DESIGN, VALIDATION AND IMPLEMENTATION OF SCHEMATIC DIAGRAMS AND ILLUSTRATIONS AS A LEARNING TOOL FOR BLOOD AND FAECAL SAMPLES COLLECTION IN GOATS AND CATTLE

LUI XIN YEN

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Design, Validation and Implementation of Schematic Diagrams and Illustrations as a Learning Tool for Blood and Faecal Samples Collection in Goats and Cattle

By

Lui Xin Yen

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DESIGN, VALIDATION AND IMPLEMENTATION OF SCHEMATIC DIAGRAMS AND ILLUSTRATIONS AS A LEARNING TOOL FOR BLOOD AND FAECAL SAMPLES COLLECTION IN GOATS AND CATTLE

ABSTRACT

Blood and faecal samples are the primary samples used in disease diagnosis and herd health evaluation of goat and cattle. There is a lack of instructional material regarding the sampling in FPV,UMK. This study aims to develop a learning module on blood and faecal sample collection in goat and cattle for easier reference in FPV,UMK. Design of illustrations and schematic diagrams were done by using digital drawing software and designing websites. For the validation of the design, face validation was done by collecting feedback from undergraduate students on a face–to-face basis after reviewing the design. Content validation was done by providing a self-administered online questionnaire for pre-clinical undergraduate veterinary students and two academicians in FPV,UMK to assess the influence of the design in improving understanding. Data were analysed by using Google Sheets and SPSS software and the result concluded that the veterinary students achieve better understanding on blood sampling (mean score 4.78 out of 5) and faecal sampling (mean score 4.77 out of 5) after review of the design. Lastly, implementation of the design was done by compiling them into a user-friendly learning module in electronic form and physical form. In conclusion, the use of the learning manual can improve understanding and solve the problem of heterogeneity and confusion from various references.

Keywords: Blood sample collection, Faecal sample collection, Veterinary, Illustration, Schematic diagram, Learning module

REKABENTUK, PENGESAHAN DAN PELAKSANAAN RAJAH SKEMATIK DAN ILUSTRASI SEBAGAI ALAT PEMBELAJARAN MENGENAI PENGUMPULAN SAMPEL DARAH DAN NAJIS DALAM KAMBING DAN LEMBU

ABSTRAK

Sampel darah dan najis adalah sampel utama yang digunakan dalam ujian diagnostik penyakit dan penilaian kesihatan gerompok kambing dan lembu. Terdapat kekurangan bahan pengajaran mengenai persampelan dalam FPV,UMK. Kajian ini bertujuan untuk membangunkan modul pembelajaran pengambilan sampel darah dan najis dalam kambing dan lembu bagi menjadikan rujukan dalam FPV,UMK. Reka bentuk ilustrasi dan gambar rajah skematik dilakukan dengan menggunakan perisian lukisan digital dan laman web. Untuk pengesahan reka bentuk, pengesahan muka dilakukan dengan mengumpul maklum balas daripada pelajar prasiswazah secara bersemuka selepas menyemak reka bentuk. Pengesahan kandungan dilakukan dengan menyediakan soal selidik untuk pelajar pra-klinikal veterinar dan dua ahli akademik di FPV,UMK untuk mengumpul maklumat dalam mengesahkan kesesuaian dan prestasi reka bentuk. Data dianalisis dengan menggunakan Google Sheets dan SPSS dan hasilnya menyimpulkan bahawa pelajar veterinar mencapai pemahaman yang lebih baik tentang pengambilan sampel darah (skor min 4.78 daripada 5) dan pengambilan sampel najis (skor min 4.77 daripada 5) dalam kambing dan lembu selepas menyemak reka bentuk. Akhir sekali, pelaksanaan reka bentuk dilakukan dengan menyusunnya ke dalam modul pembelajaran mesra pengguna dalam bentuk elektronik dan fizikal. Kesimpulannya, penggunaan manual pembelajaran dapat meningkatkan pemahaman dan menyelesaikan masalah heterogen dan kekeliruan daripada pelbagai rujukan.

Kata kunci: Pengambilan sampel darah, Pengambilan sampel najis, Veterinar, Ilustrasi, Gambar rajah skematik, Modul pembelajaran

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LIST OF ABBREVIATIONS

FPV UMK	Faculty Perubatan Veterinar, Universiti Malaysia Kelantan
SPSS	Statistical Package for the Social Sciences

LIST OF SYMBOLS

%	Percentage
≥	Greater and equal to
<	Less than

CHAPTER 1

INTRODUCTION

1.1 Background

In Malaysia, goat and cattle are two economically important livestock species which contribute to the agricultural sector and the livelihoods of millions of people. Veterinary medicine has made significant advances in diagnostic techniques and tools to monitor the health status of livestock over recent years. In order to diagnose various diseases and conditions on animals, blood and faecal samples are invaluable resources. Faecal samples are helpful for the identification of gastrointestinal parasites as well as to assess digestive health. The blood sample will provide biochemical profiles which are important in assessing the health status of animals and the result is a prerequisite for diagnosis of pathophysiological and metabolite disorders (Zafar *et al.,* 2020).

Sample collection is a step prior diagnostic workup that can be easily neglected for its importance in providing high-quality samples and minimal stress to the animal. In order to ensure the integrity of laboratory results, a proper sample collection is an important pre-analytical step (Bowen & Remaley, 2014). Furthermore, the quality and relevance of submitted samples can determine the validity of laboratory testing in disease investigation (Constable *et al.,* 2016). Given the importance of these samples, it is imperative to develop clear guidelines for their collection. However, currently there is a lack of instructional materials established by the Faculty of Veterinary Medicine, Universiti Malaysia Kelantan (FPV UMK) regarding the guideline of blood and faecal sample collection in both goat and cattle that can be utilised by veterinarian and

veterinary students. Reference to various sources and teaching materials which may lead to confusion and lack of standardisation on the sample collection procedure (Vaitsis *et al.*, 2017). In addition, improper sample collection can also result in animal stress and discomfort, which may impact animal welfare.

A schematic diagram can be utilised to simplify a complex process by visual representation, to make it easier for users to understand and follow procedures (Gates, P., 2018). In the context of sample collection, schematic diagrams allow the procedure to be easily understood by veterinary professionals and students and make the collection process more efficient, reducing errors thus ensuring consistent and high-quality samples collected.

By designing, validating, and implementing a schematic diagram for blood and faecal sample collection, this project aims to improve understanding, hence promoting the efficiency, accuracy and consistency of blood and faecal sample collection procedures in goat and cattle. Ultimately, this project intends to facilitate sample collection and contribute to a more effective disease surveillance system, thus improving animal health management, disease prevention, and livestock productivity, benefiting both farmers and the veterinary community.

1.2 Problem Statement

The lack of instructional material for blood and faecal sample collection in cattle and goat in the Faculty of Veterinary Medicine, UMK may lead to the usage of various reference sources to understand the sampling method. The usage of reference to various sources of sampling methods leads to confusion and heterogeneity in practice. This

project aims to design an instructional material for blood and faecal sample collection procedures in goat and cattle to be used in FPV UMK.

1.3 Research Questions

i. How to design an instructional material for blood and faecal sample collection procedures that can achieve high understanding among veterinary undergraduates?

ii. How to validate an instructional material for blood and faecal sample collection procedures that can achieve high understanding among veterinary undergraduates?

iii. How to implement the design to a user-friendly reference?

1.4 Hypothesis

H_0 : The use of a schematic diagram and illustration for blood and faecal sample collection procedures in goat and cattle will not lead to improved understanding among veterinary students and veterinarians.

H_A : The use of a schematic diagram and illustration for blood and faecal sample collection procedures in goat and cattle will lead to improved understanding among veterinary students and veterinarians.

1.5 Objectives

i. To design schematic diagrams and illustrations for blood and faecal sample collection procedures in goats and cattle.

ii. To validate the suitability and performance of the schematic diagrams and illustrations in achieving high understanding among veterinary undergraduates.

iii. To implement the usage of the design into a user-friendly reference for blood and faecal sample collection procedures in goats and cattle.

1.6 Importance of expected research findings

This project aims to design a schematic diagram and illustration for the blood and faecal sample collection in goat and cattle. The final outcome of this project will serve as a reference for veterinarians and veterinary students. By providing a clear and easy-to-understand illustration of the procedure, veterinarians and veterinary students can visualise and understand the procedure better.

CHAPTER 2

LITERATURE REVIEW

2.1 Livestock

Livestock are animals primarily raised for the production of various commodities such as meat, milk, eggs, leather, and wool, and play an important role in agricultural economies worldwide. In Malaysia, non-ruminant livestock, primarily chickens, constitute the majority of the total livestock population. Conversely, the majority of registered livestock farms are ruminant-based, specifically beef cattle farms, followed by goat, sheep, buffalo, and dairy cattle farms (Zayadi, 2021). As livestock farming continues to advance, an array of challenges has emerged, encompassing disease-related issues and production constraints (Vincente *et al.*, 2021). Routine health screening is important to carry out to ensure the animals live healthily (Shahudin *et al*., 2018).

2.2 Importance of sampling in animal disease surveillance

According to the Department of Veterinary Service in Malaysia, animal disease surveillance programmes require the collection of samples from animals. For example, blood sample for screening of bovine or caprine Brucellosis while faecal sample for screening of Johne's Disease (Shahudin *et al.*, 2018). Common diagnostic tools in this context are serum biochemistry and complete blood count for haematological values, which play a crucial role in identifying and managing various animal diseases (Brooks *et al.*, 2022).

While the significance of routine blood sample collection cannot be overstated in veterinary practices, blood sample collection is one of the most neglected procedures and it suffers from a high degree of pre-analytic variability and involves serious health risks. For example, accidental needlestick injuries to the operator and casual lesions inflicted on the patient due to improperly performed venipuncture. The major sources of blood collection failure are due to needle size, blood collection device, venous stasis and venous access (Gosselin, 2023). For example, the collection of blood samples by using an unsuitable needle may cause excessive aspiration which leads to haemolysis of blood (Noordin & Isa, 2021). In addition, improper collection and handling can lead to invalid test results and cause harm to the patient if inappropriate interventions are applied based on false results (Russell & Roussel,2007).

Other than blood samples, faecal samples are other valuable samples that can be used for disease diagnosis. In small ruminants, one of the most common diseases is gastrointestinal and external parasitism (Johns & Heller, 2021). The presence of gastrointestinal parasites can be detected by faecal examination and the detection of gastrointestinal parasites through faecal examination can be qualitative or quantitative. It is equally important to document the parasite burden and the evaluation of therapy efficacy through faecal analysis method(Johns & Heller, 2021). A systematic screening program for parasite control is imperative. This involves the collection of faecal samples from the herd once every three months to be used for diagnostic tests such as faecal flotation (Shahudin *et al*., 2018).

2.3 Usage of schematic diagram and illustration on comprehension of a procedure

Humans are highly dependent on their vision to process information from what is seen (Thapa *et al.*, 2021). Two main factors that appear to be influencing the ease of understanding instructions and procedures are the intrinsic complexity of information and how it is presented, in which visual aids like illustrations play an important role in the learning process (Sweller, 2020). Medical illustrations are the combination of observations, technical and skills that are scientifically informed to portray the subjects and facts in the medical field. It helps in the process of teaching and learning as well as a comprehensive understanding of concepts and is fundamental in communication (Thapa *et al*, 2021). Delving deeper into the effectiveness of visual aids, a study by Sojourner and Wogalter found that the combination of textual instructions with illustrations outperformed reliance on text or illustrations alone. This combined approach not only enhanced comprehension but also significantly improved the recall of provided information (Lee, 2021).

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Equipment and software used

The equipment used for the development of illustrations was a Huion® H640P digital graphic drawing tablet paired with a Huion® PW100 digital pen stylus, a laptop and Krita® 5.2.1 as the digital painting software. Canva® website was used for the development of schematic diagrams and posters. For validation of design, Google Forms was used to create questionnaires, while Google Sheets and IBM® SPSS® Statistics version 27 were used for data analysis.

3.2 Development of schematic diagrams and illustrations

The process of creating schematic diagrams and illustrations started with the decision on the number of visuals and the specific elements to be included. Preliminary sketches were then created in Krita® 5.2.1 software, using a digital drawing tablet and stylus. The initial focus involved sketching the general body outlines of goats and cattle, followed by the detailed depiction of various body parts. Tools such as digital painting brushes, shadowing, layers, masking, and colour balance were used to enhance the visual appeal and clarity.

Transitioning to schematic diagrams, Canva® was used as the designing website. Jugular venipuncture, coccygeal venipuncture, and faecal collection procedures were outlined in a step-by-step manner. The sentences were arranged to match the procedural steps. Components such as text boxes, arrows, and connecting lines were employed to construct these schematic diagrams.

The final stage involved the integration of these illustrations and schematic diagrams into a cohesive visual representation by using Canva® as well. The poster was designed by combining the information on the types of blood tubes, jugular venipuncture, coccygeal venipuncture, and faecal sample collection, as shown in Figure 4.1.

3.3 Preparation of questionnaire for design validation

For the validation of the design created, a self-administered online questionnaire was created using Google Forms. The questionnaire consisted of a set of 13 statements divided into two sections. The statements were designed to assess the respondents' understanding of blood and faecal sample collection in goat and cattle using a five-point Likert scale to state their agreement or disagreement. The Likert scale, featuring statements ranging from "1 = Strongly Disagree" to "5 = Strongly Agree," provided a straightforward and intuitive means for respondents to convey their opinions.

The first section comprises two statements to assess the respondents' baseline knowledge of sampling before the review of the poster. The second section of the questionnaire consisted of the poster and post-evaluation statements. After reviewing the posters, two statements were used in collecting their agreement and disagreement in their understanding of sampling, eight statements were used to obtain feedback on the clarity, relevance, and suitability of the posters. Respondents were also encouraged to provide recommendations for improving the illustrations and schematic diagrams.

After the questionnaire was constructed, the questionnaire underwent a validation process before being distributed to the targeted participants by a statistician.

This additional step ensured that the questionnaire's items were comprehensible and aligned with the research objectives. The statistician's input added a layer of expertise to the validation process, reinforcing the questionnaire's reliability as a tool for assessing respondents' knowledge and perceptions regarding blood and faecal sample collection in goats and cattle.

3.4 Validation of design

To validate the suitability and performance of the schematic diagrams and illustrations, face validation and content validation were used. Face validation involved the direct engagement of 10 undergraduate veterinary students from FPV, UMK. These students were selected randomly to evaluate the posters in a face-to-face setting. Subsequent to their review, comments were collected to have valuable insights into their perceptions and understandings of the designs.

For content validation, the questionnaire prepared was administered and collected through Google Forms from 21st November until 26th November 2023, over a span of six days. The targeted study population consists of pre-clinical undergraduate veterinary students from FPV UMK, commonly referred to as Year 1 and Year 2 because preclinical students have not yet undergo their clinical practice and have lower exposure to the knowledge of sample collection in goat and cattle, thus making them suitable subjects to assess the understanding. The link of the questionnaire was distributed through messaging applications among preclinical veterinary students in FPV UMK, ensuring widespread access and participation.

The combination of face validation and content validation ensured a well-rounded and thorough assessment of the designed educational materials. The direct engagement with undergraduate veterinary students provided immediate feedback,

while the structured questionnaire added a layer of systematic assessment. Both methods, rooted in accessibility and clarity, underscored a commitment to understanding the efficacy of the educational materials in enhancing students' understanding of blood and faecal sample collection in goats and cattle.

3.5 Data analysis

Upon completion of data collection via Google Forms, the raw data is transferred into Google Sheets for initial organisation of information. The subsequent phase involved a thorough analysis facilitated by using SPSS®. In SPSS, a Paired T-test was used to analyse the data to ascertain any significant differences in responses before and after participants reviewed the designs created. The statistical analyses will be significant if $p<0.05$. The results generated from the analysis were inserted in a table to allow a more organised presentation. Then, the interpretation of the data can be carried out to identify the pattern of the data.

3.6 Implementation of design

The design was compiled into electronic form as a learning module to be distributed by the Department of Veterinary Clinical Studies.

CHAPTER 4: RESULTS

4.1 Posters

The details of blood and faecal samples collection were included in posters. Figure 4.1 showed the overall poster consists of blood and faecal sample collection and types of blood tubes and equipment needed in blood collection in goats and cattle. Figure 4.2 showed a single poster of types of blood tubes and equipment needed in blood collection while Figure 4.3 showed the single poster of jugular venipuncture in goats and cattle. In Figure 4.4, the single poster of coccygeal venipuncture in goats and cattle was shown and Figure 4.5 showed the poster of faecal sample collection in goats and cattle.

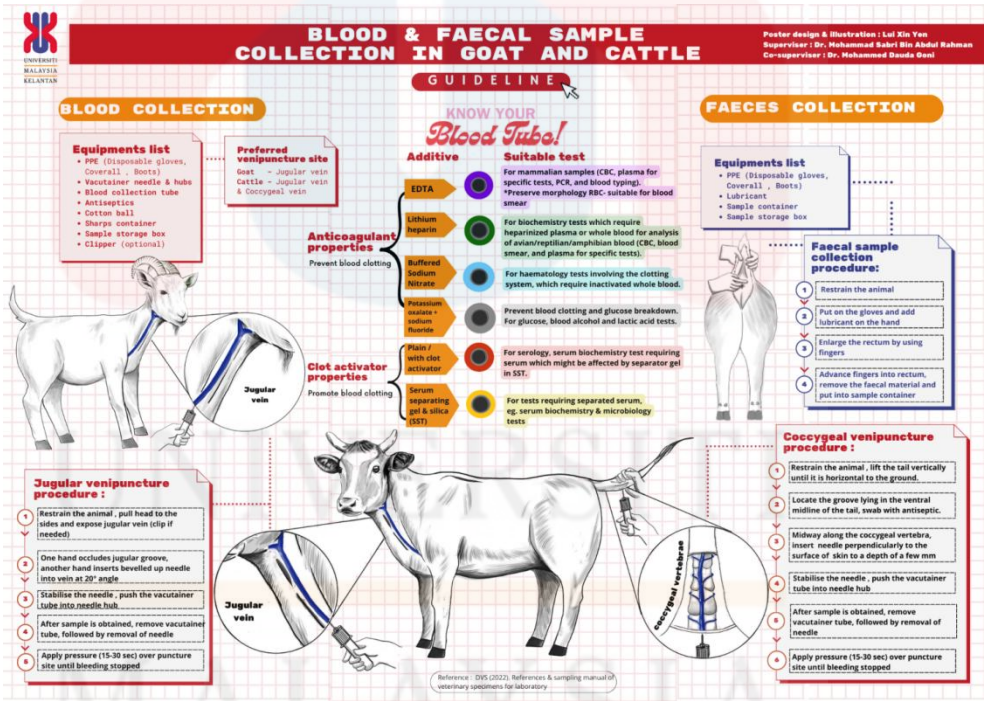

Figure 4.1 : Overall poster of blood and faecal sample collection in goat and cattle

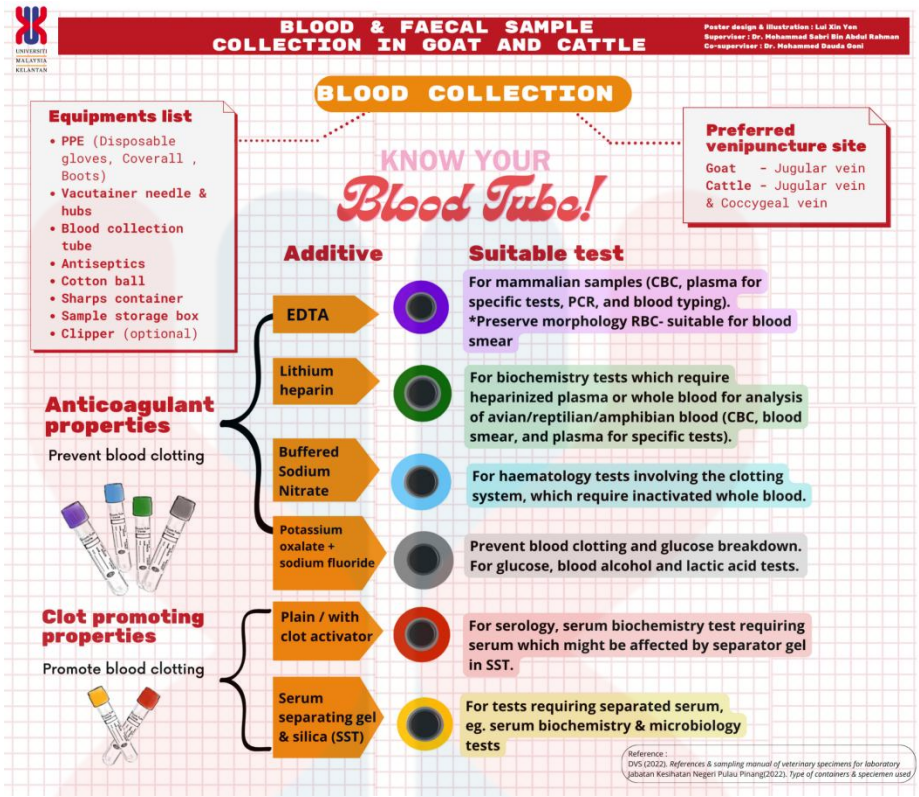

Figure 4.2 : Poster of types of blood tubes and equipment needed in blood collection

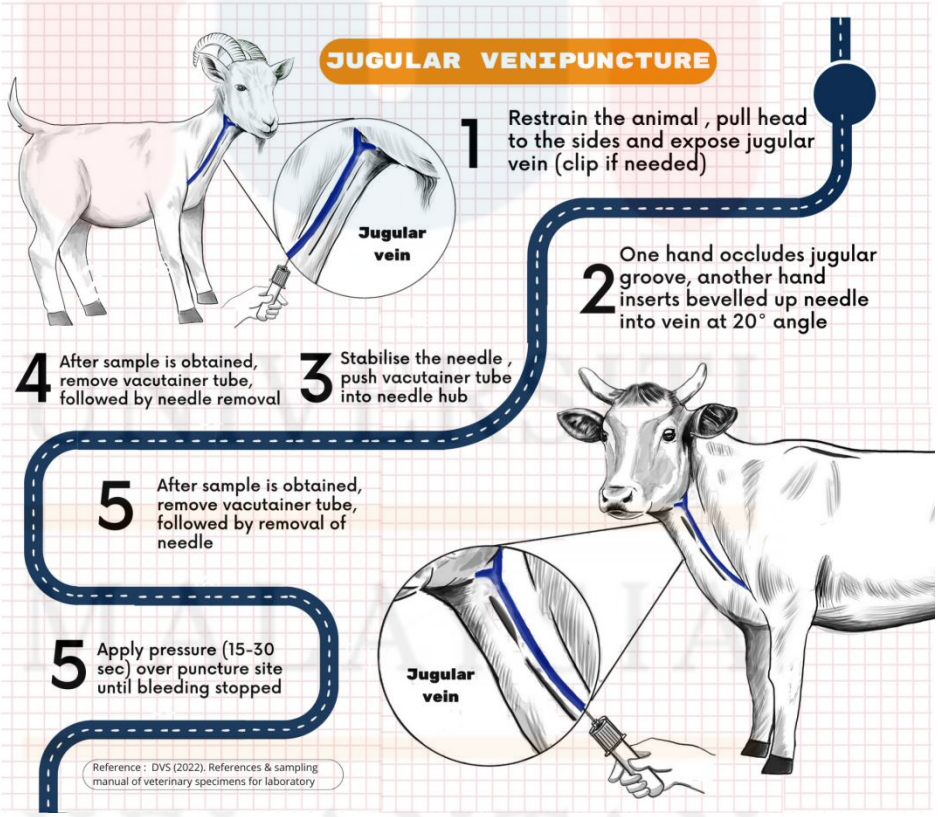

Figure 4.3 : Poster of jugular venipuncture in goats and cattle

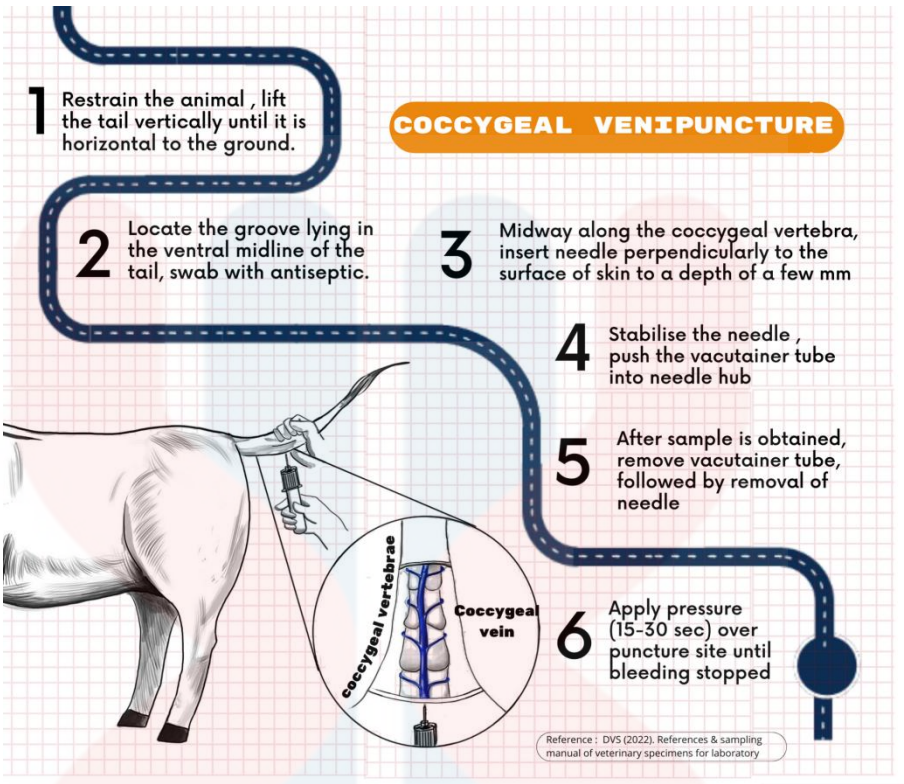

Figure 4.4 : Poster of coccygeal venipuncture in goats and cattle

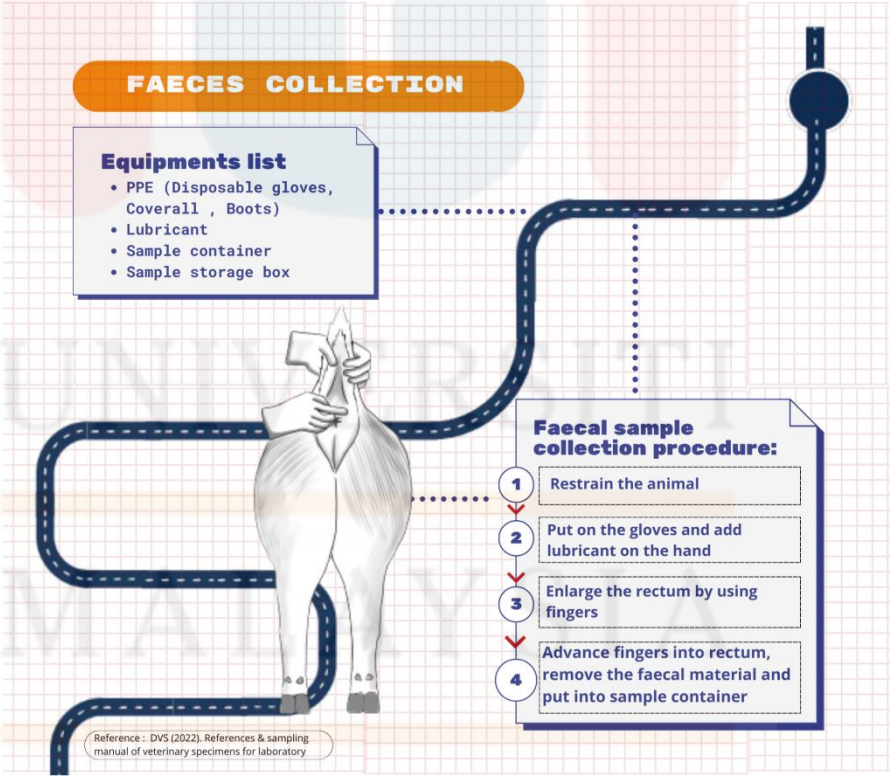

Figure 4.5 : Poster of faecal sample collection in goats and cattle

4.2 Face validation result

From the face validation in ten respondents, 6 respondents have no comments on improving the design while 4 respondents have recommendations on the punctuation, missing details and presentation of information as shown in Table 4.1.

Table 4.1:Recommendation from face validation respondents in poster improvement

Respondent	Recommendations
1	The distance of the comma mark in the sentence should be the same.
2	The "mm" in faecal sampling procedure can state what is the exact distance instead of "mm" only.
3	Missing the step of antiseptic swab on jugular venipuncture
4	Too much information in one poster, a little bit crowded.
5-10	Satisfactory with no comments.

4.3 Respondent's Demographic

For content validation, a total of 78 participants out of 107 (73%) Year 1 and Year 2 pre-clinical students participated in the questionnaire, of which 52 respondents (66.7%) were DVM 1 students and 26 respondents (33.3%) were DVM 2 students as shown in Table 4.2.

Table 4.2:Respondent's demographic (n=78)

Variables	Number	Percentage (%)
Year 1	52	66.7%
Year 2	26	33.3%

4.4 Respondent's perception towards design relevancy, suitability and presentation

In table 4.3, a total of 88.5% respondents (n=69) from the 78 total respondents strongly agreed that the content in the poster is relevant to the procedure. 85.9% of respondents (n=67) strongly agreed that the poster provides clarity in explaining the procedure and 84.6% respondents (n=66) strongly agreed that the presentation of the poster is suitable in presenting the procedure. From the result, we can depict that the design is relevant, suitable and the presentation provides sufficient clarity to the viewer.

For the statements "The schematic diagrams (procedure flow) in the poster improve understanding of the procedure" and "The illustrations used in the poster improve understanding of the procedure.", 84.6% of the respondents (n=66) and 85.9% of the respondents (n=67) strongly agreed to the statements respectively. From the result, we can conclude that the use of schematic diagrams and illustration can help in improving understanding.

Lastly, 83.3% respondents (n=65) strongly agreed that the use of this poster in UMK as instructional material can help avoid confusion and heterogeneity in practice due to the presence of various reference sources. This result helped to justify the importance of using the poster in FPV, UMK.

Table 4.3: Respondent's perception towards design relevancy, suitability and presentation

Statement	Response %				
	Strongly	Disagree	Neutral	Agree	Strongl

	Disagree				**y Agree**
The content in the poster is relevant to the procedure.	0.0	0.0	2.6 (n=2)	9.0 (n=7)	88.5 (n=69)
The poster provides clarity in explaining the procedure.	0.0	0.0	3.8 (n=3)	10.3 (n=8)	85.9 (n=67)
The presentation of the poster is suitable in presenting the procedure.	0.0	0.0	5.1 (n=4)	10.3 (n=8)	84.6 (n=66)
The schematic diagrams (procedure flow) in the poster improve understanding of the procedure.	0.0	0.0	5.1 (n=4)	10.3 (n=8)	84.6 (n=66)
The illustrations used in the poster improve understanding of the procedure.	0.0	1.3 (n=1)	1.3 (n=1)	11.5 (n=9)	85.9 (n=67)
The use of this poster in UMK as instructional material can help avoid confusion and heterogeneity in practice due to the presence of various reference sources.	0.0	0.0	3.8 (n=3)	12.8 (n=10)	83.3 (n=65)

4.5 Pre-evaluation and post-evaluation of respondents' understanding on sampling in goat and cattle (Paired T-test)

Table 4.4 showed the analysed data using paired T-test to compare the pre- and post-understanding of the respondent before and after reviewing the design. The mean Likert score of understanding on blood sampling and faecal sampling are both 2.55 out of 5 before the respondents review the poster. The mean Likert score of understanding on blood sampling and faecal sampling are 4.78 and 4.77 respectively after the respondents review the poster. The mean score before and after reviewing the poster was significantly different (p<0.001). The score was higher after reviewing the poster, the mean score increased by 2.33 for blood sampling and 2.22 for faecal sampling. The null hypothesis is rejected since p<0.001, thus the alternate hypothesis was concluded that there is a mean difference of score before and after the evaluation of the instructional material for blood and faecal sampling in goat and cattle, thereby indicating participants' basic understanding has improved after reviewing the design.

Table 4.4 Mean and mean difference of Likert score on sampling before and after review of design

Variables	**Measurement, Mean (SD)**		**Mean difference (95% CI)**	**P value**
	Before review of design	**After review of design**		
Likert score on blood sampling (1-5)	2.55 (1.517)	4.78 (0.474)	2.23 (-2.596, -1.866)	<.001

Likert score on faecal sampling (1-5)	2.55 (1.492)	4.77 (0.533)	2.22	(-2.577, 1.859)	- <.001

4.6 Respondent's recommendation in improving the design

Table 4.5 listed the recommendation from the respondents in improving the design. 66.67% of the respondents (n=52) left the section blank, 12.82% of the respondents (n=10) have no recommendations, 2.56% of the respondents (n=2) commented on improving the illustration, 7.69% of the respondents (n=6) commented on improving the details provided, 2.56% of the respondents (n=2) commented on the general presentation which QR code can be included and 7.69% of the respondents (n=6) gave other feedback regarding the design.

Table 4.5 : Respondent's recommendation and comments in improving the design

Recommendations	Number of respondent	Percentage, %
Blank answer	52	66.67
No comments/ recommendation	10	12.82
1. No		
2. Nope		
3. No, all good and clear.		
4. No suggestions everything is perfect		

5. No
6. Nope.
7. no
8. no, very cute drawing
9. Nope.
10. No

Comments on Illustration: 1. Maybe a more realistic figure on the site where to withdraw blood 2. You can colour the animal to make it more attractive.	2	2.56%
Comments on procedure details: 1. Everything is very helpful! the only thing i'm still unsure of is the needle preparation (?), but besides that, nice work!! 2. Further details on rectum enlargement. 3. I suggest that the colour of text can use the same colour to make it look more tidy. 4. I think you can put precautions of sampling as well. 5. Maybe you can add more details 6. I will suggest to add on details on what type of needle can be use and how to install the needle to vacutainer.	6	7.69%

Comments on general presentation: 1. Can attach QR code for easier distribution. 2. Maybe you can put QR code so we can scan and get the document	2	2.56%
Others: 1. Nice and good guidelines, really improve my understanding 2. I think overall is good. 3. You have to put ur name and signature every poster so people not stolen work from you 4. pretty good 5. All good. 6. Good	6	7.69%

CHAPTER 5

DISCUSSION

The initial design was created in the form of a single poster only. All three procedures which are jugular venipuncture, coccygeal venipuncture and faecal sample collection with additional information on types of blood tubes and equipment required in the procedure were all incorporated into one poster. From the face validation result, some respondents flagged the issues related to punctuation marks and missing information, prompting the need for further corrections to enhance overall presentation. Moreover, another respondent pointed out that the combination of all three procedures in one poster can be visually overwhelming.

The rationale behind this observation can be related to the cognitive limitations of working memory in humans. According to Robinson (2014), our ability to hold and manipulate information is limited. Presenting an abundance of information concurrently can overload the visual–pictorial channel, which processes visual and auditory information. This overload can limit our processing ability upon the receival of information, emphasising the need for a more digestible format (Robinson, 2014). Building on these insights, the proposed solution involves separating the three procedures, along with additional information about the types of blood tubes and required equipment. This separation would manifest in four distinct posters, each dedicated to a specific procedure, contributing to improved visualisation and cognitive processing as each poster becomes a focused, digestible unit, allowing learners to absorb information without cognitive overload as shown in Figure 4.2, Figure 4.3, Figure 4.4 and Figure 4.5.

From the survey responses obtained for recommendation in improving the design, 2.56% of the respondents suggested to improve the illustrations, 7.69% of respondents suggested to include more detailed information and 2.56% of the respondents suggested to include QR code for the ease of distribution of the document. The recommendation of integrating Quick Response (QR) codes aligns with the insights of Gradel and Edson (2012). According to Gradel and Edson (2012), QR codes can facilitate the seamless transition of information from offline to online platforms. These codes serve as practical learning tools, particularly in an era where the use of mobile devices has become increasingly prevalent. Incorporating QR codes not only aligns with technological trends but also enhances engagement of the learner by leveraging the familiarity and convenience of mobile devices (Gradel and Edson, 2012). In this project, interactive materials such as videos can be embedded into the poster using QR code.

The online-administered questionnaire managed to obtain responses from 78 respondents, encompassing both Year 1 and Year 2 undergraduate veterinary students from FPV,UMK. Notably, a majority of respondents (66.7%, n=52) are from Year 1, while 33.3% (n=26) represented Year 2 undergraduate veterinary students. This distribution is probably due to the fact that Year 1 students have less workload compared to Year 2 students and they have a higher number of students in one class and , which is 63 students, while Year 2 has a smaller number of students, which is 44 students.

Furthermore, a paired T-test analysis result indicated a significant difference in understanding levels before and after reviewing the poster. The duration of pre-review and post-review is short and it allows the level of understanding of the respondents to be

assessed immediately. The result can be related to a research by Cowan (2014) which emphasised that human comprehension, information processing, and learning ability hinge on working memory demand. Given the limited capacity of working memory in cognition, the integration of illustrations with text becomes crucial (Robinson, 2014). Liu (2009) notes that illustrations complementing text serve as cues, aiding readers in information interpretation and mitigating the demands on working memory. Consequently, it is reasonable to conclude that a poster featuring information presented through schematic diagrams and accompanied by illustrations contributes significantly to improve the comprehension among the respondents. This analysis not only validated the effectiveness of the educational materials but also sheds light on the cognitive mechanisms at play, providing valuable insights for future educational interventions.

CHAPTER 6

CONCLUSION

In conclusion, combining jugular venipuncture, coccygeal venipuncture, and faecal sample collection procedures into one poster received valuable feedback during face validation. Suggestions for improvement, such as addressing punctuation and adding missing details, led to a thoughtful reconsideration of the poster's presentation. Survey responses indicated a highly positive reception, with 88.5%(n=69), 85.9%(n=67) and 84.6%(n=66) of respondents stating a strong agreement on the poster's relevance, clarity, and suitability respectively. The rejection of the null hypothesis and the observed mean difference in Likert scores before and after reviewing the instructional material underscored the positive impact of the design on understanding blood and faecal sampling procedures in goats and cattle.

The project successfully achieved its objectives by designing schematic diagrams and illustrations for blood and faecal sample collection in goats and cattle. The validation process has confirmed the effectiveness of the design and the implementation of posters in electronic form has the potential to serve as a valuable instructional guide. Overall, the learning manual shows promise as a tool to enhance comprehension and resolve challenges in the study of blood and faecal sample collection procedures.

CHAPTER 7

RECOMMENDATIONS AND FUTURE WORK

In addressing recommendations, a redesign process can be carried out and involves refining the illustration quality, enriching the content with more detailed information, and integrating QR codes strategically. This approach ensures that the revised posters not only meet the standards of clarity and correctness but also resonate with the visual and technological preferences of the target audience. Moreover, for the implementation of the design, the poster can be printed out in physical form to be displayed in the faculty.

Furthermore, the current study did not assess free recall of information. We will recommend that future studies in validation of a design can include a free recall test following exposure to information in order to fully assess the practicality of the poster. For example, the assessment can be done by comparing the performance of students who have exposure to the instructional material design and those who did not in a practical setting where they have to prepare and perform the procedures by themselves in the field .

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