study, it is recommended that esteemed veterinary educational institutions, such as Universiti Malaysia Kelantan (UMK) and Universiti Putra Malaysia (UPM), consider incorporating VR-based modules into their veterinary curricula. The study has demonstrated that virtual reality (VR) can enhance veterinary students' understanding of conceptual subjects, such as Veterinary Anatomy and Physiology, as evidenced by the notable improvement in post-intervention scores. Additionally, the research indicates that students express a preference for the integration of VR as a supplementary teaching tool in veterinary education. Furthermore, VR has shown potential for application in various aspects of veterinary medicine, particularly in areas such as surgical procedure demonstrations and diagnostic tests.

VR is an available, combinative option in various domains of Veterinary Medicine. this is inclusive of certain surgical procedures, communication role-playing in clinical settings, and many more. These implementations are advantageous for students to strengthen their practical experience and skill while ensuring zero animal patients are harmed during the process. To achieve this, educators are encouraged to incorporate VR sessions as supplemental resources concurrently with traditional lectures and practical labs.

Given that VR technology can simulate various aspects of animal anatomy, developing additional modules covering different species and anatomical systems could be highly beneficial. Future modules should be inclusive of anatomically and physiologically detailed small animals, equines, bovines, and avian anatomy. Specialized topics such as neurology, cardiology, and gastrointestinal can also be studied. This is extremely advantageous as comparative anatomy between multiple species can be performed simultaneously. Developing these models could provide students with an even broader, species-specific understanding, which would be especially valuable in diverse clinical settings.

Further studies could investigate the long-term retention of knowledge gained through VR modules versus traditional methods. Understanding how VR influences memory consolidation and practical recall could help educators determine the most effective teaching practices and tailor content to maximize student comprehension. Additionally, research exploring VR's potential role in diagnostic skill-building would be valuable.

While VR offers countless advantages, this study has identified that extended use can occasionally cause physical discomfort, such as eye strain and headaches. Physical discomfort can be caused by many factors. Visual disorientation and Eye strain have often resulted due to the VR Headsets requiring continuous focus on screens that are inches away. The continuous focus results in headaches, blurred vision, and general discomfort. Additionally, VR can induce motion sickness due to a sensory conflict between the visual motion experienced in the virtual environment and the lack of corresponding physical movement. This mismatch can cause symptoms like nausea and dizziness. Future VR module development should focus on enhancing user comfort, including shorter or adjustable session lengths and user-friendly controls. Moreover, thorough orientation sessions before VR use can help familiarize students with the controls, potentially reducing discomfort caused by navigating unfamiliar environments.

Collaborative efforts between VR developers, veterinary educators, and industry experts are crucial to producing accurate, high-quality VR content. Institutions could partner with VR development firms and experienced veterinarians to ensure that models are anatomically precise and clinically relevant. This collaboration could also enable access to more resources for enhancing and updating VR applications, keeping pace with educational advancements and technological capabilities

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7.0 Appendix

Figure 2: Poster to help participants familiarize themselves with VR controllers.

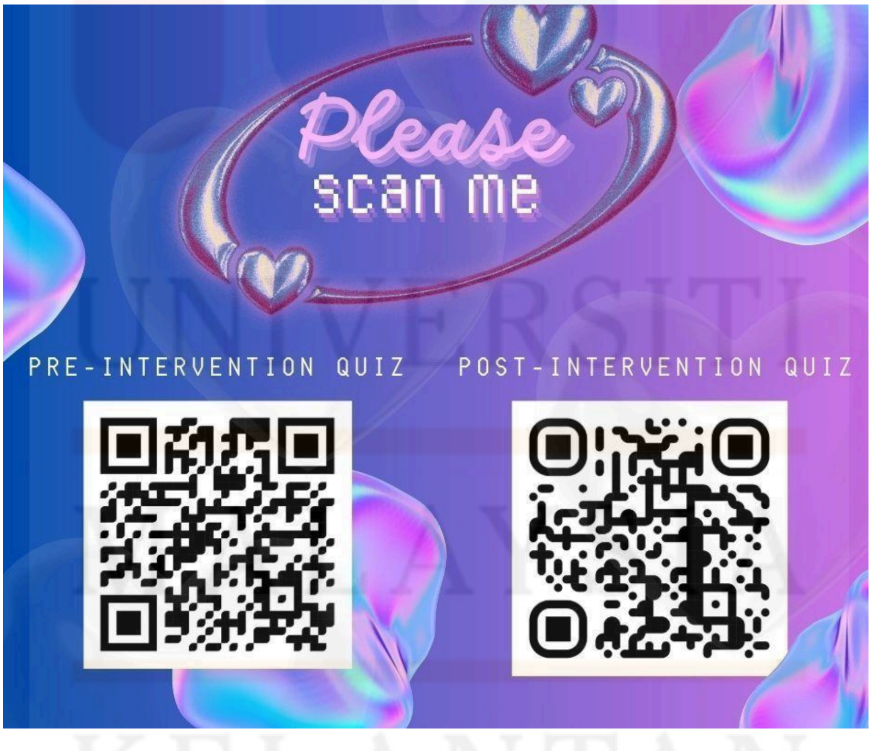

Figure 3: Poster that contains QR Codes that directs participants to both sets of questionnaire

Figure 4: Initial Version of the Implemented Intervention Model

Figure 5: Professional Validation with Dr. Dauda Goni

Figure 6: Paraclinical participants undergoing their VR session