Project-Oriented Problem-Based Learning and Innovation within TVET Ruminant Education

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Abstract

Malaysia is seeing a decrease in its self-sufficiency rate for beef, buffalo, goat, and sheep flesh due to a scarcity in supply. Even while the government has taken steps to reduce reliance on imports, the problem remains. The lowest number of TVET graduates are produced by the agricultural and veterinary sectors, which has a negative impact on both food safety and productivity. As a result, Project-Oriented Problem-Based Learning (POPBL) in TVET for ruminant education cultivates practical problem-solving and hands-on skills in a real-world vocational experience. This issue is exacerbated by the mismatch between institutions and industry, as well as the competency of lecturers. Consequently, the objective of this investigation is to investigate the constructs, sub-constructs, and components of institutional facilities, as well as the expertise of lecturers, in order to facilitate the education of ruminants in vocational colleges in Malaysia. The researcher employed a qualitative approach and a phenomenological study design. A purposive sampling technique is employed to conduct a semi-structured interview with five administrators of ruminant livestock farms in order to gather data. The study's findings indicate that the researcher generated three constructs, 15 sub-constructs, and 59 elements that pertain to institutional facilities, lecturer abilities, and lecturer knowledge. The implications of this study have the potential to assist a variety of stakeholders, including students, lecturers, Malaysian Vocational College institutions, and the government or policy makers, in the development of more effective strategies for the empowerment of technical and vocational education in the field of ruminant livestock.

1. Introduction

Agriculture is a vital worldwide food source, and food safety and security are crucial for countries like Malaysia. However, according to Mohd (2010), the country still struggles to reach the criteria of developed countries in the agricultural sector, with roughly one-third of the world's population lacking enough food in 2020 (Food and Agriculture Organization (FAO), 2021). The Malaysian government regards the agriculture sector as having significant potential to minimize the socioeconomic gap and boost the national economy (Abdul Raof et al, 2022). The Ninth Malaysia Plan (RMK-9) promotes human resource development to enhance farmers' mindsets and attitudes. Ismail (2020) argues that Technical Vocational Education and Training (TVET) can be used to improve the development of agricultural professionals in Malaysia and assist in the development of skilled personnel in the agricultural sector. As such, there are several additional ministries that have formally offered agricultural

programs through Ministry of Education Malaysia (MOE), Ministry of Higher Education Malaysia (MOHE), Department of Veterinary Medicine Malaysia (DVS), and Ministry of Agriculture and Food Security (MAFI). MOE Malaysia has 86 Vocational Colleges, but only six provide agriculture programs. One of the agricultural programs provided by the Malaysian Vocational College is ruminant livestock agroindustry, which introduces students to the world of ruminant animal husbandry such as cattle, goats, and sheep. This program intends to build a skilled workforce in the ruminant industry and address self-sufficiency challenges. The program teaches courses on ruminant animal farm management, pasture and fodder management, livestock breeding, and livestock health management.

Project-Oriented Problem-Based Learning (POPBL) in the context of TVET for vocational education is an educational technique that blends academic knowledge with practical, real-world problem-solving (Rahman et al., 2022). In POPBL, students are challenged with complicated, real-life challenges connected to ruminant management and husbandry. These projects require students to utilise their understanding of animal biology, nutrition, and care to design new solutions. The strategy promotes critical thinking, teamwork, and communication skills, since students must work in teams to study difficulties, provide solutions, and execute their ideas. This hands-on strategy ensures that students obtain a solid comprehension of the subject matter and build competencies that are directly applicable to their future professions in the livestock sector.

Innovation within this framework stems from the ongoing inclusion of new technology and approaches to improve educational outcomes and the efficiency of ruminant management. By incorporating current tools such as data analytics, IoT devices for monitoring animal health, and sustainable practices, POPBL in TVET ensures that students are equipped with cutting-edge skills and knowledge. This not only prepares them for the demands of modern animal husbandry but also develops a mindset of continuous learning and adaptation (Francisco, Ibrohim & Susilo, 2024). The innovative aspect also includes the development of new educational materials and tools that reflect the latest research and industry trends, ensuring that the education given is relevant and forward-thinking.

According to UniSZA Publishers (2021), the field of agriculture and livestock production is one of the jobs that the country critically needs based on the technical report by TalentCorp. Rashid et al. (2020) who stated that agricultural growth and its contribution to national production are actively influenced by agricultural students. However, Malaysia currently has a scarcity of highly skilled and semi-skilled people in the agriculture sector (Ryan, 2023). Statistics from the Malaysian Ministry of Higher Education suggest that agriculture and veterinary are among the low producers of TVET graduates, with 1700 graduates compared to engineering, services, and information and communication technology. The mismatch of skills between institutions and industry causes the industry to experience a shortage of trained personnel in technical capabilities (Khairul Anuar Hasnan, Zainizam Zakariya., et, 2019). Hasami & Buang (2021) claimed that lecturer need to be competent in their respective professions to generate graduates who are competent and have skills in line with the needs of the industry. Ealangov (2023) also agreed that when the agriculture professor has limitations in terms of skills and knowledge in the field will cause failure to implement teaching and learning appropriately.

MOE Malaysia (2010) in the Direction Report (Agriculture) stated the lack of facility infrastructure, shortage of competent and professional lecturers in agricultural education sector. This insufficiency might cause a deterioration in the quality of education offered to students (Kumar & Kumar, 2014) and add to the issues faced by the agricultural business, resulting in low production and revenues. Thus, the researcher believes that research on the empowerment of ruminant cattle education in educational institutions in Malaysia, particularly in Malaysia Vocational Colleges, is necessary based on government recommendations to empower education through Ninth Malaysian Plan (RMK-9) and the alignment of skilled manpower in the needs of the industry as stated in. The aim of this research is to investigate the structures, sub-contracts, and elements for institutional facilities, lecturer knowledge and abilities, so enabling ruminant education in Malaysian Vocational Colleges. The findings of this study can be used as a reference and information source for the government going forward as well as a component of strategies meant to improve the nation's food supply by means of Malaysian Vocational College curriculum.

2. Literature Review

2.1 Technical Vocational Education and Training

Technical and Vocational Education and Training (TVET) is an educational procedure that attempts to equip students with career-related skills, enabling them to acquire job or continue living (Mutebi & Kiplagat, 2023). The term TVET defined by UNESCO and quoted in Kingombe (2012) is that it is used to describe all aspects of the educational process, including the study of technology and matters related to science as well as the development of skills directly (hands-on), affective, knowledge, and understanding related to careers in various areas of economic and social life. According to Mutebi and Kiplagat (2022), unemployment is the biggest factor to poverty in most nations. PLTV combats this issue by giving employment skills to the people so that they can start working as soon as they graduate.

In Malaysia, TVET under the Malaysian Ministry of Education is overseen by the Vocational Technical Education and Training Division. The 10 main fields offered include design, business, agriculture, community service, hospitality, information technology, mechanical and manufacturing technology, electrical and electronic technology, civil technology, and manufacturing and processing. These ten fields are separated into 86 distinct Vocational Colleges. The field presented has gone through the accreditation procedure by the Malaysia Qualification Agency (MQA) and the Malaysia Board of Technologists (MBOT).

Agriculture is separated into industrial crops and food, with industrial crops including coconut, rubber, and palm oil being the main sources. Food is obtained from crops, cattle, and aquaculture (Iman, 2023). The food supply influences a country's ability to support human life (Mohamed and Shafiai, 2021). Ruminant is an animal that contains four primary digestive systems (stomach) notably rumen, reticulum, omasum and abomasum (Michael, Rosali & Ab Jalal, 2020). Animal husbandry is an agricultural activity that serves daily needs, develops economic resources, and secures food supply and safety (Firuza, 2020).

2.2 Institutional Facilities

Agriculture is a practical discipline that involves infrastructure such as land, equipment and instruments as well as laboratories (Oraye and Dy, 2021). They underline the significance of proper learning facilities and land, equipment, and laboratories in agriculture for effective teaching and learning. This also supported by Education Development Master Plan (PIPP) which emphasizes the development of high quality non-physical and physical infrastructure to achieve primary objectives in teaching and learning. Manzeke, G., Muwaniki, C., Siziba, S et al., (2024) also argues that the availability of teaching and learning support materials such as facilities is one of the most important drivers of efficacy in agricultural education and training. Even if a lecturer is competent and trained, they will frequently find it difficult to teach successfully when there is a dearth of teaching and learning resources that are suitable and relevant to local agricultural conditions (Oraye and Dy, 2021).

This indicated that lack of these tools might be a big barrier for lecturer, as they are often unable to successfully teach. According to Ealangov (2023), limited teaching resources produce a detrimental influence on the education system and are unable to meet teaching and learning objectives. Practical activities in agriculture, such as animal husbandry, are generally limited and focus on theory rather than real demonstration due to the absence of learning facilities (Oraye and Dy, 2021). This weakness can prevent curriculum revisions made to comply with MBOT certification standards (Ealangov, 2023) and significantly affect student academic performance (Mohd Amir, A et al., 2016).

Institutional facilities are vital in the teaching and learning process, since they generate realistic learning experiences that encourage students to build skills and knowledge in agriculture (Heidenreich, 2018). They also provide students with opportunity to learn about animal care and handling (Scott et al., 2023), changing their perspectives and comprehension of specific themes (Erickson et al., 2019). Previous research has demonstrated that adapting experiential learning to institutional settings can lead to growth in technical skills for persons involved in the animal business (Ramsey & Edwards, 2011). The study of equine science also provides a favorable influence on students and the discovery that students retain more information when they observe animals (George & Cole, 2018)

2.3 Lecturer Competency Enhance POPBL Innovation

Sheng and Ibrahim (2023) emphasize the importance of self-competence in lecturer to stay relevant in their field. Lecturer competence is defined as having the necessary knowledge, skills, and abilities for a specific role, measured by factors such as pedagogical, professional, personality, and social competence (Armstrong, 2010). The Malaysian Education Development Plan 2013-2025 and the Eleventh Malaysia Plan (2016-2020) issued by the Malaysian government have highlighted the country's concern for the competence of TVET educators. According to Raof and Musta'mal (2021), lecturer competence affects the learning outcomes of students.

Agricultural lecturer must have a strong background and experience in theory and practical aspects of agricultural subjects to facilitate various activities (Oraye and Dy, 2021). They should be experts in field and study the agricultural program well, especially in animal production to attract students' attention and create an impact on students (Ukam and Ntui, 2016). Agriculture education needs to be geared towards a higher cognitive level and requires sophisticated skills to adapt to globalization and the industrial revolution (Ealangov, 2023). Peake et al. (2007) suggested that the most effective approach to learning agriculture is through hands-on experience, rather than just attending lectures. According to Villacorta and Arnado (2023), the lecturer must be skilled in various aspects of ruminant livestock, including the selection and use of farm tools, operation of farm equipment, preventive maintenance, estimation, and stock selection and procurement. However, the issue of lack of skilled and knowledgeable lecturer in agriculture has yet to be addressed.

POPBL and innovation within TVET ruminant education are greatly influenced by lecturer competency (Rus et al., 2020). Competent educators provide a comprehensive understanding of both conventional and contemporary ruminant management approaches, enabling them to effectively assist students through difficult,

real-world situations. Their knowledge helps them to design and deliver interesting, practical projects that correspond with industry needs and technology improvements. By utilizing their experience, lecturers foster a learning environment where students may confront relevant difficulties, implement innovative solutions, and develop skills that are directly useful to their future professions in animal husbandry.

Moreover, lecturer competency is vital for integrating innovation into the POPBL framework. Educators that stay aware of the newest breakthroughs in ruminant management and educational technologies might incorporate these improvements into their teaching approaches (Murugan, 2024). This not only enriches the learning experience but also ensures that students are exposed to cutting-edge methods and resources. In this sense, talented lecturers work as catalysts for both learning and creativity, preparing students to flourish in a fast-expanding area and contribute to developments in ruminant education.

3. Methodology

This research used a qualitative approach which used semi-structured interview. Researcher have done interview with five farm managers who have at least 5 years of experience in ruminant industry and ruminant background education. The sample technique utilized is purposive sampling. Before the actual interviews were done, semi-structured interview transcripts were confirmed in advance by one expert in the language field and one farm manager where both have experienced above 10 years in their industry to make sure the content meaning is clear and easy to grasp. Next, pilot interviews were done to identify whether there are any vulnerabilities to the interview transcripts. Once modifications were made, genuine interviews were carried out. The raw data from the interviews conducted were recorded, organized, processed and interpreted to make it meaningful in this study. These data were handled manually using Microsoft Word. Data were studied through three phase which were code preparation, analysis phase and interpretation phase (Lochmiller, 2021). In the process of data analysis, the researcher read the transcript of the interviews numerous times, select and summarize data that are significant to the study. Data were sorted into meaningful units called 'segmenting' while data that did not give any importance was deleted. Next, the data selected was sent to two experts in ruminant education to review and command. This approach was done to get interrater reliability of the construct utilizing the Cohen Kappa Index Approval Rating Scale. The Cohen Kappa Index Approval Coefficient will be used to determine the degree of agreement of the findings.

4. Result and Discussion

Once all the data were transcribed, the researchers employed thematic analysis recommended by Lochmiller (2021). Data were studied through three phase which were code preparation, analysis phase and interpretation phase. The developed construct is based on literature review. Meanwhile, the sub-constructs and features that emerge are based on a study framework consisting of training standards in educational institutions for ruminant animal production (TESDA, 2013) and Iceberg Theory (Spencer and Spencer, 1993). In addition, there are additional sub-constructs and new elements after the interviews done. The result of the interview analysis was 59 elements empowerments of ruminants' education in Malaysia Vocational College and has been categorized into 15 sub-constructs adapted from TESDA (2013) and Spencer and Spencer (1993), namely animal housing with facilities, permanent building with facilities, farm area, tools equipment and materials, technology used in teaching, technologies used in ruminant, knowledge of the implementation of the ruminant health program, knowledge of the implementation of ruminant feed management work, knowledge of the implementation of ruminant waste handling work, knowledge of the implementation of ruminant farm supervision activities, knowledge of ruminant program curriculum, skills in the implementation of the work of ruminant care, skills in the implementation of ruminant health programs, skills in the implementation of ruminant breeding programs and skills in teaching ruminant. A complete table of the of the sub-construct and the factors of empowerment of ruminant education in Malaysia Vokasional College is said by the research participant can be seen in Table 1 below:

Table 1 *A complete table of the sub-construct and the elements of empowerment of ruminant education in Malaysia Vocational College said by the research participant*

Animal housing with facilities	R1	R2	R3	R4	R5
Complete enclosure (F1-1)	/	/	/		/
Livestock passage facility to go to other facilities (travis) (F1-2)	/				
Male breeding place (F1-3)	/		/		
Isolation place for sick livestock (F1-4)	/				
Mother and child livestock isolation place (F1-5)	/		/		
Fence around the enclosure (F1-6)	/				

Food trough (F1-7)	/				
Milking place (F1-8)	/				
Ruminant slaughtering house (F1-9)	/				
Storage place for carcass after slaughter (F1-10)	/				

Permanent Building With Facilities	R1	R2	R3	R4	R5
Study and research laboratory (F2-1)					/
Breeding laboratory (F2-2)	/	/			/

Farm Area	R1	R2	R3	R4	R5
Fodder field (F3-1)			/		
Pasture field (F3-2)	/				
3-layer of sewage pond (F3-3)	/				

Tools Equipment and Materials	R1	R2	R3	R4	R5
Disinfectants (F4-1)			/		
Ropes (F4-2)			/		
Nitrogen liquid (F4-3)			/		
Ultrasound machine (F4-4)	/	/	/	/	/
Weighing scales for ruminant (F4-5)					/

Technology Used in Teaching	R1	R2	R3	R4	R5
The use of SMART TV in teaching (F5-1)			/		
The use of virtual technology in teaching (F5-2)					/
The use of the internet in teaching (F5-3)			/		/
The use of mobile applications in teaching (F5-4)					/

Technologies Used in Ruminant	R1	R2	R3	R4	R5
Food mixer (F6-1)	/		/		
Pallet machines to make food pallets (F6-2)	/				
Milking parlor (F6-3)			/		
Pasteurization machine for pasturize the milk (F6-4)			/		
Chopper (F6-5)			/		
Ear tags and microchips as identification tags (F6-6)	/			/	

Knowledge of the Implementation of the Ruminant Health Program	R1	R2	R3	R4	R5
Lecturer must have knowledge in medicines (P1-1)			/		
Lecturer needs to know the procedures for the treatment of ruminant (P1-2)	/				
Lecturer needs to know the health symptoms of ruminant (P1-3)		/			
Lecturer needs to know how to manage diseases (P1-4)		/			

Knowledge of the Implementation of Ruminant Feed Management Work	R1	R2	R3	R4	R5
Lecturer needs to have knowledge in livestock feed regimes (P2-1)	/	/			
Lecturer needs to have knowledge in the nutrition required for ruminant (P2-2)	/	/			
Lecturer needs to have knowledge in the lifecycle phase of ruminant (P2-3)		/			

Knowledge of the Implementation of Ruminant Waste Handling Work	R1	R2	R3	R4	R5
Lecturer needs to have knowledge in sewage pond management (P3-1)	/				
Lecturer needs to have knowledge in the types of ruminant waste (P3-2)		/			

Knowledge of the Implementation of Ruminant Farm Supervision Activities	R1	R2	R3	R4	R5
Lecturer needs to know the importance of biosecurity (P4-1)	/				
Lecturer needs to have knowledge of disinfectants that can be used (P4-2)	/				
Lecturer needs to know the preventive measures that can be taken (P4-3)	/				

Knowledge of Ruminant Program Curriculum	R1	R2	R3	R4	R5
Lecturer needs to be involved with courses and seminars to improve the program curriculum (P5-1)	/	/	/	/	/
Lecturer needs to attend training to improve the program curriculum (P5-2)					/
Lecturer needs to read to improve the program curriculum (P5-3)	/	/			
Lecturer needs to establish relationships with the ruminant industry to improve the program curriculum (P5-4)	/		/		
Lecturer needs to increase visits to farm industry to improve the program curriculum (P5-5)	/				
Lecturer needs to hold discussions with other colleges to improve the program curriculum (P5-6)			/		
Lecturer needs to have knowledge in the current needs of the industry to improve the program curriculum (P5-7)	/	/			/
Lecturer needs to collaborate or see foreign countries to improve the program curriculum (P5-8)		/			/

Skills in the Implementation of the Work of Ruminant Care	R1	R2	R3	R4	R5
Lecturer needs to be proficient in handling ruminant (K1-1)	/	/			
Lecturer needs to be skilled in observing the behavior of ruminant (K1-2)	/	/			/

Skills in the Implementation of Ruminant Health Programs	R1	R2	R3	R4	R5
Lecturer needs to be proficient in ruminant injections (K2-1)	/	/			
Lecturer needs to be proficient in ruminant treatment procedures (K2-2)	/				
Lecturer needs to be skilled in identifying ruminants' health symptoms (K2-3)	/	/			/

Skills in the Implementation of Ruminant Breeding Programs	R1	R2	R3	R4	R5
Lecturer needs to be skilled in the process of artificial insemination (K3-1)	/	/			

Skills in Teaching Ruminant	R1	R2	R3	R4	R5
Lecturer needs to be proficient in effective teaching techniques (K4-1)					/
Lecturer needs to be proficient in communication skills (K4-2)				/	
Lecturer needs to be proficient in social media mastery (K4-3)				/	

All 15 sub-constructs then are categorized into three constructs which are institutional facilities, lecturer knowledges and lecturer skills. A complete table of the constructs, sub-construct and the elements of of empowerment of ruminant education in Malaysian Vokasional College can be seen in Table 2 below

Table 2 *A complete table of the sub-construct and the elements of empowerment of ruminant education in Malaysia Vocational College*

ELEMENTS	SUB-CONSTRUCTION	CONSTRUCT
Complete enclosure (F1-1)	Animal Housing with facilities (F1)	Institutional Facilities
Livestock passage facility to go to other facilities (travis) (F1-2)		
Male breeding place (F1-3)		
Isolation place for sick livestock (F1-4)		
Mother and child ruminant isolation place (F1-5)		
Fence around the enclosure (F1-6)		
Food trough (F1-7)		
Milking place (F1-8)		
Ruminant slaughtering house (F1-9)		
Storage place for carcass after slaughter (F1-10)		
Research and development laboratory (F2-1)	Permanent building with facilities (F2)	
Breeding laboratory (F2-2)		
Fodder field (F3-1)	Farm area (F3)	
Pasture field (F3-2)		
3-layer of sewage pond (F3-3)		
Disinfectants (F4-1)	Tools Equipment and Materials (F4)	
Ropes (F4-2)		
Nitrogen liquid (F4-3)		
Ultrasound machine (F4-4)		
Weighing scales for ruminant (F4-5)		
The use of SMART TV in teaching (F5-1)	Technology Used in Teaching (F5)	
The use of virtual technology in teaching (F5-2)		
The use of the internet in teaching (F5-3)		
The use of mobile applications in teaching (F5-4)		
Food mixer (F6-1)	Technology Used in Ruminant (F6)	
Pallet machines to make food pallets (F6-2)		
Milking parlor (F6-3)		
Pasteurization machine for pasturize the milk (F6-4)		
Chopper (F6-5)		
Ear tags and microchips as identification tags (F6-6)		
Lecturer must have knowledge in medicines (P1-1)	Knowledge of the Implementation of the Ruminant Health Program (P1)	Lecturer Knowledge
Lecturer needs to know the procedures for the treatment of ruminant (P1-2)		
Lecturer needs to know the health symptoms of ruminant (P1-3)		
Lecturer needs to know how to manage diseases (P1-4)		
Lecturer needs to have knowledge in livestock feed regimes (P2-1)	Knowledge of the Implementation of Ruminant Feed Management Work (P2)	
Lecturer needs to have knowledge in the nutrition required for ruminant (P2-2)		
Lecturer needs to have knowledge in the lifecycle phase of ruminant (P2-3)		
Lecturer needs to have knowledge in sewage pond management (P3-1)	Knowledge of the Implementation of	

Lecturer needs to have knowledge in the types of ruminant waste (P3-2)	Ruminant Waste Handling Work (P3)	
Lecturer needs to know the importance of biosecurity (P4-1)	Knowledge of the Implementation of Ruminant Farm Supervision Activities (P4)	
Lecturer needs to have knowledge of disinfectants that can be used (P4-2)		
Lecturer needs to know the preventive measures that can be taken (P4-3)		
Lecturer needs to be involved with courses and seminars to improve the program curriculum (P5-1)	Knowledge of Ruminant Program Curriculum (P5)	
Lecturer needs to attend periodic training to improve the program curriculum (P5-2)		
Lecturer needs to read to improve the program curriculum (P5-3)		
Lecturer needs to establish relationships with the ruminant livestock industry to improve the program curriculum (P5-4)		
Lecturer needs to increase visits to industry to improve the program curriculum (P5-5)		
Lecturer needs to hold discussions with other colleges to improve the program curriculum (P5-6)		
Lecturer needs to have knowledge in the current needs of the industry to improve the program curriculum (P5-7)		
Lecturer needs to collaborate or see foreign countries to improve the program curriculum (P5-8)		
Lecturer needs to be proficient in handling ruminant (K1-1)	Skills in the Implementation of the Work of Caring for Ruminant (K1)	Lecturer Skills
Lecturer needs to be skilled in observing the behavior of ruminant (K1-2)		
Lecturer needs to be proficient in ruminant injections (K2-1)	Skills in the Implementation of Ruminant Health Programs (K2)	
Lecturer needs to be proficient in ruminant treatment procedures (K2-2)		
Lecturer needs to be skilled in identifying livestock health symptoms (K2-3)		
Lecturer needs to be skilled in the process of artificial insemination (K3-1)	Skills in the Implementation of Ruminant Breeding Programs (K3)	
Lecturer needs to be proficient in effective teaching techniques (K4-1)	Skills in Teaching Ruminant (K4)	
Lecturer needs to be proficient in communication skills (K4-2)		
Lecturer needs to be proficient in social media mastery (K4-3)		

Next, the researchers have verified the interviews data to ensure the reliability of the findings. The verification process is performed by obtaining index inter-rater reliability towards the code and the unit using Kappa Agreement values (Cohen's Kappa). The formula for finding the coefficients of the agreement is as in Figure 1.

$$K = \frac{Fa - Fc}{N - Fc}$$

Where,
K= A Coefficient of Agreement
fo= the number of units in which the judges agreed
fc= the number of units for which agreement is expected by chance
N= the number of the units coded

Fig. 1 *Formula for Cohen's Kappa*

According to Cohen et al. (2007), this set of agreement forms between experts is important because experts as an assessment between experts (inter-rater realibility) to confirm the development of themes and codes that have been developed by the researcher. The coefficient of agreement between experts is also the reliability of the themes that have been constructed. According to Lange (2011), inter-rater reliability uses two or more raters (or observers, coders, examiners) to agree. This is to see the consistency of the themes that have been analyzed by the researcher. Therefore, researcher have chosen two experts in ruminant education from Universiti Putra Malaysia (UPM) to determine the reliability of the themes developed by the researcher. The formula as shown in Table 2 was referred.

Table 3 *Kappa agreement value scale (Landis and Koch, 1997)*

Cohen Kappa Index Coefficient of Agreement Value (K)	Indicator
0.81- 1.00	Very good
0.61 - 0.80	Good
0.41-0.60	Medium
0.00 - 0.40	Weak

As a result of the assessment conducted by 2 experts on 59 elements of empowerment of ruminant education in Malaysia Vocational College, the 59 elements of institutional facilities, lecturer knowledge and lecturer skills identified and mentioned in Table 2. All of them are approved the constructs, sub-constructs and elements prepared by researcher. Therefore, the calculation process was carried out and the agreement value between the inter raters was 1.0. Table 4 below shows the calculation process to get the Cohen Kappa Index Approval Coefficient. According to Landis and Koch (1997), an agreement value greater than 0.81 indicates a very good reliability scale. Therefore, the building of constructs, sub-constructs and elements of empowerment of ruminant education in Malaysia Vocational College is at a very good level.

Table 4 *The calculation for the Cohen Kappa Index Approval Coefficient*

Cohen Kappa Expert Index Approval Coefficient 1	Cohen Kappa Expert Index Approval Coefficient 2	Average Coefficient of Cohen Kappa Index Approval Rating
Fa = 59	Fa = 59	
Fc = 29.5	Fc = 29.5	
N = 59	N = 59	
K = (Fa-Fc)/(N-Fc)	K = (Fa-Fc)/(N-Fc)	
K = (59 - 29.5) / (59 – 29.5)	K = (59 - 29.5) / (59 – 29.5)	K = (1 + 1) / 2
K = 1	K = 1	K = 1

Therefore, the reliability of constructs, sub-constructs and elements in this study is very good. This further indicates the high reliability for each unit that is used to describe a theme. Finally, the data obtained from the interviews should be displayed. The researchers have compiled the interviews data in the form of construct arrangement which was obtained with its respective unit.

According to Oraye and Dy's (2021) research, a lecturer has substantial obstacles due to a lack of learning facilities and enough land, equipment, and laboratory facilities. The research discoveries in the first constructs are animal housing, permanent building with facilities, agricultural land, tools, equipment, and materials. The first sub-construct includes 10 features to strengthen ruminant education, including complete barns, livestock transit facilities (travis), male and sick livestock separation, fences, feed troughs, milking places, slaughter locations, and meat storage areas. It is in conformity with the training facility criteria defined by TESDA (2013). TESDA identifies infrastructure such as barns, milking locations, food troughs and food storage areas as necessary in a ruminant education institution to ensure competence in the production of ruminant milk and meat (TESDA, 2013). The remaining six parts are new results from the interview data that have been conducted. The second sub-construct includes two new fingings of a permanent structure with facilities elements which are research and development laboratory and the reproduction laboratory.

Facilities such as farms, industrial workshops, and laboratories are vital for giving students with opportunity to learn about animal care and management (Scott et al., 2023). McCarthy (2016) said that when students perform activities using this facility, they can learn through experiences such as doing laboratory work, active observation of animals, field trips, hands-on activities, and problem solving. Oraye and Dy (2021) investigations shows the lack of practical learning facilities in the field of animal husbandry causes activities to be more centred on theory. Heidenreich (2018) agrees that the provision of facilities similar to industry can give realistic learning and assist students acquire skills in the field of agriculture. Additionally, Edem et al. (2022) and Eniola-Arigbe et al. (2022)

have underlined that vocational education will be efficient if the student's training setting mirrors the environment in which the student would work. Ealangov (2023) also underlined that the lack of teaching resources might have a detrimental impact on the education system and the attainment of learning objectives. Adequate and high-quality facilities play a significant part in the teaching and learning process and give students with real-world experiences that connect techniques and ideas (Miller et al., 2011; McCarthy, 2016). Previous research have demonstrated that the use of active learning facilities and hands-on experience can improve student comprehension in animal science and agriculture (Deslauriers et al., 2016; Erickson et al., 2020b). Thus, the entire institutional facilities is needed to empowered ruminant education.

Knowledge is part of competency. The study indicated that there are five sub-constructs and 20 factors to empower lecturer competency in empowerment of ruminant education. These sub-constructs include information about ruminant health programs, feed management work, waste management work, farm supervision activities, and knowledge about the ruminant livestock program curriculum. In Oraye and Dy's study (2021), 70% of the respondents believed that lecturer should master the subject of the class before instructing. Lack of conceptual understanding and abilities among professor can cause failure to implement teaching and learning correctly (Ealangov, 2023). In addition, teaching agriculture demands a good academic background and practical expertise from a lecturer. According to Cook (1963) and Stewart et al,. (1983), the key determinant of lecturer competence is subject knowledge. This is backed by Villacorta and Arnado (2023). The outcomes of the study for the following sub-construct are knowledge of lecturer in ruminant program curriculum.

The informants indicates that lecturer should participate in courses, seminars, frequent training, readings, creating contacts with the industry, expanding farm visits, and having discussions with other colleges to improve the program curriculum. According to Muttalip (2020), lecturer who are not given with courses and training will add to the unpreparedness to offer lessons. Research has revealed that the efficiency of teaching and learning activities is affected by the lack of confidence of lecturer which often occurs due to a lack of expertise in their profession (Chimbude & Kgari-Masonda, 2020). Lecturer encounter additional challenges owing to lack of professional development training and time restrictions. However, most instructors have limited expertise in the sector which may lead to a gap in knowledge and abilities regarding the current technology and improvements. According to Peake, Duncan, and Ricketts (2007), claimed that several researchers have identified training needs for agricultural instructors.

Peake et al. (2007) concluded that the most effective technique to learning agriculture is through hands-on experience, rather than just attending lectures. Therefore, a lecturer must be skilled in that discipline. According to Villacorta and Arnado (2023), lecturer must be able to teach and lead students in a number of elements of ruminant livestock, such as selecting and utilizing farm tools, operating farm equipment, preventive maintenance, estimating, and stock selection and procurement. They must also be able to observe livestock health, select breed stock, perform pre- and post-slaughter activities, administer preventive and therapeutic measures, select and manage goats and sheep, prepare feed and implement feeding practices, implement group health programs, and maintain and analyze records. This agreed with NOSS standard that demand graduates become expert before they graduated. In Oraye and Dy's study (2021), 70% of the respondents believed that lecturer should master the subject of the class before instructing.

The sub-construct of the program curriculum demands professor to participate in courses, seminars, regular training, reading, creating ties with the industry, increasing visits to the industry, and holding conversations with other colleges to improve the program curriculum. Most participants felt that lecturer should be participating in these programs to develop their knowledge and expertise in the ruminant livestock industry. According to Muttalip (2020), lecturer who are not given with courses and training will add to the unpreparedness of lecturer to offer lectures. Through a study by Chimbunde and Kgari-Masonda (2020) indicated that professor will be more confident in educating and delivering content when they have considerable expertise in the sector. Furthermore, professor need to have knowledge in the current needs of the industry and collaborate or look at international nations to develop the program curriculum. Without expertise in the industry sector, presenting curriculum knowledge becomes challenging (Jalil et al., 2015).

POPBL and innovation within TVET ruminant education are considerably boosted by the combination of institutional facilities, lecturer abilities, and expertise. Adequate institutional facilities provide the necessary infrastructure, such as modern laboratories, animal husbandry equipment, and simulation tools, which are essential for properly implementing POPBL (Filmi, Ibrohim & Prabaningtyas, 2024). These tools enable students to engage in realistic projects and hands-on learning experiences, bridging the gap between academic knowledge and practical application. Well-equipped facilities promote the development of creative solutions and the application of modern technology in ruminant management, providing an environment conducive to advanced learning.

Lecturer skills and knowledge play a significant role in the successful application of POPBL and innovation in TVET ruminant education (Chongdarakul, Kirimasthong & Sutthaluang, 2021). Educators with expertise in both traditional and developing ruminant management approaches may assist students through complicated problems, ensuring that the learning process is both relevant and impactful. Their ability to integrate new

technologies and approaches into the curriculum enriches the educational experience, preparing students to meet current market demands and drive future advancements. In summary, a combination of solid institutional facilities and talented educators produces a dynamic learning environment where students can grow, build practical abilities, and contribute to improvements in the field of ruminant education.

5. Conclusion

The findings of this research generate three conceptions, 15 sub-constructs and 59 aspects of empowered ruminant education in Vocational Collage Malaysia. The constructions are institutional facilities, lecturer knowledges and lecturer skills. The ultimate result of this study is to benefit many stakeholders, including TVET graduates, teaching staff, educational institutions and the Malaysian Ministry of Education in the process of further increasing the quality of ruminant livestock education in Malaysia.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: Yin Liangyu: **Literature review, methodology, data collection and project administration**. *Khairul Anuar Abdul Rahman:* **Drafted the manuscript and provided substantial revisions formal analysis, and validation**. *Contributed to* **writing the results and discussion sections, conceptualization, methodology and resources**. *Nuramiratul Hafizah Jurime:* **Conceptualization, methodology and resources**.

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