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Development of Work-Based Learning and Assessment Module for Agricultural Extension Training

Shafeeqa Shahruddin[1*], Zaliza Hanapi[1], Anizah Mohd Salleh[1], Norzeha Othman[2], Fardila Mohd Zaihidee[1]
[1]Faculty of Technical and Vocational, Universiti Pendidikan Sultan Idris, Perak, Malaysia
[2]Institut Pendidikan Guru Malaysia, Kampus Pendidikan Teknik, Negeri Sembilan, Malaysia

*Corresponding author: shafeeqa@ftv.upsi.edu.my

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Abstract

The gap between the industry's skill requirements and the competencies of agricultural extension graduates undermines the ecosystem and impedes economic development. Graduates' limited soft skills and communication abilities highlight the urgent need for curriculum improvements, particularly in strengthening assessment practices that measure workplace-relevant competencies. Developing a learning and assessment module in collaboration with industry stakeholders could help bridge this gap by offering reference materials and assessment components that effectively connect theoretical knowledge with practical applications in real-world contexts. This study aimed to: (i) identify the requirements and criteria for the development of a learning and assessment module among agricultural industry stakeholders, (ii) develop the module utilizing a work-based learning (WBL) approach, and (iii) evaluate both the usability and assessment suitability of the WBL module from the standpoint of agricultural practitioners and industry stakeholders. This study employed both qualitative and quantitative methodologies within an exploratory framework. The module was created utilizing the ADDIE model, incorporating assessment elements aligned with workplace tasks and performance expectations. The module was subsequently assessed for usability by twelve participants, comprising agricultural industry stakeholders. The findings indicated that most participants agreed the module could serve as a valuable guide for strengthening trainees' soft skills, enhancing assessment of practical competencies, and improving their ability to manage extension programs with targeted communities. The development of this WBL module may also act as a standard for enhancing collaboration between industry stakeholders and higher education institutions, including the co-development of authentic assessment criteria relevant to the agricultural extension field.

Keywords: *Agriculture Extension, Learning Module, Work-based Learning, Assessment Module*

INTRODUCTION

With the rapid advancement of technology and the passage of time, the nation's Technical and Vocational Education and Training (TVET) ecosystem must also evolve under industry leadership. Such transformation is crucial to producing a workforce capable of meeting current industrial demands. In line with this objective, the Eleventh Malaysia Plan (RMK-11) emphasized the need for TVET to shift towards training programs that directly address industry requirements (MOHE, 2020). Nonetheless, several obstacles and challenges have been recognised in the fulfilment of this aspiration.

A research by Khazanah Research Institute (2023) indicated a discrepancy between the capabilities held by TVET graduates and the demands of the business. Additional studies indicate that the employment rate of TVET graduates does not align with the knowledge and skills demanded by the

business. Furthermore, the 2019 TVET Empowerment Town Hall event revealed that the curriculum, resources, and technology at most TVET schools are not updated or improved to align with the latest technical breakthroughs and current market requirements. The Development Study of the TVET National Master Plan Towards Developed Countries identified the necessity of establishing a suitable and pertinent education system to produce autonomous and resilient TVET graduates. Furthermore, the industry perceives that TVET graduates are deficient in soft skills, including collaboration, flexibility, leadership, critical thinking, and communication (ILMIA, 2018). These persistent gaps highlight the urgent need to develop a structured Work-Based Learning (WBL) module that can embed real workplace practices, strengthen relevant competencies, and ensure that learning outcomes are aligned with current industrial expectations.

The advent of the Fourth Industrial Revolution (IR 4.0) is expected to reduce reliance on human labor as technology increasingly replaces existing job roles. This rapid technological progress poses significant challenges if TVET graduates are not adequately equipped with competitive skills and entrepreneurial mindsets to shift from merely seeking employment to creating new job opportunities. Enhancing collaboration between industry stakeholders and TVET institutions in domains such as human capital development, curriculum design, technology, and expertise is crucial to guarantee that TVET institutions provide a highly trained and industry-relevant workforce (Aziz & Subramaniam, 2023). The Malaysian Higher Education Institutions (HEIs) have launched the 2u2i academic program as outlined in the Malaysian Education Development Plan (2015-2025) (DOHE, 2023). The curriculum integrates academic instruction with practical application in the workplace. As a result, graduates will gain relevant industry experience related to their field of study, while simultaneously fostering an entrepreneurial attitude through academic and industrial interaction via a WBL approach.

Conventional assessment methods, although supportive, are less suitable for competence-based curricula, as competence is inferred from observable performance outcomes on a set of tasks (Shavelson, 2013). Appropriate assessment of professional competencies should incorporate actual observation of trainees' performance in real professional practice and correspond to the expectations of the workplace (Biemans et al., 2009). This underscores the need to develop and implement competence-based assessments that are performance-oriented, requiring trainees to perform professional tasks in authentic work settings, while also strengthening assessment quality through the inclusion of key stakeholders' perspectives and qualitative insights (Gulikers et al., 2009). Within training programmes, assessment should integrate knowledge, skills, and attitudes, include regular evaluation of trainees, and incorporate reflection, and career competences throughout the training process. Limitations in current assessment practices can be addressed by adopting multidimensional strategies, such as using a variety of formative and summative tools, strengthening assessments conducted by experts and trainers with additional oversight, developing assessment programmes with institutional support, and enhancing supervisor involvement to connect training with workplace application (Jackson et al., 2019). Industrial training programmes should actively stimulate competence-based assessments and feedback to support ongoing professional development, shifting the focus from assessment of learning towards assessment for learning and assessment as learning, thereby encouraging continuous reflection, improvement, and self-directed competency growth among trainees.

Thus, this study aimed to develop a WBL module to facilitate effective collaboration between the course and the industry, ensuring the educational program's objectives are met in creating highly competent agricultural graduates. The development of a structured WBL module with embedded assessment mechanisms is critical, as it provides a systematic approach to monitor and evaluate students' competencies, practical skills, and employability.

LITERATURE REVIEW

1. Agricultural TVET in Malaysia

The agricultural sector is a key contributor to the Malaysian economy, particularly in terms of food security, export earnings, and employment opportunities. To strengthen this sector, the Malaysian government has introduced various initiatives; TVET programs, to encourage greater participation from the younger generation. The construction of vocational institutions and public technical universities has facilitated the development of skilled people capital to satisfy labor market demands across many industries. Despite the focus on incorporating high-quality TVET programs into the national education framework, agriculture-based education initiatives are frequently marginalized (Omar, 2020).

Since 2011, Malaysia has undertaken substantial attempts to cultivate local human capital through diverse governmental incentives designed to enhance the TVET system and cultivate future potential for the nation (MEA, 2019). The agriculture industry is now governed by the National Agro-Food Policy 2.0 (2021–2030) and the Twelfth Malaysia Plan (RMK-12, 2021–2025), which both prioritize the integration of new technology in the agro-food sub-sector to improve production and revenue. This modernization agenda includes the integration of advanced technologies such as drones, smart farming systems, artificial intelligence, big data, and greater mechanization. The transition from conventional farming to high-tech agriculture is deemed crucial to ensuring sufficient food supply, particularly as Malaysia's population is projected to reach 50 million by 2050 (RMK-12, 2019). Accordingly, assessment frameworks in agricultural education must evolve to evaluate students' mastery of emerging technologies, digital competencies, and problem-solving abilities, ensuring that graduates are fully equipped to support the nation's agricultural transformation.

2. Agricultural Extension Field

The integration of contemporary technology in Malaysia's agricultural sector is moderate, shaped by various factors; e.g. inadequate comprehensive initiatives to advance smart agriculture, reliance on low- and semi-skilled labor, an ageing farming demographic, and insufficient investment from the private sector. Farmers also face specific challenges in adopting smart agricultural practices, such as inadequate technical knowledge, fragmented information, high implementation costs, and poor network connectivity to support digital technologies (RMK-12, 2019). In this context, agricultural extension services play a vital role as an informal education process that systematically facilitates the transfer of agricultural technology to help farmers enhance their capabilities and achieve greater socio-economic progress. Informal education here is understood as a process of fostering individual transformation while meeting farmers' needs and contributing to broader community goals through the dissemination of relevant information (Mahmood et al., 2016).

To ensure effective delivery of agricultural TVET, extension agents must possess sound knowledge of agricultural science, relevant field experience, and training in vocational pedagogy. Therefore, any initiative to integrate agricultural TVET into extension services must first establish a strong foundation to ensure that extension officers are adequately prepared for this role. Developing structured reference materials to guide and train extension officers should also be prioritized (Brown & Majumdar, 2023). Accordingly, embedding robust assessment practices is essential to determine extension officers' mastery of pedagogical skills, evaluate their competence in facilitating technology transfer, and ensure that both farmers and trainees achieve measurable improvements in knowledge, skills, and adoption of modern agricultural practices.

3. The TVET Industry Status

TVET graduates are expected to meet the quality standards set by industries. Industry feedback has revealed a consistent disparity between the competencies, knowledge, and attitudes of graduates and the demands of the labor market (Hussain et al., 2021). In recent decades, the TVET system has progressively shifted towards partnership with industry stakeholders by including industry requirements and long-term objectives into curriculum development. The establishment of the National Dual Training

System (SLDN) represents one such effort to strengthen industry partnerships and produce more employable graduates.

At both institutional and program levels, TVET providers have engaged with industry to varying degrees. Successful models, such as the Penang Skills Development Centre (PSDC), frequently credit their success to collective accountability, with industry acting as the principal force behind curriculum design and implementation (Aziz & Subramaniam, 2023). The Auditor General's Report (2023) indicates that employer satisfaction with TVET graduates is now at 88.5%. Nevertheless, feedback from industry also reveals several concerns. Industry players report that their involvement in TVET program development remains irregular and unsystematic, with limited opportunities for meaningful collaboration in institutional initiatives. Furthermore, many industry stakeholders perceive little tangible return on investment when collaborating with ministries and other governing bodies in the TVET ecosystem (Sohimia et al., 2022). These challenges highlight the need for more coherent and industry-aligned assessment practices that accurately measure graduates' workplace competencies, ensure that learning outcomes reflect real job expectations, and provide employers with credible indicators of graduate readiness and capability.

4. The 2u2i Program at Malaysian Higher Education Institutions (HEIs)

The Malaysian Education Development Plan (2015-2025) aims to produce skilled, and knowledgeable graduates capable of addressing 21st-century issues. To nurture well-rounded, enterprising individuals, flexible education pathways such as 3+1 and 2+2 programs have been introduced, integrating off-campus and industry-based learning. The 2u2i trademark denotes a pedagogical model in which teaching and learning occur both on-campus and off-campus in various formats. The letter 'u' in 2u2i denotes the university, and the letter 'i' denotes the sector in which education occurs within the practical realm of employment.

This academic curriculum is designed to blend theoretical knowledge with real-world application, thereby strengthening experiential learning through industry involvement. By offering field-specific workplace experience, the program helps bridge the gap between the skills demanded by industry and the competencies of graduates produced by HEIs. Furthermore, active engagement in structured workplace learning enhances graduates' cognitive, psychomotor, and affective domains. Achieving this objective requires close collaboration between HEIs and industry in the design and delivery of 2u2i programs, ensuring that academic offerings remain current, competitive, and industry-driven (DOHE, 2023).

5. Learning Module TVET with Industry

Modules function as a conduit for students to attain learning objectives through fundamental competencies or competence success indicators, self-directed learning activities, and opportunities for self-assessment through integrated exercises. Within the assessment context, modules enable systematic monitoring of learners' progress by embedding formative tasks that provide feedback, reinforce understanding, and guide competency development. Modules are methodically constructed as structured training tools that encompass content, methodologies, and assessments, enabling autonomous usage to attain the desired competences (Darwis et al., 2020).

Before developing a technical communication pedagogy module for educators, it is necessary to identify the common teaching strategies currently employed in teaching technical communication. A lack of industry input in TVET curricula and modules often results in graduates who are underprepared and lack the competencies required by employers (Ramamurthy et al., 2020). Integrating assessment considerations, such as measuring workplace-aligned communication performance, evaluating task authenticity, and ensuring assessment validity is crucial to bridging this gap. The demand for a highly efficient workforce that meets present and future business requirements is rising in the context of enhancing human intelligence and cognitive computing. Consequently, the design of educational modules should be informed by insights gained via collaboration with industry to ensure an improvement in the quality of education, the emphasis on relevant competencies, and the development of assessment practices that reflect industry standards in TVET programs (Ismail et al., 2019).

In the assessment context, alignment ensures that what is taught and evaluated mirrors real job expectations, enabling students to demonstrate competencies required by employers. Moreover, to deliver a substantial and impactful learning experience for TVET students, educators are urged to continuously revise the TVET curriculum, refine assessment strategies, and strengthen partnerships with industry stakeholders to ensure that learning outcomes and their corresponding assessments remain current and meaningful (Chinedu & Wan-Mohamed, 2017).

6. Work-Based Learning (WBL)

Curriculum serves as the "blueprint" for teaching and learning, shaping the overall student learning experience throughout a study program. The effectiveness of a curriculum is reflected in how well it supports students in understanding and managing their expectations of learning. In today's context, students increasingly take charge of their own learning process and construct personalized learning experiences. Within this shift, assessment plays a crucial role in guiding learners' self-regulation, providing meaningful feedback, and validating progression toward intended learning outcomes. Nevertheless, curriculum design must remain centered on students' learning processes rather than being driven solely by technology and its availability (Jam & Puteh, 2020).

A WBL curriculum is collaboratively designed, delivered, and assessed by both HEIs and industry to ensure mutual relevance. In the assessment context, industry participation ensures that evaluation methods, such as performance-based assessments, authentic tasks, workplace portfolios, and supervisor feedback, accurately reflect professional standards. The method utilizes real-world circumstances, allowing students to practice skills, reflect on genuine concerns, and convert their experiences into relevant course or program learning goals (MQA, 2016).

The fast progression of information and communication technology, the expanding knowledge-based economy, heightened globalization, and alterations in job structures and content have presented problems to both educational institutions and enterprises. WBL aims to enhance students' educational experiences by intensifying industry collaboration in program development and implementation, improving experiential and service learning to foster 21st-century skills, and embracing technology-driven models that facilitate personalized learning. These shifts necessitate the development of more flexible, authentic, and competency-based assessment practices that capture learners' ability to apply knowledge in dynamic workplace settings.

METHODOLOGY

1. Module Development: ADDIE Model

The ADDIE model was utilized in the development of the Program Management and Communication training module via the WBL technique. The ADDIE model comprising the phases of Analyze, Design, Develop, Implement, and Evaluate; provides a systematic and comprehensive framework that supports the creation of effective and well-structured teaching modules (Wang & Hsu, 2009). Figure 1 illustrates the research implementation procedure.

The module development process was guided by the ADDIE instructional design model, integrating both qualitative and quantitative methods. In the Analysis phase, qualitative methods were employed to conduct a needs analysis that informed the content and structure of the WBL module. Semi-structured interviews with key stakeholders, including industry practitioners were used to identify essential knowledge areas, practical skills, and soft-skill competencies required to ensure alignment with industry expectations and academic outcomes. Subsequently, during the Evaluation phase, quantitative methods were used to assess the usability of the developed module. Structured surveys were administered to industry practitioners and TVET educators to gather feedback on aspects such as content construction, module design, and the effectiveness of the module's learning components. By combining qualitative insights for needs analysis with quantitative evaluation of usability, and structuring these processes within the ADDIE framework, the development of the WBL module was systematic, evidence-based, and responsive to stakeholder requirements.

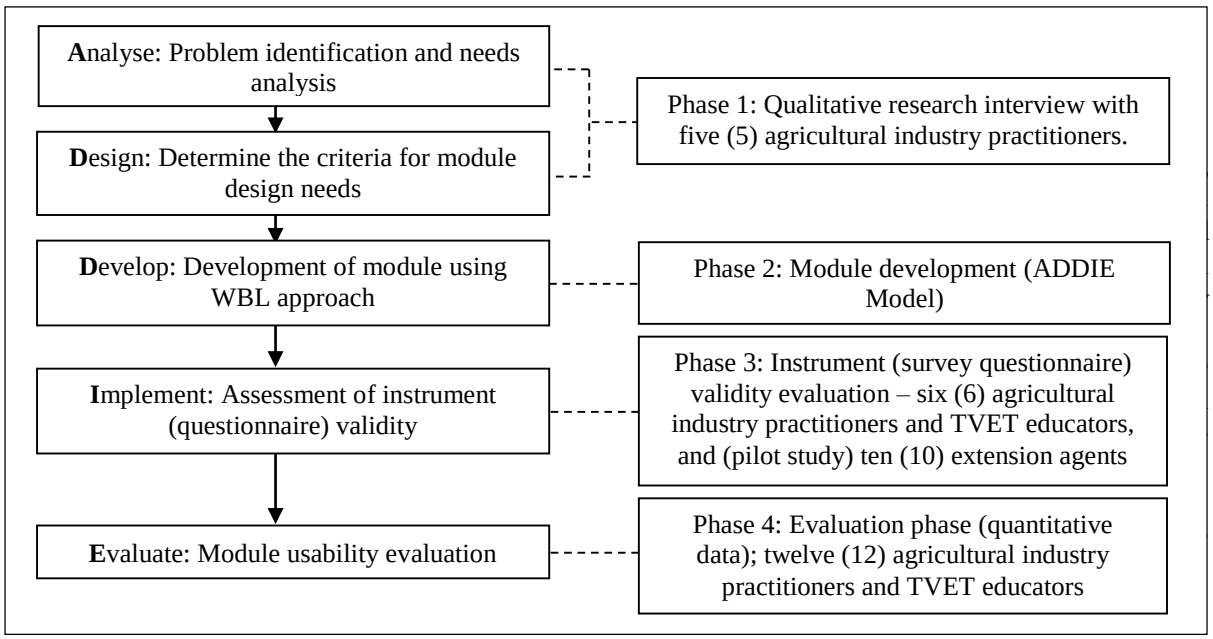


Figure 1 Research implementation procedure design using ADDIE model

2. Research Instrument

Two instruments were used: interview questions and survey questionnaires. The interview questions were designed to gather qualitative data for identifying the needs of the WBL module development. The newly generated semi-structured interview questions are as illustrated in Figure 2. The interview questions were validated by six experts (agricultural industry practitioners and TVET educators) (Table 1). A face-to-face semi-structured interview was conducted using a pilot-tested guide with respondents.

Introductory session:

- Purpose of Session - This interview session is conducted to gather expert insights for the need analysis process related to the development of the WBL Module for the Program Management and Communication course.
- Target Users - The module is intended for Bachelor of Agricultural Science (Agriculture Extension) with Education students who will be undergoing Industrial Training.
- Scope of Feedback - Feedback will focus on identifying essential needs, content requirements, and suitability to ensure the module aligns with industry expectations and supports effective WBL.
- Role of Expert Panel - Your participation is highly valued in contributing informed perspectives that will guide the structure, relevance, and practicality of the module.
- Appreciation - We sincerely appreciate your time and expertise in supporting the development of a WBL module.

Illustrative key questions:

1. a. How would a university-developed WBL module help trainees during their industrial training?
   b. Why do you think it is important for the training module to align with both faculty requirements and industry needs?
2. a. How can a structured WBL module help improve trainees' practical skills during industrial training?
   b. What types of practical skills do you think trainees struggle with the most, and how could the module support their development?
3. a. How can e-learning tools be integrated into the WBL module to support trainees during their industrial training?
   b. What challenges do trainees face in using e-learning platforms, and how can the module help address these challenges?
4. a. How can a PBL approach be incorporated into the training module to enhance trainees' problem-solving and hands-on skills?
   b. What types of projects would be most effective for trainees in agricultural extension to ensure meaningful and practical learning experiences?
5. a. Which soft skills do you think are most important for trainees, and how can the module support their development?
   b. What challenges do trainees face in developing soft skills during industrial training?

Closure questions:

- Do you have any additional comments or suggestions to improve the module development?
- Based on our discussion, do you find the proposed module relevant and feasible for Industrial Training students?

Figure 2 Interview protocols with semi-structured interview questions

Table 1 Professional role and appointment percentage of validity expert panels for instrument items

Panel	Participant	Professional Role	Appointment Percentage (%)
1	(Private) Agricultural Extension	Research Officer	50 Extension; 50 Research
2	(Private) Agricultural Extension	Agricultural Officer	50 Extension; 50 Research
3	(Government) Agricultural Extension	Agricultural Officer	70 Extension; 30 Research
4	(Government) Agricultural Extension	Agricultural Officer	70 Extension; 30 Research
5	(Government) Agricultural TVET Educator	(University) Lecturer	50 Teaching; 25 Research; 25 Extension
6	(Government) Agricultural TVET Educator	(University) Lecturer	50 Teaching; 25 Research; 25 Extension

Validity refers to the extent to which an instrument accurately measures its intended construct. Content validity (CV) assesses the extent to which the items on the assessment instrument encompass the complete content domain. Experts knowledgeable in the instrument's subject domain assess and ascertain the validity of the items. A CV ratio (CVR) is a numerical figure that reflects the validity of an instrument, as assessed by expert evaluations of CV. A CVR may be computed for each item and collectively for an instrument. Experts evaluate each item on a four-point ordinal scale: 3 = vital; 2 = beneficial, however not essential; 1 = unnecessary. The formula employed to compute an item's CVR is as follows: $CVR = (N_e - N/2)/(N/2)$ (Lawshe, 1975). In this ratio, N_e represents the number of content experts who deemed the item important. N represents the aggregate quantity of content specialists. Table 2 shows the calculations of CVR for a sample of instrument's items (interview questions).

Table 2 Calculating of CVR for a sample of instrument's items (interview questions)

Items	N_e*	CVR**	Interpretation		Items	N_e*	CVR**	Interpretation
1a.	6	1.00	Remained		4b.	6	1.00	Remained
1b.	6	1.00	Remained		5a.	6	1.00	Remained
2a.	6	1.00	Remained		5b.	6	1.00	Remained
2b.	6	1.00	Remained		Closure 1	6	1.00	Remained
3a.	6	1.00	Remained		Closure 2	6	1.00	Remained
3b.	6	1.00	Remained		Closure 3	6	1.00	Remained
4a.	6	1.00	Remained		Closure 4	6	1.00	Remained

Note: *Number of experts evaluated the item essential, **CVR or Content Validity Ratio = $(N_e-N/2)/(N/2)$ with 6 expert panels (N=6), the items with the CVR bigger than 0.99 remained at the instrument and the rest eliminated (Lawshe, 1975).

Participants for the qualitative phase were selected through purposive sampling and consisted of agricultural practitioners from both the private and government sectors. Table 3 shows their roles and percentages of appointment. The interviews allowed participants to share their experiences and identify effective industrial training strategies in agricultural extension. Five extension practitioners were purposively selected to join the interviews. They were invited through email and met via *Google Meet* for a one-hour interview session guided by predetermined questions. Each participant later took part in a 30 - 45 minutes individual interview. Member checking was conducted with participants to confirm that the lead researcher had accurately interpreted their responses and comments. No revisions were suggested by participants during the member-checking process following the interviews. Subsequently, each member of the research team reviewed the transcripts as part of a peer debriefing process. The researchers independently carried out content analysis on the transcripts and compared the emerging themes to ensure consistency in data interpretation.

Quantitative data for WBL module usability were collected using a survey questionnaire consisting of four sections: (a) seven questions on demographic and job characteristics; (b) eight items on the content construction of module; (c) fifteen items on the module design construct; and (d) eight items on the effects of content design in module. Questionnaire was developed based on the requirements during industrial mode, outlined by MQA (2016). All items were measured using a five-point Likert scale ranging from "strongly disagree" (1), to "strongly agree" (5). The questionnaire was

validated by six experts (agricultural industry practitioners and TVET educators) (Table 1), and Table 4 shows the calculations of CVR for a sample of instrument's items (survey questionnaire), and a pilot study was done with ten extension agents. The agreeableness subscale consisted of 8 items ($\alpha = 0.836$), the leadership subscale consisted of 15 items ($\alpha = 0.892$), and the overall satisfaction subscale consisted of 8 items ($\alpha = 0.861$).

Table 3 Professional role and appointment percentage of participants for need analysis (interview method)

Sample	Participant	Professional Role	Appointment Percentage (%)
P1	(Private) Agricultural Extension	Chief Research Officer	50 Extension; 50 Research
P2	(Private) Agricultural Extension	Farm Manager	100 Extension
P3	(Government) Agricultural Extension	Agricultural Officer	70 Extension; 30 Research
P4	(Government) Agricultural Extension	Agricultural Officer	70 Extension; 30 Research
P5	(Statutory Body) Agricultural Extension	Agricultural Extension Officer	70 Extension; 30 Research

Later, the survey respondents were selected through purposive sampling, and included agricultural industry practitioners (private and government sectors) and TVET educators, to evaluate the usability of the developed WBL module (Table 5). Data were analysed using descriptive statistic tools, such as means, percentages, standard deviations, and frequency distributions.

Table 4 Calculating of CVR for a sample of instrument's items (survey questionnaire)

Items	N_e*	CVR**	Interpretation		Items	N_e*	CVR**	Interpretation
A1	6	1.00	Remained		B10	6	1.00	Remained
A2	6	1.00	Remained		B11	6	1.00	Remained
A3	6	1.00	Remained		B12	6	1.00	Remained
A4	6	1.00	Remained		B13	5	0.83	Eliminated
A5	6	1.00	Remained		B14	6	1.00	Remained
A6	6	1.00	Remained		B15	6	1.00	Remained
A7	6	1.00	Remained		B16	6	1.00	Remained
A8	6	1.00	Remained					
					C1	6	1.00	Remained
B1	6	1.00	Remained		C2	6	1.00	Remained
B2	6	1.00	Remained		C3	6	1.00	Remained
B3	6	1.00	Remained		C4	5	0.83	Eliminated
B4	6	1.00	Remained		C5	6	1.00	Remained
B5	6	1.00	Remained		C6	6	1.00	Remained
B6	6	1.00	Remained		C7	6	1.00	Remained
B7	6	1.00	Remained		C8	6	1.00	Remained
B8	6	1.00	Remained		C9	6	1.00	Remained
B9	6	1.00	Remained					

Note: *Number of experts evaluated the item essential, **CVR or Content Validity Ratio = $(N_e\text{-}N/2)/(N/2)$ with 6 expert panels (N=6), the items with the CVR bigger than 0.99 remained at the instrument and the rest eliminated (Lawshe, 1975).

Table 5 Professional role and appointment percentage of participants for module usability (survey method)

Sample	Respondent	Professional Role	Appointment Percentage (%)
1	(Private) Agricultural Extension	Research Officer/ Branch Manager	50 Extension; 50 Research
2	(Private) Agricultural Extension	Farm Manager	100 Extension
3	(Private) Agricultural Extension	Farm Manager	100 Extension
4	(Private) Agricultural Extension	Farm Manager	100 Extension
5	(Government) Agricultural Extension	Agricultural Officer	70 Extension; 30 Research
6	(Government) Agricultural Extension	Agricultural Officer	70 Extension; 30 Research
7	(Government) Agricultural Extension	Agricultural Extension Officer	70 Extension; 30 Research
8	(Statutory Body) Agricultural Extension	Agricultural Extension Officer	70 Extension; 30 Research
9	(Statutory Body) Agricultural Extension	Agricultural Extension Officer	70 Extension; 30 Research
10	(Statutory Body) Agricultural Extension	Agricultural Extension Officer	70 Extension; 30 Research
11	(Government) Agricultural TVET Educator	(University) Lecturer	50 Teaching; 25 Research; 25 Extension
12	(Government) Agricultural TVET Educator	(University) Lecturer	50 Teaching; 25 Research; 25 Extension

3. Data Analysis

Data constitutes the fundamental raw material of a study, allowing researchers to attain a comprehensive grasp of the topic being examined. In this study, the data collected through interviews and survey questionnaires were analyzed to generate findings that align with the research objectives. Table 6 presents the types of analyses conducted to achieve these objectives.

Qualitative Data: Interview transcripts were transcribed verbatim and analyzed using thematic analysis (Braun & Clarke, 2006). This process involved coding the data, generating initial themes, and then reviewing and refining these themes to ensure they accurately represented participants' views. *Quantitative Data*: Survey responses were analyzed using SPSS, where descriptive statistics such as frequencies, means, and standard deviations were computed.

Table 6 Research objective, instrument and data analysis

No.	Research Objective	Instrument	Data Analysis
1	To identify the requirements and criteria for the development of learning and assessment module among industry stakeholders	Interview questions	Thematic analysis
2	To develop learning and assessment modules utilizing WBL approach	Module development	Module development
3	To evaluate the usability of WBL and assessment module from the standpoint of industry stakeholders	Survey (questionnaire)	Descriptive analysis

RESULT

From the ten questions that were presented to the interview participants, five predominant themes emerged from the data. Effectively communicating about needs and requirements for the WBL module development involves: (1) Educational Context, (2) Practical and Skills Development, (3) Technology and E-Learning, (4) PBL Module-Driven, and (5) Soft-skills Development. The interview results

obtained from five (5) agricultural industry practitioners, intended to ascertain the requirements for creating an industrial module about pedagogical elements and learning resources using a thematic approach, uncovered numerous significant themes from the data analysis. The needs analysis, as described through the thematic approach, is presented as follows:

1. Theme one: Educational Context

All interview participants (P1, P2, P3, P4, and P5) asserted that the creation of such modules would function as a significant reference and guidance resource for trainees, enhancing the structure and clarity of the educational setting and learning process.

P1 stated that it is good to have a specific module as it provides some help for the industry. P2 agreed, adding that although they already have a specific schedule, the module could greatly help students to be better prepared each day. P3 explained that they already have a module designed for trainees, but it is still beneficial to have one developed by the university to align with the requirements of both parties. P4 and P5 emphasized that having a module from the university is particularly valuable, as it ensures the requirements set by the faculty are met while also fitting the needs of the industry.

The participants agreed that having a university-developed module is valuable, as it not only supports trainees in being better prepared each day but also ensures alignment between faculty requirements and industry needs. Such a module is crucial as it provides a structured framework for evaluating trainee competencies, monitoring progress, and ensuring that learning outcomes are achieved in a way that reflects both academic standards and workplace expectations. Embedding assessment within the module allows instructors and industry supervisors to provide timely feedback, identify skill gaps, and reinforce practical learning, thereby enhancing the overall effectiveness and accountability of the industrial training program.

2. Theme two: Practical and Skills Development

All participants also agreed that industrial training primarily serves as a platform for trainees to apply the skills acquired during their studies while simultaneously developing new competencies that can only be experienced in real workplace settings. Consequently, the practitioners emphatically recommended that the produced module integrate exercises that correspond with the trainees' evolving competencies, starting with easier tasks and then rising to more intricate ones.

P1 and P2 mentioned that the module would be very helpful for trainees, particularly in providing ideas related to their job areas at the selected industrial sites. P3 and P4 added that, although trainees need to gain more experience and perform various tasks during their on-the-ground training, the module could support them in developing the necessary skills to explore throughout the training. P5 emphasized that industrial training is primarily about practical exposure and skill development, and the module could spark trainees' interest while helping them be better prepared to face new tasks each day.

All participants agreed that the module would be very useful in supporting trainees by providing ideas, developing skills, and preparing them to face new tasks during industrial training. Embedding structured evaluation within the module is essential to monitor trainees' progression, measure the acquisition of practical competencies, and ensure that exercises are appropriately scaffolded to match their skill development. Such assessments provide feedback to both trainees and supervisors, highlight areas for improvement, and validate that the learning objectives of industrial training are effectively achieved.

3. Theme three: Technology and E-Learning

The results demonstrate that all participants advocate for the use of learning materials enriched with information and communication technologies (ICT) and compelling visuals in the module to stimulate trainees' interest and enhance their passion and abilities. This may enhance trainees' involvement with the task material, making the learning process more dynamic and accessible. Although ICT-enhanced resources and materials may aid the trainees, it is imperative that practical and clear materials or support be provided to the farmers.

P1 and P2 emphasized that while technology is beneficial, it is important to consider the needs of farmers in remote areas, most of whom are low-skilled. P3 highlighted that, as future extension workers, trainees should focus on being on-the-ground and reaching farmers directly whenever possible. P4 suggested that trainees should explore more efficient ways of applying technology in farming. Meanwhile, P5 stressed the need to identify the most suitable medium, particularly social media, to effectively disseminate new knowledge and technologies in agriculture. Integrating ICT-based and practical materials within the module allows for the evaluation of trainees' ability to apply knowledge in diverse contexts, communicate effectively, and adapt digital tools to real-world agricultural challenges. Structured assessments can measure both technological proficiency and practical competence, ensuring that trainees are prepared to deliver relevant and impactful services to farmers across varying skill levels and environments.

4. Theme four: Project-Based Learning (PBL) Module-Driven

All five participants advocated for student-centered tactics, emphasising their significance in promoting engagement, personalised learning, and the planning and evaluation of task outcomes during their training. They emphasized that learning activities such as group work, discussions, presentations, and PBL are particularly effective.

P1 and P2 asserted that engagement with PBL is advantageous since it equips trainees to strategise and evaluate material prior to disseminating new knowledge or technology. P3 and P4 agreed that PBL is important for trainees, as extension agents must be familiar with new research findings. P5 emphasized that agricultural trainees need to stay updated, with research outcomes serving as a key element in their learning resources. Integrating PBL within the module allows for the systematic evaluation of trainees' problem-solving skills, critical thinking, and application of research knowledge. Structured assessments can capture individual and group performance, provide feedback on decision-making and knowledge integration, and ensure that trainees can effectively translate learning into practical, real-world outcomes in agricultural contexts.

5. Theme five: Soft-skills Development

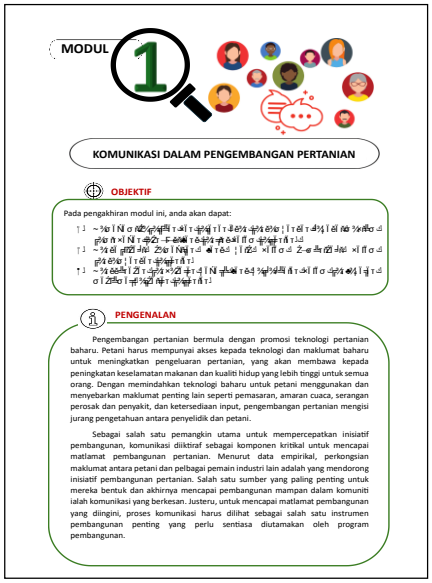
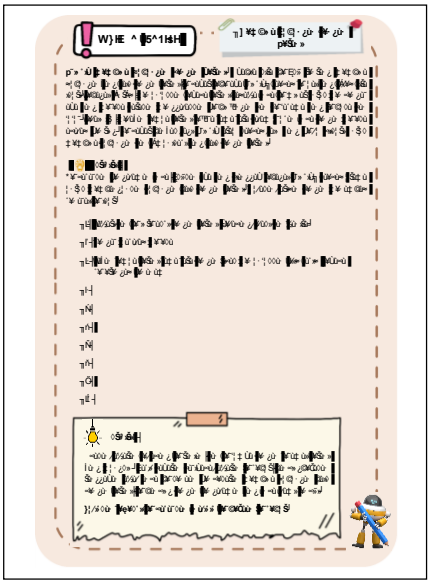
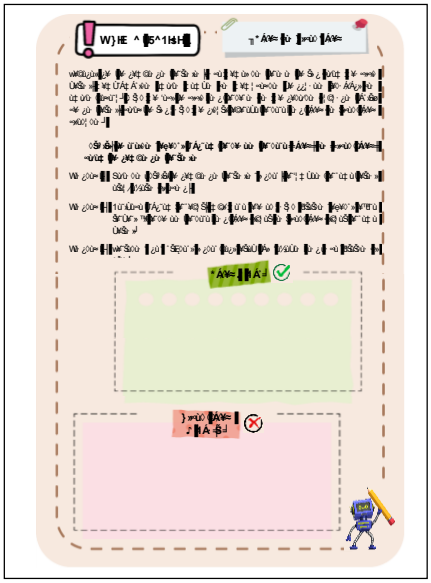
Effective workplace communication and leadership are crucial for career progression, and a systematic soft-skills development framework guarantees that individuals acquire the requisite competences to lead, cooperate, and communicate proficiently in professional settings. All five participants recognised that contemporary students frequently have difficulties with soft skills, especially during practical industrial training.

P1 and P2 highlighted that the modules should provide guidance on techniques to help trainees practice and refine their soft skills during industrial training. P3 underscored the importance of soft-skills development in enhancing trainees' confidence and proficiency in certain occupations. P4 pointed out that students should begin polishing these skills during their university studies, stressing that modules focusing on soft-skills development are essential. P5 said that trainees must enhance their comprehension of the practical functioning of the agricultural industry, and the module material should facilitate this objective. Embedding structured evaluation within the module is critical to measure the development of soft skills such as communication, teamwork, leadership, and problem-solving. Assessments can include performance observations, reflective journals, peer evaluations, and scenario-based exercises, providing feedback that helps trainees refine their interpersonal and professional abilities while ensuring alignment with industry expectations.

6. Development of WBL and Assessment Module

This study generated learning module infused with the WBL method utilising *Canva*, which offers a variety of engaging elements appropriate for creating instructional materials. This module is also regarded as a self-learning module. This design allows trainees to take an active role in the learning process while constructing their own knowledge. To ensure wider accessibility, the module was prepared in both printable and digital formats. Guided by these elements, the WBL module was developed through four systematic steps as outlined below:

1. Objective-driven – The module articulates the intended learning outcomes, enabling trainees to understand what they are expected to achieve at the end of each section (Figure 3).
2. Structured content with assessment – The content is systematically organized; begin with a title and introduction, followed by lessons, case studies, hands-on tasks, and reflection activities (Figure 4 and 5).
3. Interactive elements – The module incorporates supplementary digital resources (e.g., online articles and internet-based tools) to encourage trainees to remain updated on current issues and technological advancements.
4. Self-paced or instructor-led – The design allows flexibility, making the module suitable for independent learning or guided sessions with supervisors.

Parts of Module	Figures and Description
Example of objectives and introduction, in each of sub-modules	 **Figure 3** Objective and introduction stated in both Sub-Module 1 (Communication in Agriculture Extension) and Sub-Module 2 (Management of Extension Program)
Example of assessment constructions: Reflection activities and Hands-on tasks	  **Figure 4** Reflection activities

Continued

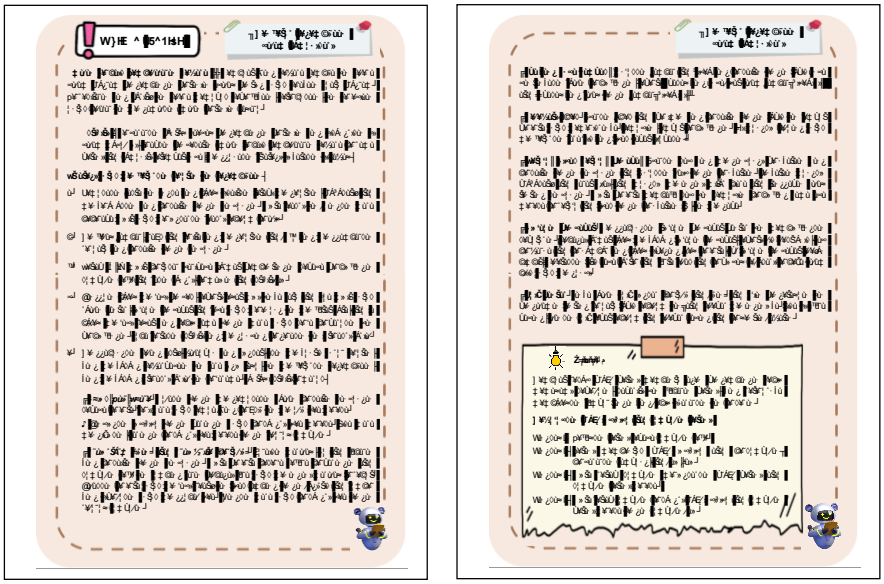


Figure 5 Hands-on tasks

7. Usability Evaluation

The quantitative data from the respondents' feedback (n = 12) revealed that most agricultural industry practitioners and TVET educators concurred with statements regarding the program's industrial module content construction, module design, and the impact of content design on users.

8. Usability: Content Construction of WBL Module

The findings revealed a range of agreement levels, from moderate (MS: 60–79: 8.33% of respondents) to high (MS: 80–100: 96.88% of respondents) regarding the statements on the content construction of the WBL module (Table 7). Among these, item A8; "*This learning module's material aligns with the students' practical competence level*", recorded the highest positive consensus, with MS: 98.33±0.29, indicating strong confidence among practitioners that the module content is well aligned with industry practices. Conversely, the lowest MS were reported for item A1; "*The content of this module aligns with the needs of Bachelor of Agricultural Science (Agriculture Extension) with Education trainees*", and item A2; "*The content of this module is systematically arranged according to students' learning levels*", both at MS: 93.33±0.49. Although these items still demonstrated strong agreement, the relatively lower scores suggest a more moderate perception of the module's theoretical content in terms of alignment with industry requirements.

9. Usability: The WBL Module Design Construct

The results indicate moderate (MS: 60 to 79: 9.72% of respondents) to high (MS: of 80 to 100: 96.11% of respondents) individual consensus with the comments on the content development of the WBL module (Table 8). The highest MS were observed for item B5; "*The use of this module can stimulate students to complete the tasks given*", and item B15; "*The assignments in this module can serve as exercises to build group co-operation in agricultural extension programs*", both at MS: 98.33±0.29. This result highlights the strong confidence of practitioners in the module's practical content, particularly its relevance and applicability to real industry tasks expected of future trainees. In contrast, the lowest MS was recorded for item B7; "*This module presents information in an easy-to-follow manner*", with MS: 88.33±0.79. Although still within the high agreement range, the relatively lower rating, together with the minimum MS: 60; suggests that aspects of the module's design and structural presentation may appear complex or less accessible, particularly for first-time users.

Table 7 Mean agreement scores to statements on content construction of WBL module (n = 12)

Item	Statement	Mean score, MS ± Standard Deviation, SD	(Min;Max)	df
A1.	The content of this module aligns with the needs of Bachelor of Agricultural Science (Agriculture Extension) with Education trainees.	93.33±0.49	(80;100)	11
A2.	The content of this module is systematically arranged according to students' learning levels.	93.33±0.49	(80;100)	
A3.	The content of this module is clear and easy to understand.	96.67±0.58	(60;100)	
A4.	The contents of this module are clear and well presented.	95.00±0.45	(60;100)	
A5.	The contents of this module can be effectively used.	95.00±0.62	(80;100)	
A6.	This lesson offers precise information on program management strategies and communication within agricultural extension.	93.33±0.51	(80;100)	
A7.	This module's material aligns with the students' cognitive level.	93.33±0.67	(60;100)	
A8.	This module's material aligns with the students' practical competence level.	98.33±0.29	(80;100)	

Table 8 Mean agreement scores to statements on WBL module design construct (n = 12)

Item	Statement	MS ± SD	(Min;Max)	df
B1.	The design of this module is aligned with the topic content.	90.00±0.67	(60;100)	11
B2.	The selected design in this module enhances students' comprehension.	96.67±0.39	(80;100)	
B3.	This module engages students in both learning and applying the course content.	91.67±0.51	(80;100)	
B4.	This module adopts a WBL approach.	95.00±0.45	(80;100)	
B5.	The use of this module can stimulate students to complete the tasks given.	98.33±0.29	(80;100)	
B6.	Every icon used in this module is appropriate.	91.67±0.67	(60;100)	
B7.	This module presents information in an easy-to-follow manner.	88.33±0.79	(60;100)	
B8.	The pictures used in this module are clear and easy to understand.	90.00±0.67	(60;100)	
B9.	The development of this module meets the course content requirements.	93.33±0.65	(60;100)	
B10.	This module is suitable for 21st century learning.	95.00±0.45	(80;100)	
B11.	The ‘Technology Literacy Corner’ in this module can broaden students’ perspectives on current applications of technology in agriculture.	93.33±0.49	(80;100)	
B12.	The assignments in this module can raise students’ awareness of the importance of communication in agricultural extension programs.	93.33±0.49	(80;100)	
B13.	The assignments in this module can raise students’ awareness in selecting appropriate extension programs to be implemented with the community.	95.00±0.62	(80;100)	
B14.	The assignments in this module can be completed independently by students.	95.00±0.45	(60;100)	
B15.	The assignments in this module can serve as exercises to build group co-operation in agricultural extension programs.	98.33±0.29	(80;100)	

10. Usability: Effects of Content Design in WBL Module

The findings revealed levels of agreement ranging from moderate (MS: 60–79: 8.33% of respondents) to high (MS: 80–100: 98.96% of respondents) regarding the effects of content design in the WBL module (Table 9). The highest mean scores were recorded for item C1; "*Students can be considered capable of applying critical thinking skills to try new things using the module during training*", and item C2; "*Students can be considered capable to generate new ideas with the module*", both at MS: 98.33±0.29. These results indicate strong expert confidence that the module can foster trainees' critical thinking and creativity when engaging with industry-related tasks. Conversely, the lowest MS were observed for item C4; "*Students can be considered capable of interpreting ideas or information with the module*", and item C5; "*Students can be considered capable of producing something innovative with the module*", both at MS: 93.33±0.49. While these scores remain within the high range, they suggest that trainees may still require additional workplace exposure and practical experience to strengthen higher-order abilities, particularly in interpreting complex information and generating innovative outputs aligned with industry demands.

Table 9 Mean agreement scores to statements on effects of content design in WBL module (n = 12)

Item	Statement	MS ± SD	(Min;Max)	df
C1.	Students can be considered capable of applying critical thinking skills to try new things using the module during training.	98.33±0.29	(80;100)	11
C2.	Students can be considered capable to generate new ideas with the module.	98.33±0.29	(80;100)	
C3	Students can be considered capable of gathering supporting information with the module.	95.00±0.62	(80;100)	
C4.	Students can be considered capable of interpreting ideas or information with the module.	93.33±0.49	(80;100)	
C5.	Students can be considered capable of producing something innovative with the module.	93.33±0.49	(80;100)	
C6.	Students can be considered capable of explaining information or performing tasks in writing or orally with the module.	96.67±0.39	(80;100)	
C7.	Students can be considered capable of trying various methods to solve a problem with the module.	95.00±0.62	(80;100)	
C8.	Students can be considered capable of analysing information and problems to identify the cause with the module.	93.33±0.65	(60;100)	

DISCUSSION

A co-production methodology for developing WBL module that is better matched with the requirements of both employers and TVET institutions. This method prioritises continuous communication among employers, educational institutions, and learners, facilitated by analytical instruments that enable stakeholders to collaboratively design the learning experiences and working settings essential for cultivating professional proficiency. The most effective training programs are those in which providers and employers jointly bear responsibility for program design and delivery (Bahl & Dietzen, 2019).

In the present study, inductive qualitative data coding indicated that agricultural industry stakeholders view the WBL module as valuable, particularly when designed to meet both industry and university requirements. All interview participants in the current study concurred that a significant disparity exists between industry requirements and the qualifications of university graduates. Brandt et al. (2017) recognized that awareness of knowledge deficiencies, particularly regarding agricultural processes, must be assessed, and appropriate material incorporated into the curriculum to address these deficiencies. To bridge these gaps, educational materials should be developed based on students' actual needs. Customizing lessons to align with learners' requirements not only enhances engagement but also supports deeper comprehension and skill development. Tailored module design ensures students acquire the necessary competencies, with content and delivery methods adapted to their learning preferences

and challenges. The teaching of practical agricultural skills, in particular, requires clear and detailed instructions to allow students to follow processes and reproduce skills effectively. Traditionally, such instruction relies heavily on the expertise of instructors to both deliver knowledge and provide precise step-by-step guidance. However, shifting away from conventional approaches toward a model that emphasizes facilitation of skill acquisition calls for more student-centered, active, and exploratory learning methodologies in training courses.

In agricultural extension, trainee assessment has always been performed informally. Nonetheless, there is an increasing necessity to formalize this process, especially by utilizing structured resources like WBL modules. This module offers explicit indicators and assessment levels for trainees in theoretical knowledge, practical and cognitive skills, and professional attitudes. In formulating a curriculum that amalgamates work and study, a crucial initial step is the examination of professional work as a cohesive manifestation of subjective and objective activity (Gagnon & Collay, 2006). The curriculum creation process necessitates meticulous oversight of all methodological elements, encompassing sector and occupational analysis, task analysis, curriculum design, implementation, evaluation, and assessment.

In this study, the WBL module was developed to provide guidance for agricultural extension trainees by emphasizing the key priorities they need to cultivate during on-the-ground training. The major emphasis is on the PBL approach, designed to enhance trainees' enthusiasm and strengthen their technical competencies for self-employment in agriculture. PBL encourages trainees to generate solutions for community challenges while actively engaging in problem-solving and applying skills to real-world contexts. Since its early adoption, PBL has been a cornerstone of agricultural education. Supporting this, Fathima et al. (2016) found that rural students demonstrated stronger agricultural knowledge compared to urban students; however, curriculum materials remained the most influential factor, as students engaged in PBL learning showed greater agricultural literacy. For extension trainees, planning or managing programs with farmers and communities requires careful assessment of specific needs, particularly problems that demand tailored solutions. Different extension approaches should therefore be applied depending on the issues raised. Jeong and Choi (2020) highlighted the value of extension services and experiential farm visits in fostering the frameworks necessary for building agricultural knowledge. On-the-job training, in this sense, not only improves technical ability but also contributes to professional, personal, and social development.

While current competency assessment tools predominantly focus on actual job execution, they frequently neglect the foundational specialized knowledge. Complex occupational tasks necessitate decision-making autonomy, specialized knowledge, and advanced cognitive abilities, including analysis, reflection, planning, and organization, as important requirements for professional competence (Nickolaus & Walker, 2016). Consequently, there is a need for assessment instruments that may render experiential knowledge more apparent, while simultaneously pinpointing regions necessitating more qualification or assistance. Effective validation methods rely on solid and well-established diagnostic techniques that guarantee competency evaluations are reliable and acknowledged as similar types of learning. This legitimacy is essential for allowing trainees to attain advanced degrees of professional development and roles within the employment framework. The curriculum designed for our WBL module is explicitly matched with the notion of fundamental work processes and the related procedures of evaluation and assessment (Scott, 2008).

The WBL curriculum created in this study includes explicit instruction on technology transfer approaches, bolstered by individual and group activities as reflective exercises. The majority of agricultural practitioners provided positive feedback, underscoring the importance of embedding these elements into the module to ensure its effectiveness and relevance. Furthermore, Jeong and Choi (2020) emphasized that agricultural curriculum should reflect the realities of contemporary farming to reframe traditional perceptions of agriculture. While online lessons have proven effective in enhancing agricultural knowledge, they highlighted the need for complementary activities, such as guided discussions or practical exercises, at the end of each module. In line with this, the practitioners in the present study stressed that, despite the digitalization of agriculture, meaningful on-the-ground experiences with farmers and communities, particularly in remote areas remain indispensable.

Agricultural extension, however, entails far more than simply introducing a new technology to farmers. To encourage adoption, extension agents must apply systematic and sophisticated approaches tailored to farmers' contexts, requiring a broad range of technical and interpersonal skills.

Communication, whether digital or face-to-face, is recognized as a vital input in ensuring effective technology transfer. The success of an extension agent is determined by their ability to convey ideas clearly, persuasively, and in ways that resonate with farmers' lived realities. Aremu et al. (2019) identified key characteristics of effective communication as timeliness, accuracy, clarity, knowledge transfer, and the ability to support farmers in fully understanding the subject matter.

Communication strategies in extension can therefore be understood as the tools and procedures employed to shape farmers' perceptions, behaviors, and attitudes in pursuit of a shared understanding of the intent, meaning, and application of agricultural messages. Findings from the needs analysis in this study revealed that industrial practitioners were particularly concerned about the lack of soft skills among many previous trainees. To address this, the WBL module intentionally embeds opportunities for trainees to practice and refine variable communication techniques when transferring agricultural information and technology during their training. This reflects the view that a skilled and competent workforce is a prerequisite for effective extension services. Yusoff et al. (2024) highlighted training and re-training as essential strategies for equipping extension agents with the communication skills necessary to perform their roles effectively. The WBL module developed in this study can thus serve not only as a training tool but also as a resource for continuous professional guidance and self-development among trainees.

On the other hand, WBL has gained increasing attention in higher education as a means of bridging the persistent gap between academia and industry. WBL model positions industry as a direct partner in the teaching and learning process, moving beyond theoretical instruction toward authentic, practice-oriented knowledge delivery. A shift from a typical teacher-centered approach to a student-centered methodology necessitates careful examination and has significant implications for pedagogy, curriculum, and assessment strategies (Thompson & Harbaugh, 2013). In this study, all agricultural industry practitioners determined that the module is appropriate for industrial application, with minimal revisions required. Given that trainees will be engaging with industry for the first time, several practitioners emphasized the importance of providing clear yet impactful guidance. In parallel, Brandt et al. (2017) highlighted the need to adapt agricultural language for age and developmental appropriateness, ensuring that learners fully comprehend the terminology and benchmarks used. The ideas acquired at the university must be effectively transformed into a well-structured practical framework during their training.

Moreover, there is a need to emphasize the job scope of extension agents, including incorporating module inputs that focus more on group and community-based activities to help trainees become familiar with the nature of the role. The WBL-driven module emphasizes experiential learning while strengthening partnerships between higher education institutions and industry (Mohamad et al., 2021). The significance of WBL underscores that problem-based, experiential learning integrated into work-based modules offers students a genuine opportunity to connect the workplace with the classroom. Collaborative activities with peers not only augment critical thinking and problem-solving abilities but also foster transferable talents that transcend academic environments. Furthermore, all practitioners in this study agreed that the developed module has the potential to positively impact the breadth of trainees' skills, as reflected in the consistently high mean scores recorded for the effects of content design. The methodology suggested in the WBL module indicates that previous research demonstrates that self-learning modules are enhanced by components that enable them to function effectively as instructors. Such modules encourage students to think independently, adapt learning to their personal style, and cultivate self-study habits that build confidence (Kanchan, 2016).

CONCLUSION

The results show that the WBL and assessment module for agricultural extension trainees meets industry needs. Industrial practitioners also stressed that the module must clearly align with practical tasks and real training experiences. The findings highlight the development of a hybrid learning module and practical guidance that reflect a clear understanding of agricultural extension work and its target communities. The involvement of industry stakeholders plays an important role in shaping the module and strengthening collaboration between universities and industry. The assessments included in the

module help ensure that trainees achieve the intended learning outcomes, identify areas for improvement, and develop both technical and soft skills needed by the industry, thereby improving the overall quality and accountability of the WBL program. This collaboration may support the production of competent graduates who meet the quality standards required by the agricultural sector.

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DATA AVAILABILITY STATEMENT

Data will be made available on request.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

In the declaration of generative AI and AI-assisted technologies in the writing process during the preparation of this manuscript, the author(s) utilized ChatGPT to assist with grammar refinement. Following the use of this AI-assisted tool, the author(s) thoroughly reviewed and edited the content to ensure accuracy and clarity and assume full responsibility for the integrity and quality of the final publication.

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