Co-funded by the European Union

D-VETYA PROJECT

PAPER FROM CENTRE BASED TRAINING to eLEARNING

Project Deliverable 5

Deliverable Description Sheet

Deliverable: D5 Paper from Centre Based Training to eLearning

Due Date: Month 23 (30th November 2024)

Actual Completion Date: 29th November 2024

Work Package Concerned: WP 2 – Development of the YA eLearning Platform

Deliverable Type: R – Report

Dissemination Level – PU Public. This resource, along with other project resources, are freely available at these links https://serve.ie/digital-vet-youngafrica/ and https://youngafrica.org/en/project/digital-vocational-education-and-training-for-young-africans/)

Information on the Young Africa eLearning Platform is also available at Young Africa YouTube Channel

The eLearning Platform itself is available at https://yaelearning.org/

Authors – Ireen Theu (D-VETYA Project Coordinator with Young Africa)

Disclaimer: "Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA) – the Granting Authority. Neither the European Union nor the granting authority can be held responsible for them."

Contents

D-VETYA Project Background

The Digital VET (Vocational Education and Training) for Young Africans (D-VETYA) project is being implemented by SERVE and Young Africa (YA) from January 2023 to December 2024. SERVE is an international development NGO based in Ireland. YA is a federation of independent NGOs and includes YA International – based in The Netherlands, YA International - Africa Hub Trust (based in Zimbabwe), YA Zimbabwe, YA Mozambique, YA Zambia and YA Namibia. YA has a network of 23 organisations across 11 African countries that are replicating its successful models. YA provides holistic and accredited VET to marginalised youth through 6-12 month training courses in 46 disciplines, which is integrated with life skills education, entrepreneurship and digital literacy.

The objectives of the D-VETYA Project are (1) Coordinating implementation of the Project Workplan and achievement of Project Deliverables; (2) YA's eLearning Platform available for 8,150 disadvantaged youth across southern and Eastern Africa; (3) YA's Postgraduate Service Toolbox (PGST) contributes to a substantial increase in the percentage of YA graduates in employment; (4) 4 YA Affiliates and 23 dissemination partners using the PGST across Africa; (5) 2 new YA models (eLearning & PGST) integrated into YA MEL system and 73 YA and dissemination partner staff trained in MEL system leading to improved data driven performance; (6) Evaluate the impact, successes, challenges and lessons from the Project; and (7) Increase awareness about Digital VET in Africa amongst 50 policymakers and 3,500 members of the public in Ireland and the Netherlands.

The project has five Work Packages – (1) Coordination and Management; (2) Development of the YA eLearning Platform; (3) Development of the YA Postgraduate Service Toolbox (4) Improvement of the YA Monitoring Evaluation and Learning System; (5) Impact and Dissemination. SERVE is the Coordinator, YA International (YA Int. NL and YA Int. - Africa Hub Trust) are Beneficiaries, and the four YA Affiliates are Affiliated Entities. YA's dissemination network will also benefit.

Abstract

This study examines the development, implementation, and impact of the D-VETYA e-learning platform as a tool for enhancing Technical and Vocational Education and Training (TVET) across Young Africa affiliates in Zimbabwe, Mozambique, and Zambia. Using a mixed-methods approach, the study integrates insights from surveys, interviews, and document reviews. Findings highlight key successes, including improved accessibility, theoretical learning outcomes, and engagement, alongside challenges such as connectivity barriers, gaps in digital literacy, and the integration of practical skills. Best practices identified include iterative feedback mechanisms, hybrid learning models, and localized content development, while pitfalls emphasize the need for robust infrastructure, internal capacity, and continuous curriculum review. Recommendations focus on fostering sustainability through strategic partnerships, advanced simulation tools, and enhanced training for stakeholders. This study offers actionable insights for scaling e-learning platforms within resource-constrained TVET settings.

1. Introduction and background for e-learning

The integration of e-learning is proven to optimise learning outcomes because learners have greater access to resources and more flexibility in developing their learning paths (Means et al., 2013). According to Sahin (2010) blended learning can play a vital role in promoting skills development in vocational training environments. Research shows that blended learning can lead to improved engagement and academic performance compared to traditional methods alone (Bernard et al., 2014; Bond et al., 2021). In vocational training environments, blended learning—combining digital tools with traditional methods—has been shown to significantly enhance skills development, engagement, and academic performance (Sahin, 2010; Bernard et al., 2014; Bond et al., 2021).

Young Africa (YA) (www.youngafrica.org), in collaboration with SERVE (www.serve.ie), is developing an e-learning platform that is intended to increase access to vocational skills training for young people in Africa. The project is called D-VETYA (Digital VET for Young Africans). The project was funded by the European Union Erasmus+ Fund and further information about the project can be found here.

The process of developing this platform was ground-breaking for YA and SERVE, hence, as part of the project design, it is important that the processes, experiences, challenges, lessons and observations made during the development of the platform are documented and disseminated to other TVET providers that may wish to embark on similar journeys. This study was commissioned to document this process.

1.1. Objectives of the study

The objectives of the study were to:

a) Assess the effectiveness of the process of integrating the e-learning platform into existing TVET programs;
b) Identify the challenges encountered and the strategies employed to address them;
c) Document best practices and lessons learned to guide similar projects in the future.

1.2. Research Questions

a) What were the key steps taken in the development, launch and integration of the e-learning platform into the YA training programme?
b) What challenges (internal and external) were encountered during the development and launch process, and how were they addressed?
c) How was the practical component of TVET integrated in the learning process and how effective was this approach?
d) How does the e-learning platform influence student engagement, learning outcomes, and overall training effectiveness?
e) What worked well (best practices that can be replicated in similar processes)?
f) What did not work well (pitfalls that must be avoided in future similar processes)?
g) How can the e-learning platform be sustained and scaled alongside existing traditional training methods for broader use in the TVET sector?

The study evaluates the process and provides a framework for scaling and sustaining such initiatives in the future. The findings aim to serve as a practical guide for organizations seeking to replicate or adapt similar models in vocational education and beyond.

2. Methodology

This study employed a mixed-methods (both quantitative and qualitative) approach to gather data needed to answer the study questions.

2.1. Data Collection Methods

a) Surveys

Target Groups: Two distinct survey tools were developed: (i) **Students:** Focused on user experiences, platform accessibility, and perceived learning outcomes. (ii) **Administrators and Trainers:** Examined implementation challenges, platform usability, and overall effectiveness. The surveys were deployed using Kobo Collect, allowing responses to be collected digitally using mobile devices or computers. A total of 134 respondents completed the surveys (103 students and 27 administrators/trainers and 4 consultants).

Table 1: Profile of survey respondents

Respondent	Female	Male	Total Respondents
Students	60	43	103
Administrators/Trainers	13	14	27
Consultants	1	3	4
	74	**60**	**134**

b) Interviews

In-depth interviews were conducted with (i) project administrators and trainers directly involved in platform development and deployment and (ii) external consultants who contributed to platform design or training. The interviews covered (i) development and Integration of the E-learning platform, (ii) challenges encountered during implementation, (iii) successes and lessons learned and (iv) integration of e-learning with practical components in TVET. Interviews were conducted virtually or in person, depending on respondent availability, and audio recorded (with consent) for transcription and analysis.

c) Document Review

A wide range of project documents was analysed, including project proposal, mid-term review report, induction reports, user testing reports, beginning and end of user-training course surveys and M&E Logical Framework and communication and dissemination strategy. The review concentrated on alignment with project objectives, documented performance metrics, challenges, and recommendations, and lessons that could inform future initiatives.

2.2. Data Analysis

a) Quantitative data analysis

Survey data were analysed using descriptive statistics to identify trends, distributions, and significant patterns in responses. Key findings were visualized through charts (e.g., bar charts, pie charts) to enhance interpretability.

b) Qualitative data analysis

Interview transcripts were analysed thematically, with responses categorized under predefined themes aligned to the research questions: user engagement, platform challenges, integration of practical components in e-learning, and thematic insights were synthesized and integrated into the findings.

c) Document Analysis

Data from project documents were systematically extracted using a predefined data extraction sheet. Extracted data were aligned with research questions to provide supporting evidence for survey and interview findings.

2.3. Limitations

While the study employed rigorous data collection and analysis methods, certain limitations were encountered:

- **Participant Availability:** Scheduling constraints limited participation in some interviews.
- **Digital Literacy:** Challenges in administering surveys in remote areas with limited access to devices or internet connectivity.
- **Concurrent Evaluations:** Overlap with external evaluation exercises caused coordination challenges.
- **Representation:** The findings are representative of those who participated and may not capture the full diversity of perspectives.

3. Analysis of Study Findings

The purpose of this study was to evaluate the development, implementation, and impact of the D-VETYA e-learning platform on vocational training and education. The findings reveal a multi-faceted perspective on the platform's successes, challenges, and areas for improvement, addressing key research questions and shedding light on practical implications for future initiatives.

Key themes emerged from the findings, including the effectiveness of the platform in supporting practical and theoretical learning, usability, and accessibility, challenges encountered during the rollout, and the sustainability and scalability of the platform. These findings provide critical insights into the strengths of the platform, such as its user-friendly design and improved access to learning resources, while also highlighting gaps in areas like digital literacy, connectivity, and practical skills training.

In the following discussion, these findings are interpreted in the context of the research questions, existing literature, and the broader objectives of the project. Practical implications

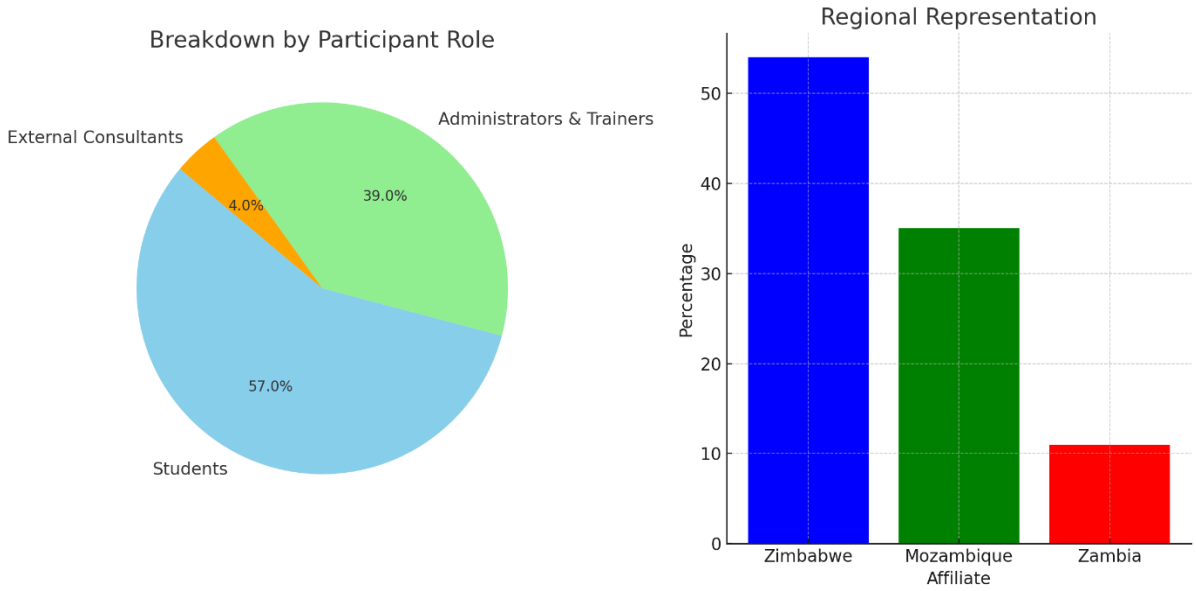
and recommendations are also provided to inform the ongoing development and potential scale-up of the e-learning platform within TVET programs.

3.1 Demographics of the Respondents

Demographics of Respondents

The demographic distribution of participants provides a comprehensive understanding of the diverse perspectives captured during the study. A total of 134 individuals participated in the data collection process, with representation across students, administrators/trainers, and external consultants.

Figure 1: Demographic distribution of participants



Participant Roles

Students formed the majority, representing **57% (77 participants)** of the total. Their insights were instrumental in understanding the user experience and evaluating the platform's impact on learning outcomes. Administrators and trainers accounted for **39% (53 participants)**, providing critical perspectives on the platform's implementation, usability, and challenges. External consultants made up the remaining **4% (4 participants)**, offering expert views on the platform's design and scalability. These consultants were evenly distributed between Zimbabwe and Uganda, with two representatives from each country.

Affiliate Representation

Participants were drawn primarily from three Young Africa affiliate regions:

- **Zimbabwe:** The largest group, with **54% (72 participants)**.
- **Mozambique:** Contributed **35% (47 participants)**.
- **Zambia:** Represented **11% (15 participants)**.

This regional breakdown illustrates the platform's varied adoption and implementation across the affiliates. The inclusion of external consultants further adds an external perspective, enriching the study's findings.

3.2 Key Steps in Development, Launch, and Integration of the e-LP

The development, launch, and integration of the D-VETYA e-learning platform followed a structured and collaborative process that aligned with best practices for digital education transformations. This systematic approach emphasized planning, stakeholder engagement, content adaptation, and iterative improvements, ensuring the platform met the unique needs of the TVET program and its diverse user base.

Planning and Needs Assessment

The project began with an extensive needs assessment to identify gaps in traditional training delivery methods. Stakeholders, including administrators, trainers, and consultants, conducted workshops and induction sessions to outline objectives, clarify roles, and explore how digital tools could enhance vocational training. This phase provided a strong foundation for the platform's design, ensuring alignment with institutional goals and learner needs (Bates, 2019). Early planning was vital in fostering organizational buy-in and prioritizing areas for digital transformation, a key recommendation in digital pedagogy literature (Simonson, Smaldino, & Zvacek, 2019).

Supporting Quote: *"The needs assessment ensured we understood the areas where digital tools could enhance learning, particularly for theoretical components."*

Content Development and Adaptation

Adapting TVET materials (i.e. training curricula) for online delivery required a collaborative effort between trainers and content developers. The process focused on maintaining cultural and practical relevance, integrating multimedia elements like videos, simulations, and quizzes to enhance engagement. These efforts align with best practices in e-learning design, which emphasize contextualized and interactive content to improve learner outcomes (Rahimi, van den Berg, & Veen, 2015). The emphasis on localized and practical content reflects the importance of aligning curricula with learners' real-world needs (Anderson & Dron, 2011).

Supporting Quote: *"We ensured that even hands-on topics were presented in a way that encouraged critical thinking and preparation for practical sessions."*

Technical Implementation

The platform's technical development combined expertise from internal IT teams and external consultants, resulting in a Learning Management System (LMS) tailored to the program's needs. Key features included interactive content, assessment tools, and offline accessibility, which addressed connectivity challenges for users in low-bandwidth environments. This phase highlighted the importance of user-friendly design in ensuring widespread adoption and equitable access to digital learning tools (Bozkurt & Sharma, 2020).

Supporting Quote: *"One of the primary goals was to ensure that even students in remote areas with limited internet access could benefit from the platform."*

Pilot Testing and Feedback Integration

A pilot phase at select sites allowed stakeholders to test the platform's functionality and gather user feedback. Participants identified usability issues, gaps in localized content, and digital literacy challenges, which were addressed through platform updates and supplementary training sessions. This iterative approach aligns with global recommendations for e-learning platforms, emphasizing the importance of piloting and refinement to enhance user experience (Khalil & Ebner, 2017).

Supporting Quote: *"The pilot phase highlighted what worked and what didn't, allowing us to address challenges before the platform was fully deployed."*

Full Rollout and Integration

The full rollout represented a major milestone, integrating the e-learning platform into the traditional TVET framework. While challenges such as connectivity and limited digital literacy persisted, capacity-building workshops and supplementary resources supported users during this transition. The phased implementation ensured that learnings from the pilot phase informed broader deployment efforts, demonstrating the value of structured, feedback-driven rollouts in large-scale digital initiatives (UNESCO-UNEVOC, 2020).

The structured approach to development and integration underscores the importance of thorough planning and stakeholder involvement in large-scale digital transformations. The collaborative content development process and feedback-driven pilot testing emerged as key enablers of success (UNESCO-UNEVOC, 2020). However, the findings also suggest that early identification of potential barriers, such as connectivity and digital literacy issues, could have mitigated rollout challenges more effectively (Bozkurt & Sharma, 2020).

3.3 Integration of Practical Components in TVET and Effectiveness of the Approach

The integration of practical components into the D-VETYA e-learning platform was central to ensuring its relevance in vocational education, given the hands-on nature of TVET programs. Findings from the document review, interviews, and surveys reveal both successes and challenges in achieving this goal, underscoring the complexities of translating practical skill development into a digital or hybrid format.

Hybrid Learning Model

The project adopted a hybrid learning model that combined online theoretical modules with offline practical sessions. This approach was effective in balancing the need for hands-on training with the flexibility of e-learning. Theoretical content was delivered through the e-learning platform, allowing students to engage with material at their own pace, a flexibility that has been shown to enhance learner engagement and retention (Boelens, De Wever, & Voet, 2017). Offline practical workshops were critical in maintaining the experiential component of TVET, reinforcing theoretical knowledge with real-world applications (Anderson & Dron, 2011).

Despite these strengths, the hybrid model faced significant limitations:

- **Limited Practical Simulations**: While interactive features, such as video demonstrations and gamified modules, were well-received, they could not fully replicate the tactile and experiential aspects of hands-on training. This aligns with Mishra and Panda's (2020) findings that virtual tools often lack the sensory feedback necessary for certain vocational skills.
- **Logistical Barriers**: Organizing offline sessions in regions with limited infrastructure posed coordination challenges, reflecting logistical constraints noted in other hybrid learning contexts (Cavanaugh, Barbour, & Clark, 2009).

Innovative Approaches to Enhance Practical Learning

Figure 2: Support for Learning Practical Skills.

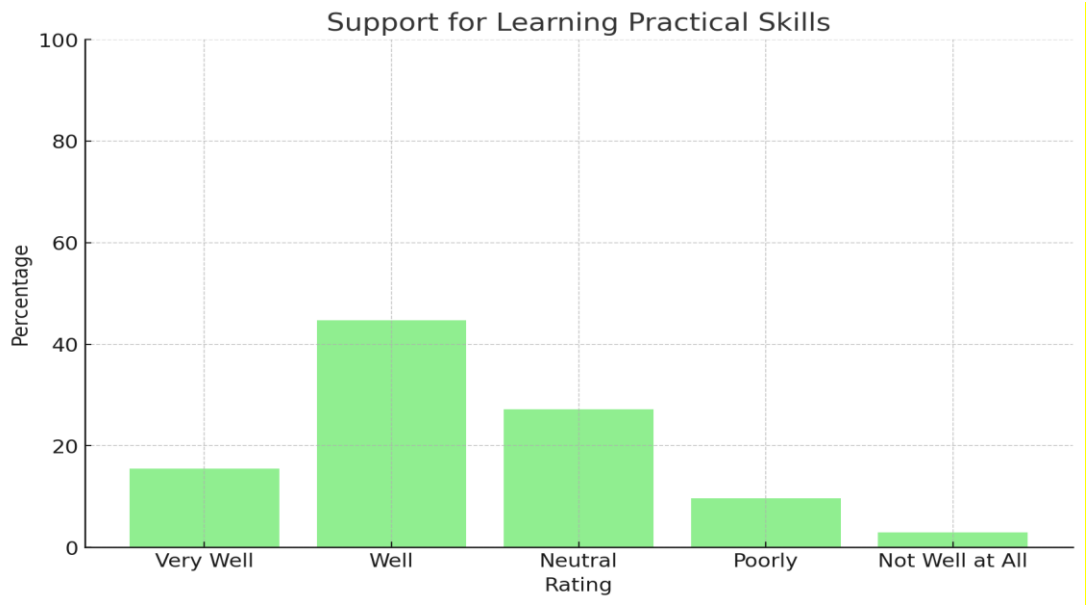


Figure 2. above *"Support for Learning Practical Skills"* demonstrates varied responses, with 44.7% rating the platform as performing "Well" and 15.5% as "Very Well" in facilitating practical learning. However, a combined 12.6% rated it poorly, indicating the need for enhancements such as advanced simulations and better logistical planning.

To address some of these limitations, the project introduced innovative strategies aimed at bridging the gap between theoretical and practical components:

- **Interactive Content**: Videos and gamified modules simplified complex concepts and were highly rated by users. Gamification, in particular, has been shown to enhance motivation and performance in vocational settings (Dichev & Dicheva, 2017).
- **Supplementary Resources**: Offline materials, including downloadable guides and exercises, supported learners in regions with limited connectivity. These resources reflect best practices in enhancing accessibility in low-resource environments (Bozkurt & Sharma, 2020).

Effectiveness and Gaps

The hybrid model demonstrated moderate success:

- **Strengths**: By maintaining the integrity of hands-on training through in-person workshops and leveraging interactive digital content, the model effectively addressed key aspects of practical learning. Similar successes have been documented in blended learning implementations, which improve accessibility and learning outcomes (Graham, 2019).
- **Gaps**: The absence of fully immersive virtual simulations and logistical difficulties in offline session coordination limited the platform's ability to meet all practical training needs. Advanced virtual labs, as suggested by Dillenbourg et al. (2009), could address these gaps by providing realistic practice environments.

Recommendations for Improvement

To enhance the integration of practical components, the following recommendations are proposed:

1. **Invest in Advanced Virtual Labs**: Developing augmented reality (AR) and virtual reality (VR) simulations could create immersive environments for practical skill development, aligning with industry best practices (Pantelidis, 2010).
2. **Improve Offline Session Coordination**: Streamlined planning and resource allocation can mitigate logistical challenges, improving the consistency and quality of in-person practical training (Bates, 2019).
3. **Foster Industry Partnerships**: Collaborations with industry partners to offer internships and apprenticeships can supplement the platform's training capabilities, providing students with real-world exposure and enhancing their employability (UNESCO-UNEVOC, 2020).

Generally, while the platform made significant strides in integrating practical components, addressing its gaps through innovative solutions and strategic partnerships will be critical for ensuring its effectiveness and scalability in the long term. By leveraging advanced technologies and fostering collaboration with industry stakeholders, the platform can better align with the needs of TVET learners and prepare them for the demands of the modern workforce.

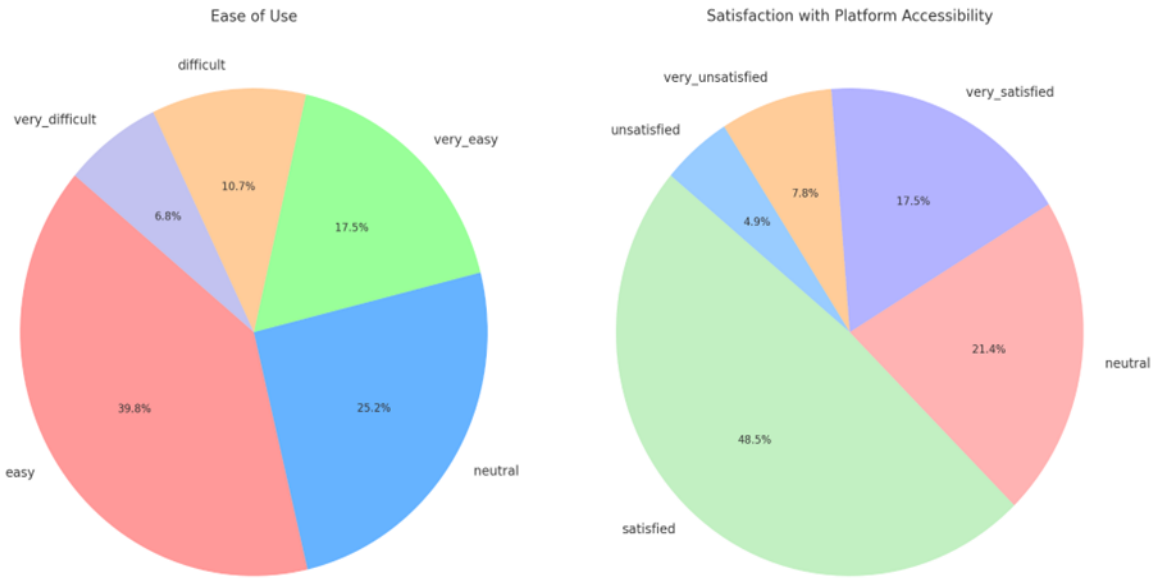
3.4 Impact of the eLP on Student Engagement, Learning Outcomes and Training Effectiveness

The implementation of the D-VETYA e-learning platform aimed to revolutionize vocational education by improving accessibility, enhancing student engagement, and delivering high-quality training outcomes. This section critically examines the platform's impact across three dimensions: **Platform Accessibility and Usability**, **Student Engagement**, and **Learning Outcomes**, incorporating data from surveys, interviews, and document reviews. The analysis also considers how these findings align with broader trends in e-learning research, highlighting both successes and areas for improvement.

3.4.1 Platform Accessibility and Usability

Platform accessibility and usability were foundational to the e-learning platform's success, shaping how students and trainers interacted with its features. Figure 3. below visually illustrates the distribution of ratings for **Ease of Use** and **Satisfaction with Accessibility**, providing a clear reference for the findings discussed.

Figure 3. Ease of Use and Satisfaction with Accessibility



Survey findings reveal that **57.3% of respondents rated the platform as "Easy" or "Very Easy" to navigate**, reflecting its intuitive design. However, **25.2% of users expressed a neutral stance**, indicating a potential gap in user training or interface optimization. A smaller yet notable group (**17.5%**) found the platform "Difficult" or "Very Difficult" to use, emphasizing the need for targeted enhancements.

In terms of accessibility, **66% of respondents reported being "Satisfied" or "Very Satisfied"**, with the platform's compatibility across mobile and desktop devices receiving praise. Nevertheless, **21.4% expressed neutrality**, and **12.7% were "Unsatisfied" or "Very Unsatisfied"**, citing connectivity challenges and device compatibility as major barriers. These findings underscore the importance of addressing infrastructural and technical support issues to enhance equitable access (Van Deursen & Van Dijk, 2019).

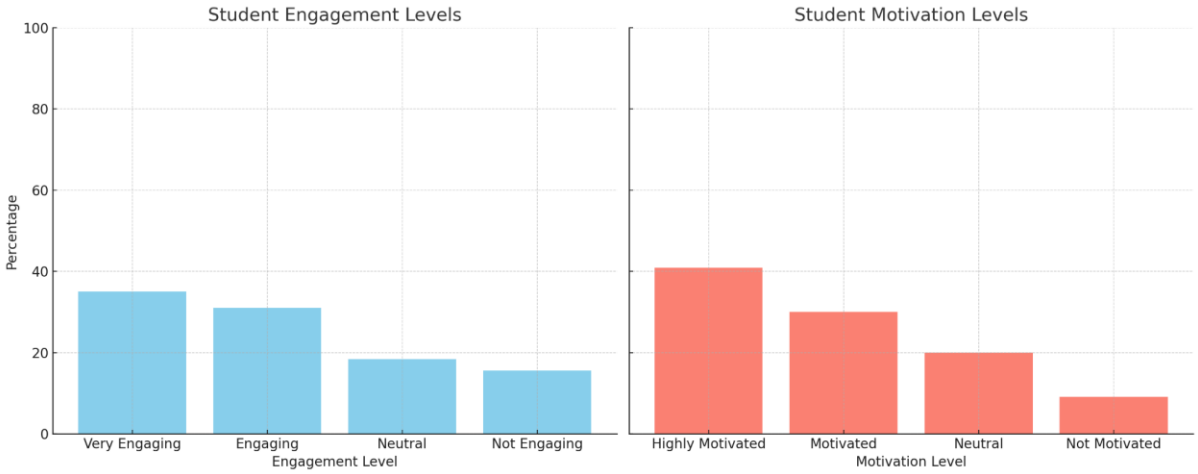
The findings highlight the platform's user-friendly design but also point to challenges in accessibility that need immediate attention. Enhancing onboarding tutorials and expanding technical support for less tech-savvy users can address usability gaps. Additionally, optimizing the platform for low-bandwidth environments and exploring offline functionalities can significantly improve accessibility for users in remote or underserved regions. These strategies

align with Bates' (2019) recommendations for inclusive e-learning systems. The correlation between high usability ratings and accessibility satisfaction underscores the platform's potential to deliver a seamless user experience if infrastructure barriers are mitigated. As demonstrated in similar projects, investing in robust infrastructure and ongoing user training is critical to maximizing the effectiveness of e-learning platforms (Bozkurt & Sharma, 2020).

3.4.2 Student Engagement

Student engagement is a critical indicator of an e-learning platform's success, influencing both learning outcomes and overall training effectiveness.

Figure 4: Student engagement and Motivation



The D-VETYA e-learning platform demonstrated substantial success in this area, with **66% of respondents rating the platform as "Very Engaging" or "Engaging"**. This high engagement level reflects the platform's interactive features, including quizzes, gamified modules, and videos, which were frequently cited as the most appealing aspects by both students and trainers. However, **18.4% of respondents expressed a neutral stance** toward their engagement experience, indicating room for improvement in interactive content and personalized learning paths. A smaller group reported that the platform was "Not Engaging," underscoring the need to address gaps in user motivation and engagement strategies. Survey findings also highlighted that **70.9% of students felt motivated or highly motivated** to complete their courses, demonstrating the platform's capacity to sustain user interest despite connectivity challenges.

The platform's success in fostering engagement can be attributed to its integration of interactive and gamified elements, which aligns with Dichev and Dicheva's (2017) findings on the positive impact of gamification in e-learning environments. Flexible access to course materials, a key feature of the platform, further contributed to engagement by accommodating diverse schedules and learning paces (Boelens, De Wever, & Voet, 2017).

Nevertheless, the findings reveal gaps that warrant attention. The neutral and negative responses suggest that some users may require additional support to fully engage with the platform. Enhancements such as adaptive learning paths, which tailor content to individual user needs, and more robust social interaction features could address these gaps. Additionally, addressing motivational barriers, particularly for students in remote areas facing connectivity challenges, is essential to sustaining engagement (Anderson & Dron, 2011).

The platform's ability to engage the majority of students reflects its potential as a transformative tool for vocational education. However, achieving universal engagement requires a holistic approach that combines technological innovation with tailored pedagogical strategies and continuous user feedback.

3.4.3 Learning Outcomes

The D-VETYA e-learning platform demonstrated a notable impact on students' theoretical understanding, with **67% of respondents stating that the platform improved their comprehension of theoretical concepts.** This aligns with trainers' observations, who noted that the ability to revisit course materials multiple times significantly reinforced learning. The flexibility offered by the platform allowed students to engage with content at their own pace, a key factor in supporting knowledge retention and conceptual clarity. However, the platform's ability to support practical skill development was less consistent. As highlighted in the earlier discussion on practical components, gaps remained in providing immersive, hands-on experiences. This limitation underscores the need for advanced virtual tools, such as simulations and augmented reality (AR), to bridge the gap between theory and practice.

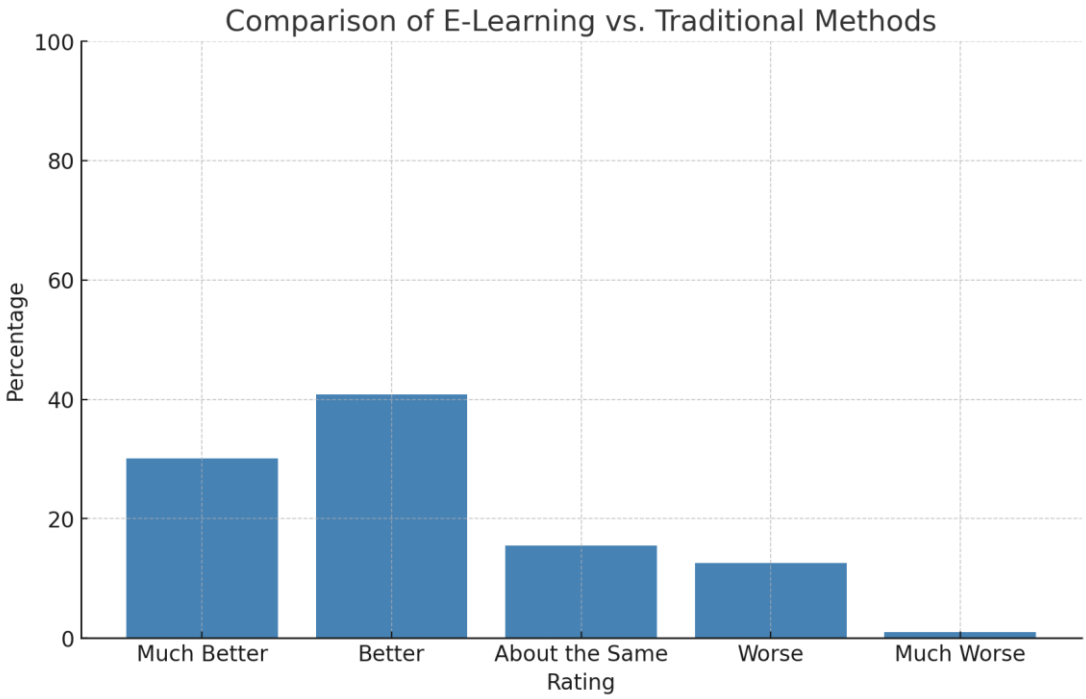
The platform's success in enhancing theoretical learning reflects broader trends in digital education, where asynchronous access to well-structured materials has been shown to improve comprehension and retention (Bates, 2019). The ability to revisit content aligns with best practices in learner-centered training, as it accommodates diverse learning styles and paces.

Despite these successes, the findings highlight persistent challenges in addressing the practical learning needs of vocational training students. This is consistent with research indicating that e-learning platforms often excel in delivering theoretical content but struggle to replicate hands-on experiences essential for skill development (Mishra & Panda, 2020). Without significant enhancements to practical training components, the platform risks falling short of its broader objectives in vocational education.

Recommendations for addressing these gaps include investing in virtual labs and simulations to provide students with realistic practice opportunities and collaborating with industry partners to offer supplementary hands-on training through internships or workshops. These

strategies would not only enhance the platform's effectiveness but also align it more closely with the holistic requirements of TVET programs (Pantelidis, 2010).

Figure 5 – Comparison of E-Learning vs. Traditional Methods



3.4.4 Training Effectiveness

From an organizational perspective, the e-learning platform achieved several efficiency gains, streamlining the delivery of standardized training content across multiple affiliates. Administrators highlighted how the platform reduced the reliance on physical resources and enabled consistent training delivery across diverse locations. This capability aligns with findings from global e-learning projects, which emphasize digital platforms' capacity to enhance operational efficiency while maintaining content quality (UNESCO-UNEVOC, 2020).

However, challenges in student retention were noted as a key limitation to the platform's effectiveness. Survey responses revealed that some students struggled with maintaining consistent engagement due to connectivity issues and motivation gaps. These challenges echo broader concerns about learner isolation and lack of engagement, which are frequently cited as barriers to retention in e-learning environments (Kizilcec, Pérez-Sanagustín, & Maldonado, 2017).

The platform's ability to standardize content delivery across affiliates demonstrates its potential to improve training efficiency, particularly in resource-limited environments. This aligns with the broader literature on the role of e-learning in reducing logistical challenges and ensuring

equitable access to quality education (Bates, 2019). The ability to maintain uniformity across training sites is a significant achievement, particularly in the context of multi-regional TVET programs.

However, the retention issues identified in the survey and interviews highlight the need for a more interactive and supportive learning environment. Research suggests that enhancing social presence and creating community-driven learning models can significantly improve retention and engagement in e-learning contexts (Anderson & Dron, 2011). Addressing these challenges will require a multi-faceted approach, including:

- **Interactive Features**: Expanding gamified elements and virtual discussions to foster a sense of connection and motivation among students.
- **Feedback Mechanisms**: Implementing regular surveys and focus groups to identify specific barriers to retention and address them proactively.
- **Technical and Emotional Support**: Establishing mentoring programs and peer networks to reduce learner isolation and provide consistent support.

By integrating these strategies, the platform can enhance its overall training effectiveness and ensure that students not only engage but also succeed in their learning journeys.

3.5 Challenges Encountered and How They Were Addressed

The development and implementation of the D-VETYA e-learning platform presented several challenges, spanning technical, user-related, and logistical domains. These challenges were addressed through adaptive strategies informed by stakeholder insights, document reviews, and survey findings. Below is a synthesis of the key challenges and how they were addressed, along with a critical analysis of their implications.

1. Limited Digital Literacy

One of the most significant internal barriers was the limited digital literacy among trainers, administrators, and students, as highlighted in interviews and survey responses. This limitation aligns with global findings on digital adoption, where a lack of foundational digital skills impedes e-learning implementation (Van Deursen & Van Dijk, 2019).

To address this challenge, the project introduced tailored capacity-building workshops for trainers and administrators. Digital literacy modules were also incorporated into the student onboarding process, equipping users with the basic skills necessary to navigate the platform effectively. These interventions were supported by findings from user testing, which showed improved engagement and usability following these efforts.

While these initiatives successfully improved digital competence, they underscore the need for integrating digital literacy training as a standard component of e-learning projects. This aligns

with best practices that advocate for hands-on, context-specific training to enhance digital skills (Mishra & Panda, 2020). However, future efforts must also consider continuous support mechanisms to sustain skill development.

2. Resistance to Change

Resistance to adopting a digital-first approach was noted among trainers and administrators accustomed to traditional face-to-face training. This resistance, rooted in skepticism about the effectiveness of e-learning for vocational training, mirrors findings in broader educational research (Anderson & Dron, 2011).

Capacity-building workshops were instrumental in addressing this challenge. These workshops demonstrated the pedagogical benefits of e-learning, emphasizing its alignment with TVET goals. Trainers' increased comfort and willingness to engage with the platform post-training highlight the importance of structured, goal-oriented workshops in overcoming resistance.

The workshops effectively mitigated resistance but fostering long-term buy-in requires ongoing engagement and showcasing tangible benefits through data and success stories. Stakeholders' early involvement in the design and rollout phases could further reduce resistance.

3. Connectivity Challenges

Connectivity emerged as the most significant external barrier to platform adoption, particularly for students in rural areas. Survey findings revealed that 71.8% of respondents experienced technical difficulties, including unstable internet connections and high data costs, highlighting the pervasive impact of the digital divide on equitable access to e-learning (Van Deursen & Van Dijk, 2019). These challenges were further exacerbated for students in remote areas with limited infrastructure and access to reliable internet.

To address connectivity barriers, the project employed multiple strategies. Initially, students close to Young Africa centres were granted access to campus internet, partially alleviating access challenges for a subset of learners. However, this solution proved unsustainable due to unstable connections, high maintenance costs, and misuse by students for non-educational purposes. Moreover, this approach failed to support remote students, leaving significant gaps in accessibility.

A more sustainable measure was the integration of the e-learning platform with the Moodle app, enabling offline access and providing downloadable content. This feature allowed students to use resources without an internet connection, aligning with sustainable e-learning practices aimed at minimizing reliance on live connectivity in low-bandwidth environments (Bates, 2019). Asynchronous learning options further accommodated students with limited internet access, offering greater flexibility for participation.

Despite these efforts, persistent connectivity challenges emphasize the need for long-term solutions. Proposed strategies include forming partnerships with telecommunications providers to offer affordable data packages and investing in infrastructure improvements to enhance digital access. Such measures are critical to addressing the systemic barriers posed by the digital divide and ensuring equitable participation in e-learning initiatives.

4. Curriculum Review Delays

The curriculum review process proved to be one of the most significant challenges in the D-VETYA e-learning platform project, critically impacting timelines, content quality, and overall implementation outcomes. This phase highlighted the inherent complexities of adapting traditional vocational training curricula for a digital environment, revealing both operational and strategic gaps that align with broader findings in e-learning transformations.

Reliance on an external subcontractor for curriculum review emerged as a key bottleneck. The initial consultant failed to meet deliverable timelines, necessitating a complete re-initiation of the recruitment process. This setback disrupted the synchronization of key project milestones, delaying the development and deployment of the e-learning platform. Without finalized curricula, the project faced significant barriers to creating and uploading course content, a prerequisite for pilot testing and full rollout. These challenges resonate with the findings by Bates (2019), who emphasizes the importance of timely curriculum readiness in e-learning projects to avoid downstream delays in implementation.

The intricate nature of adapting vocational curricula to suit an online learning format further compounded these issues. Vocational training relies heavily on practical skills, which are often difficult to replicate in digital settings. Trainers expressed significant concerns about how practical elements could be maintained without diminishing their pedagogical integrity. This aligns with observations by Mishra and Panda (2020), who argue that digital adaptation must preserve the core instructional design principles of vocational education while leveraging the affordances of e-learning tools. Despite efforts to create multimedia resources, such as video demonstrations and interactive simulations, the outcomes highlighted a persistent gap between theory and practice in digital vocational training.

In addition, the project's heavy reliance on external consultants for this critical task underscored a lack of internal capacity. This dependency introduced vulnerabilities, as the absence of internal expertise limited the organization's ability to make iterative adjustments during the review process. Research by Van Deursen and Van Dijk (2019) corroborates this finding, highlighting the risks of external reliance in digital projects, especially in contexts where internal teams lack sufficient training to manage core processes. The challenges faced in D-VETYA emphasize the need for capacity-building initiatives to equip internal teams with skills in curriculum review and adaptation, thereby reducing dependency and fostering project resilience.

The cascading effects of curriculum review delays further demonstrated the interconnectedness of project components. These delays disrupted critical phases such as stakeholder training and platform refinement, ultimately compressing the timeline for key activities. This reflects the findings of Khalil and Ebner (2017), who highlight the systemic impact of delays in foundational project components on the overall success of e-learning initiatives.

Looking forward, the findings suggest a shift in approach, treating curriculum review as a continuous process rather than a one-time milestone. Regular, iterative reviews informed by feedback from trainers, students, and industry stakeholders could help ensure content remains relevant and aligned with labor market demands. As noted by UNESCO-UNEVOC (2020), embedding iterative curriculum review within an organization's operational framework can enhance adaptability and quality, fostering long-term sustainability.

Overall, the challenges in the curriculum review process reveal critical lessons for future e-learning initiatives. A robust internal capacity for curriculum review, combined with a shift toward continuous improvement, can mitigate risks, improve project resilience, and ensure the sustained quality and relevance of digital vocational training content.

5. Resource Constraints

Logistical constraints, including limited infrastructure and trainer availability, hindered the platform's rollout. These challenges align with findings from large-scale e-learning projects, where resource limitations exacerbate implementation difficulties (Cavanaugh, Barbour, & Clark, 2009). A phased rollout strategy prioritized pilot locations, allowing for resource optimization and incremental scaling.

While the phased approach was practical, ensuring equitable resource distribution across affiliates remains a challenge. Strategic planning and stakeholder collaboration are essential to address these limitations and support broader scaling efforts.

6. Sustainability Concerns

Sustainability emerged as a significant concern, with stakeholders questioning how the platform would be maintained and updated post-project.
(*Supporting Quote*: "*We need a solid plan for maintaining the platform after the project ends*.")

The project relied heavily on external funding to cover platform maintenance, connectivity, and content development costs. As the project neared its conclusion, questions arose regarding how these recurring costs would be managed without a long-term financial model in place. This reliance on external funding underscores broader concerns about the sustainability of e-learning initiatives, as highlighted by Bates (2019), who emphasizes the risks of funding-dependent programs.

Technically, the platform's dependence on external consultants for development and maintenance posed significant risks. Without adequate internal capacity-building initiatives, the platform risks stagnation or failure due to a lack of expertise to update and adapt it to evolving user needs. Khalil and Ebner (2017) stress the importance of investing in internal technical capacity to ensure the longevity and adaptability of digital learning systems.

Operationally, integrating the platform into the institutional workflows of Young Africa affiliates remained a key concern. Stakeholders emphasized the need for organizational commitment to embed e-learning as a core part of training delivery. However, achieving this integration required aligning the platform's operational costs with affiliate budgets and fostering local ownership of the system.

Connectivity issues also influenced sustainability, as they directly impacted user participation and engagement. While the integration of the Moodle app for offline access offered a partial solution, broader systemic challenges—such as internet affordability and rural infrastructure—persisted. Partnerships with telecommunications providers were proposed as a potential strategy to address these challenges, echoing the need for collaborative approaches to digital equity (Van Deursen & Van Dijk, 2019).
Addressing these sustainability challenges requires a multi-pronged approach. Internal capacity-building initiatives, such as training local staff to manage and maintain the platform, are critical to reducing dependence on external consultants. Additionally, embedding platform costs into existing institutional budgets and pursuing partnerships with telecom providers can support financial and technical sustainability. Strategic planning, iterative evaluation, and feedback mechanisms must also be integrated to ensure the platform remains functional, accessible, and aligned with user needs over the long term.

Critical Insights and Lessons Learned

The ability to adapt and address challenges in real time was crucial to the project's progress. Capacity-building, resource allocation, and proactive stakeholder engagement emerged as key success factors. However, persistent issues such as connectivity and curriculum delays underscore the need for robust infrastructure, internal capacity-building, and iterative planning. These findings align with global best practices for e-learning implementation and offer valuable lessons for similar initiatives in the TVET sector (Bozkurt & Sharma, 2020; Khalil & Ebner, 2017).

3.6 Sustainability and Scalability of e-Learning Platforms

Sustainability and Scalability of the eLearning Platform

Ensuring the sustainability and scalability of e-learning platforms in vocational education and training (TVET) is essential for their long-term success and impact. The study revealed several

key points to consider to ensure both the sustainability and scalability of the e-learning platform. Key points included:

1. **Building Capacity for Long-Term Sustainability** - Sustainability efforts were closely tied to capacity-building initiatives for both trainers and administrators. Interviewees emphasized the importance of trainers acting as platform champions, continuously improving their digital skills to maintain and promote the platform. "*Several trainers have shown a willingness to continue developing their digital competence which bodes well for the platform's future", noted one administrator*;

2. Integrating E-Learning with Traditional Methods - A hybrid learning model, combining e-learning with traditional face-to-face sessions, was deemed critical for scalability. Administrators noted that this approach allowed the platform to complement existing training methods, making it adaptable to different contexts and resource levels. This flexibility was seen as vital for replication across affiliates;

3. **Ensuring Financial Viability** - Interviews and document reviews revealed financial sustainability as a core challenge. The platform's dependence on donor funding posed risks for long-term operations. Administrators suggested introducing cost-sharing models, such as student subscription fees or partnerships with local organizations, to diversify funding sources and ensure financial independence.

4. Partnerships with Telecoms Providers - Interviewees highlighted the potential of forming partnerships with telecommunications companies to provide students with affordable data packages. This was seen as a practical solution to overcoming connectivity barriers and expanding the platform's reach. Such partnerships could also enhance the scalability of the platform, especially in rural areas. *"Partnering with telecom providers can help students access the platform without prohibitive data costs", said a consultant;*

5. Developing localised and transferable content - Interviewees recommended further investment in localized content that aligns with regional contexts while maintaining a standardized structure that can be adapted across different affiliates. This approach supports scalability by making the platform relevant and transferable to diverse environments. *"Having localised content has improved engagement and its something that other regions can easily replicate", said one trainer;*

6. Leveraging Data for Continuous Improvement - The platform's sustainability also depends on robust monitoring and evaluation mechanisms. Administrators advocated for using data analytics to track user engagement, learning outcomes, and platform performance, which would inform ongoing refinements and demonstrate value to stakeholders;

7. Establishing Strategic Partnerships - Scalability hinges on forming partnerships with governments, private sector entities, and educational institutions. Stakeholders highlighted the importance of leveraging these relationships to access additional funding, infrastructure, and expertise, thereby increasing the platform's reach and impact.

The key recommendations for Sustainability and Scalability:

- Trainers as Champions: Support trainers in becoming advocates and leaders for the platform, leveraging their commitment to sustain its use;
- Financial Models: Explore cost-sharing approaches, such as user subscriptions or public-private partnerships, to reduce reliance on donor funding.;
- Connectivity Innovations: Strengthen partnerships with telecom providers to enhance access and affordability for students;
- Localized and Modular Content: Develop transferable content that is adaptable across regions while remaining relevant to local contexts;
- Data-Driven Insights: Utilize analytics to refine the platform and communicate its value to potential funders and partners;
- Strategic Alliances: Establish partnerships with key stakeholders to provide additional resources and expand the platform's reach.

By integrating these strategies, e-learning platforms in the TVET sector can achieve sustained growth and serve as models for similar initiatives, effectively addressing the dynamic requirements of vocational education.

3.7 Best Practices and Pitfalls in eLP Development

The development and rollout of the D-VETYA e-learning platform highlighted key best practices and challenges, providing valuable insights for similar initiatives. These findings align with the broader literature on e-learning design and implementation (Adedoyin & Soykan, 2020; Palvia et al., 2018).

The documented best practices include:

- **Stakeholder Involvement** - Active engagement of local trainers and administrators throughout the process ensured the relevance and contextualization of the platform. This collaborative approach, emphasized in the User Testing Report, facilitated a smooth adaptation of existing materials into digital formats. Stakeholder involvement is recognized as critical for ensuring alignment between platform features and user needs (Bond et al., 2021).
- **Iterative Testing and Feedback** - The User Testing Report highlighted the importance of pilot testing to refine platform features. Stakeholder feedback during this phase led to critical adjustments in interface design, interactive tools, and content delivery methods, significantly enhancing usability and engagement. The iterative development process, as emphasized by Sun et al. (2020), is pivotal in ensuring that e-learning platforms remain user-centric and effective.
- **Localized Content** - As emphasized in the Mid-Term Review, the use of culturally relevant examples and translations in content development improved student engagement and comprehension. Local trainers' involvement in curriculum adaptation ensured alignment with students' needs. Localized content is essential for fostering

learner connection and improving comprehension, particularly in diverse educational contexts (Qadir et al., 2020).

- **Effective Communication Strategies** - Tailored communication methods, such as local language materials and orientation sessions, increased outreach success. These efforts, documented in the Communications Strategy Document, played a pivotal role in familiarizing users with the platform. Context-specific communication is critical for easing transitions into e-learning, particularly for first-time users (König et al., 2020).

The documented pitfalls include:

- **Assumptions About Digital Literacy** - A key oversight was assuming that users, including trainers and students, possessed adequate digital literacy skills. This gap created barriers during initial implementation and emphasized the need for structured digital literacy programs, as reflected in the Induction Report. Recent studies highlight how insufficient digital literacy remains a barrier to e-learning adoption, particularly in regions with limited prior exposure to technology (Adedoyin & Soykan, 2020; Trust & Whalen, 2020);
- **Over-Reliance on Connectivity -** The platform's heavy reliance on stable internet connectivity created barriers for students in remote areas. This reliance overlooked the reality of infrastructure challenges in underserved regions, underscoring the need for offline functionality and low-bandwidth optimization (Bates, 2019). Addressing connectivity gaps through offline capabilities and bandwidth optimizations has proven effective in similar contexts (Basilaia & Kvavadze, 2020);
- **Limited Trainer Support During Rollout** - Insufficient technical and logistical support for trainers during the platform's early stages slowed adoption. This issue, particularly noted in the Induction Report, underscores the importance of providing continuous technical support to trainers during digital transitions. Research emphasizes the need for empowering educators through training and support systems to facilitate technology integration (Eickelmann & Gerick, 2020).
- **Delays in Curriculum Review** - The delay in finalizing curricula disrupted content development and platform integration, creating cascading effects on the project's timeline. This challenge highlights the need for curriculum review processes to be completed early in project cycles, with clear milestones and accountability mechanisms (UNESCO-UNEVOC, 2020)

To replicate best practices and avoid common pitfalls, the following steps should be taken:

- **Embed Digital Literacy Training Early** - Provide structured digital literacy training for both students and trainers before platform deployment. Comprehensive onboarding programs are critical for building confidence and ensuring smooth adoption of digital tools (Bond et al., 2021).

- **Invest in Infrastructure** - Address connectivity challenges through offline features and low-bandwidth optimization. Offline resources such as downloadable content and asynchronous learning have proven successful in mitigating connectivity barriers (Adnan & Anwar, 2020).
- **Strengthen Support Systems** - Ensure trainers have ongoing access to technical and logistical assistance. Providing real-time support and regular capacity-building sessions can improve trainer confidence and platform adoption (Eickelmann & Gerick, 2020).
- **Prioritize Localization** - Continue to engage local trainers in curriculum adaptation and emphasize culturally relevant content. Localization fosters a deeper learner connection and ensures the relevance of educational materials (Qadir et al., 2020).
- **Streamline Curriculum Review Processes** - Ensure curriculum review is treated as a foundational task, completed before platform development begins. Adopt continuous review models to keep content aligned with evolving industry needs.
- **Optimize for Offline Access** - Prioritize the development of offline functionalities, such as downloadable content and asynchronous modules, to address connectivity challenges.

4. Recommendations and Conclusions

The findings from this study have highlighted both the successes and challenges encountered during the development and implementation of the e-learning platform. These recommendations aim to address identified gaps, build on existing strengths, and guide future efforts to sustain and scale the platform effectively. They are tailored to enhance user experience, improve accessibility, and ensure the long-term impact of the platform in delivering vocational training.

1. **Strengthening Practical Skill Integration** - To address the challenges of integrating practical components into an online environment, it is recommended to develop more advanced interactive tools such as virtual labs and simulations. These tools can mimic real-world experiences and provide students with opportunities to practice skills effectively. Additionally, the hybrid training model, which combines online theoretical learning with in-person workshops for practical tasks, should be standardized across all affiliates. Providing offline resources, including downloadable manuals and instructional videos, will further support students in areas with limited internet connectivity;
2. **Approach to Curriculum Review Processes** – The curriculum review process should transition from a one-off event to a continuous, iterative process. Periodic reviews informed by feedback from trainers, students, and industry stakeholders will ensure the curriculum remains relevant and aligned with market demands. Developing internal capacity for curriculum management by training dedicated teams within the organization will reduce reliance on external consultants and increase consistency. Additionally, rigorous vetting processes for subcontractors should be established to ensure expertise and accountability, minimizing delays and disruptions;
3. **Improving Platform Usability and Accessibility** - Ensuring that the platform is optimized for low-bandwidth environments will significantly enhance accessibility, particularly for students in remote regions. Introducing comprehensive onboarding processes, which include digital literacy modules for students and trainers, will help users become more comfortable navigating the platform. Establishing structured feedback systems will also allow for continuous improvements based on user experiences, ensuring the platform evolves to meet the needs of its users;
4. **Addressing Connectivity and Infrastructure Challenges** - Connectivity challenges remain a major barrier to effective e-learning. Partnerships with telecommunications companies should be explored to provide affordable data packages for students, reducing the cost burden and ensuring more consistent access. Collaboration with stakeholders to advocate for improved internet infrastructure in underserved areas is another critical step in overcoming this challenge;
5. **Sustaining and Scaling the Platform** - The long-term success of the e-learning platform depends on building the capacity of trainers to effectively deliver content

online. Continuous professional development opportunities should be offered to ensure trainers remain proficient in e-learning delivery. Furthermore, content should be regularly updated and localized to align with the cultural and regional needs of learners. Expanding the platform's use to other Young Africa programs beyond TVET initiatives will also enhance its sustainability and broaden its impact;

6. **Building Resilience Against Challenges** - Structured digital literacy programs must be developed to address the varying levels of digital literacy among users. These programs will ensure that both students and trainers can fully engage with the platform. Additionally, establishing a robust technical support system, including an online help desk and troubleshooting guides, will provide users with timely assistance to resolve any technical issues they encounter;
7. **Enhancing Engagement and Motivation** - To increase engagement, the platform should introduce user incentives, such as certificates of completion or recognition for high achievers. Gamified elements, such as badges and leaderboards, can also be integrated to make learning more enjoyable and interactive, fostering a positive and engaging learning environment;
8. **Evaluation and Monitoring** - The platform's effectiveness should be regularly evaluated using clearly defined key performance indicators (KPIs), such as user retention rates, course completion rates, and learning outcomes. Periodic reviews will help identify areas of strength and opportunities for improvement, ensuring the platform continues to align with organizational goals and the needs of its users.

Conclusion

The D-VETYA e-learning platform project has demonstrated considerable potential in transforming vocational training through increased accessibility, flexible learning pathways, and innovative digital tools. By leveraging a hybrid model that combines online and offline learning, the platform has succeeded in bridging geographical barriers and addressing diverse learner needs. However, challenges such as limited connectivity, insufficient digital literacy, and gaps in practical skills development have highlighted areas requiring immediate attention.

Key lessons from this initiative underscore the importance of involving stakeholders at every stage, prioritizing localized content, and ensuring robust technical support. The integration of interactive tools and iterative feedback loops has further reinforced the platform's usability and user satisfaction. Moving forward, strategic partnerships, enhanced infrastructure, and targeted training for both students and trainers will be critical to ensuring the platform's sustainability and scalability.

This study contributes to the growing body of knowledge on e-learning in TVET settings, offering actionable insights for policymakers, educators, and development practitioners. It is hoped that

the lessons and recommendations derived from this initiative will inspire and guide similar efforts to expand access to quality vocational education globally.

5 - References

Adedoyin, O. B., & Soykan, E. (2020). COVID-19 pandemic and online learning: The challenges and opportunities. *Interactive Learning Environments, 28*(1), 1–13. https://doi.org/10.1080/10494820.2020.1813180

Adnan, M., & Anwar, K. (2020). Online learning amid the COVID-19 pandemic: Students' perspectives. *Journal of Pedagogical Sociology and Psychology, 2*(1), 45–51. https://doi.org/10.33902/JPSP.2020261309

Anderson, T., & Dron, J. (2011). Three generations of distance education pedagogy. *The International Review of Research in Open and Distributed Learning, 12*(3), 80–97. https://doi.org/10.19173/irrodl.v12i3.890

Basilaia, G., & Kvavadze, D. (2020). Transition to online education in schools during a SARS-CoV-2 coronavirus (COVID-19) pandemic in Georgia. *Pedagogical Research, 5*(4), 1–9. https://doi.org/10.29333/pr/7937

Bates, A. W. (2019). *Teaching in a digital age: Guidelines for designing teaching and learning*. Vancouver, BC: BCcampus.

Boelens, R., De Wever, B., & Voet, M. (2017). Four key challenges to the design of blended learning: A systematic literature review. *Educational Research Review, 22*, 1–18. https://doi.org/10.1016/j.edurev.2017.06.001

Bond, M., Buntins, K., Bedenlier, S., Zawacki-Richter, O., & Kerres, M. (2021). Mapping research in student engagement and educational technology in higher education: A systematic evidence map. *International Journal of Educational Technology in Higher Education, 18*(1), 1–30. https://doi.org/10.1186/s41239-021-00262-3

Bozkurt, A., & Sharma, R. C. (2020). Emergency remote teaching in a time of global crisis due to the COVID-19 pandemic. *Asian Journal of Distance Education, 15*(1), 1–6. https://doi.org/10.5281/zenodo.3778083

Cavanaugh, C., Barbour, M. K., & Clark, T. (2009). Research and practice in K-12 online learning: A review of open access literature. *The International Review of Research in Open and Distributed Learning, 10*(1), 1–22. https://doi.org/10.19173/irrodl.v10i1.607

Dichev, C., & Dicheva, D. (2017). Gamifying education: What is known, what is believed, and what remains uncertain. *International Journal of Educational Technology in Higher Education, 14*(1), 1–36. https://doi.org/10.1186/s41239-017-0042-5

Dillenbourg, P., Zufferey, G., Alavi, H., Jermann, P., Do-Lenh, S., & Bonnard, Q. (2009). Collaborative virtual environments for education. *Computer-Supported Collaborative Learning, 4*(1), 5–21. https://doi.org/10.1007/s11412-008-9056-5

Eickelmann, B., & Gerick, J. (2020). Learning with digital media at home and at school before and during the closure of schools due to COVID-19. *Journal of Educational Research Online, 12*(1), 162–188.

Graham, C. R. (2019). Current research in blended learning. *Handbook of Distance Education, 4*(1), 173–188. https://doi.org/10.4324/9780203846824

Khalil, H., & Ebner, M. (2017). Clustering patterns of engagement in massive open online courses (MOOCs): The use of learning analytics to reveal student categories. *Journal of Computing in Higher Education, 29*(1), 114–132. https://doi.org/10.1007/s12528-016-9126-9

Kizilcec, R. F., Pérez-Sanagustín, M., & Maldonado, J. J. (2017). Self-regulated learning strategies predict learner behavior and goal attainment in massive open online courses. *Computers & Education, 104*, 18–33. https://doi.org/10.1016/j.compedu.2016.10.001

König, J., Jäger-Biela, D. J., & Glutsch, N. (2020). Adapting to online teaching during COVID-19 school closures: Teacher education and teacher competence effects among early career teachers in Germany. *European Journal of Teacher Education, 43*(4), 608–622. https://doi.org/10.1080/02619768.2020.1809650

Mishra, S., & Panda, S. (2020). Development and validation of a scale to measure e-learning readiness. *British Journal of Educational Technology, 51*(5), 1623–1634. https://doi.org/10.1111/bjet.12967

Pantelidis, V. S. (2010). Reasons to use virtual reality in education. *VR in the Schools, 5*(1), 7–11.

Palvia, S., Aeron, P., Gupta, M., Mahapatra, D., Parida, R., Rosner, R., & Sindhi, S. (2018). Online education: Worldwide status, challenges, trends, and implications. *Journal of Global Information Technology Management, 21*(4), 233–241. https://doi.org/10.1080/1097198X.2018.1542262

Rahimi, E., van den Berg, J., & Veen, W. (2015). Facilitating student-driven constructing of learning environments using Web 2.0 personal learning environments. *Computers & Education, 81*, 23–246. https://doi.org/10.1016/j.compedu.2014.10.012

Simonson, M., Smaldino, S., & Zvacek, S. (2019). *Teaching and learning at a distance: Foundations of distance education* (7th ed.). Charlotte, NC: IAP.

Sun, L., Tang, Y., & Zuo, W. (2020). Coronavirus pushes education online. *Nature Materials, 19*(6), 687–687. https://doi.org/10.1038/s41563-020-0678-8

Trust, T., & Whalen, J. (2020). Should teachers be trained in emergency remote teaching? Lessons learned from the COVID-19 pandemic. *Journal of Technology and Teacher Education, 28*(2), 189–199.

UNESCO-UNEVOC. (2020). *Innovating technical and vocational education and training: A framework for institutions*. Bonn, Germany: UNESCO-UNEVOC.

Van Deursen, A. J., & Van Dijk, J. A. (2019). The first-level digital divide shifts from inequalities in physical access to inequalities in material access. *New Media & Society, 21*(2), 354–375. https://doi.org/10.1177/1461444818797082