ALIGNING MACHINE SHOP ENGINEERING EDUCATION WITH INDUSTRY NEEDS: A CASE STUDY OF ZIMBABWE TERTIARY INSTITUTIONS

By

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https://doi.org/10.26634/jme.15.4.22350

Date Received: 12/08/2025 *Date Revised: 10/09/2025* *Date Accepted: 13/10/2025*

ABSTRACT

The study investigated the relationship between training duration, training equipment and facilities and the acquisition of employable skills. The study aimed to show how poor equipment and facilities affect the teaching and learning of machine shop engineering for direct intake students. Surveys and interviews were carried out among twenty recent graduate students, fifteen instructors/lecturers and fifteen industry experts. Analysis of the quantitative and qualitative data revealed that inadequacy of equipment has a great impact on the development of employable skills in machine shop engineering training. Inadequate equipment, facilities, consumables and non-functionality of the current equipment were noted as the main barriers to skills training and development. The findings emphasised the importance of upgrading existing equipment to modern ones and the need to have a systematic maintenance strategy for all the institutions to reduce equipment breakdowns. The study advised policymakers and heads of institutions to increase the duration of industrial training and provide enough funds to buy modern equipment and facilities so that the training stays up to date and meets the needs of the students involved.

Keywords: Employable Skills, Skills Acquisition, Direct Intake Students, Training Facilities, Tertiary Institutions, Machine Shop Engineering Education.

INTRODUCTION

Machine shop engineering plays a key role in industrial and manufacturing processes. It requires skilled artisans and technicians to operate and maintain complex machines and equipment (Paton et al., 2012). Technical and vocational institutions play a crucial role in training these skilled technical personnel (Chipfakacha, 2019). However, the quality of training equipment and facilities can greatly impact the employability of the graduates, and the quality of facilities can also have an effect on the quality of learning outcomes (Goffar & Agustin, 2021).

The study examined whether the equipment and training facilities used to teach machine shop engineering in tertiary institutions were sufficient for effective learning. Based on the experience of machine shop instructors and lecturers in polytechnics, as well as a trade test examiner in the Industrial and Trade Testing Department, we can understand that students were not well prepared to meet industry demands.

The Minister of Skills Audit and Development also expressed concern about the growing gap between

what students learn in school and the practical skills needed in industries. This has become a national problem that needs immediate attention. The minister highlighted this at his speech at the Zimbabwe National Chamber of Commerce (ZNCC) 2025 Annual Conference in Victoria Falls. He also revealed that all engineering fields face a skills gap, with too much focus on certificates rather than the practical abilities that graduates really need. A significant number of graduates lacked the practical skills needed for modern workplaces (Mahlahla, 2025).

The 2018 National Skills Audit and the 2024 Stakeholders' Skills Landscape Reports both revealed that many key sectors of the economy are facing a serious shortage of skilled workers. There are skills mismatch between what is produced by tertiary institutions and those demanded by industry and employers. Tertiary institutions were urged to design programs that deliver both theoretical knowledge and practical learning. Zimbabwe faces a 93% shortage of engineering skills. The country needs experts at all levels - such as engineering scientists, professional and practicing engineers, consulting and technological engineers, technicians, and artisans. Machine shop engineering training falls under this engineering (Akintayo et al., 2024; Zimbabwe Council for Higher Education, 2018).

The study found several major problems: most equipment and facilities were old and in poor condition, students did not have enough access to the tools and machines needed for practice, and as a result, they struggled to learn important skills. Because of this, many graduates were not ready to meet industry requirements. This lead to quality concerns of tertiary institutions graduates. The study aimed to provide evidence on how inadequate equipment and facilities affect machine shop engineering education and to add to existing research on the topic. The research aimed at accomplishing three objectives.

- To assess the availability of key training resource for Machine shop engineering in institutional workshops
- To evaluate the impact of training facilities on the development of skills in Machine shop engineering training
- To explore strategies that can be used to mitigate effects of inadequate training resources in Machine shop engineering teaching and learning.

To accomplish the aforementioned objectives, the researcher needs to seek answers to the following research questions.

- What facilities and equipment challenges are tertiary institutions facing?
- What are the contributing factors to the inadequacy of teaching and learning facilities?
- What strategies are being employed by tertiary institutions to bridge the gap of inadequate equipment and facilities?

Facilities and equipment used in teaching and learning play a critical role in the environment in which learning will take place. Machine shop engineering training relies greatly on physical and hands-on practice to develop the required and necessary skills (Wettaka, 2020). Training facilities play a pivotal role in moulding students' abilities to apply theoretical knowledge in real-world situations (Wettaka, 2020). Inadequacy of teaching and learning equipment and facilities has a significant effect on the quality of graduates and their eventual performance in the field and workplaces. Inadequate equipment and facilities can lead to frequent breakdowns of available machines and delays and frustrations for both students and instructors during practical sessions (Ibrahim & Aslam, 2025). The overall skills competences of the students are therefore compromised, and the students may not be employable if they don't meet the expected standards of skills competences required at the end of their course.

This study is important because the workforce in this field needs both theoretical knowledge and practical skills to contribute effectively to production and manufacturing processes. The manufacturing sector plays a critical role in the economy of Zimbabwe hence the need for a skilled workforce in machine shop engineering. With most of the technical training institutions established in the 1980s with equipment and facilities that were relevant in those times.

Now that there it's more than forty years after their establishment, the facilities have either deteriorated, not functioning well or are lagging behind technological trends. The beneficiaries of the research include the students/ graduates, instructors, employers, the country (economy), institutions' reputations to the public and industry confidence in tertiary education.

Students: Graduates will be marketable/employable as they would have acquired improved practical skills and competences.

Instructors: The study provided the challenges Instructors and lecturers face due to inadequate equipment and facilities. This can serve as an external call to decision makers and resource allocators to prioritise equipping learning institutions training facilities. Instructors will be better prepared to handle the situation as and when it arises through developing and implementing alternative effective strategies as outlined in this study.

Institution: Training institutions will benefit by availing to them the necessary equipment, tooling and facility investments required to keep the teaching and learning of Machine shop engineering relevant. If their learning outcomes are competent then the institution will have a good reputation to both industry and aspiring students thereby attracting more students to enrol with the institution. The findings of the study can also be used by institutions during curriculums review and curriculum development.

Industry: Industry will benefit by employing graduates with relevant skill competences which leads to reduced training costs, improved productivity and increased competitiveness

Government and Policy makers: The study helps the government understand how important TVET programs are, what challenges currently exist, and what improvements are needed to make teaching and learning more effective. Policy makers can use the information and insights generated from the study to make informed decisions regarding funding allocations and capacitating training institutes.

The theoretical delimitation of this study focusses on skills development in the teaching and learning of National Certificate in Machine shop engineering institutional or direct students. The limitations of the study were mainly on limited access to examinable data on Trade test results and statistics, some confidential memorandums and other critical communications that could be used by the researcher could not be accessed. The study is limited to tertiary institutions offering a two year National certificate course in Machine shop engineering to direct intake or institutional students in Zimbabwe. The research focused on analyzing data about equipment, facilities, and students' overall performance, especially in skill development and learning. The study confined to the lathe machine, milling machine and drilling machine as key machines.

Industrial applications: Industrial applications of the research include a skilled worker who can solve mechanical problems and challenges in manufacturing, energy, chemical, processing, aviation and agricultural industry sectors. Where graduates are expected to contribute effectively to these organisations as maintenance personnel responsible for servicing, installing and managing related equipment.

1. Literature Survey

The literature survey aimed to provide an overview of the existing research in machine shop engineering education and training at tertiary institutions and its alignment to the needs of industry. It also seeks to find other scholar views on how the challenges of a mismatch between what is being taught and industry expectations can be used in the current study.

1.1 What Facilities and Equipment Challenges are Tertiary Institutions Facing?

With the increasing technological advancements happening around the world, many countries in developing countries struggle to keep abreast with relevance in their teaching and learning of practical courses such as machine shop engineering as they fail to upgrade, update and maintain their training facilities (Alenezi et al., 2023). Technical training institutions generally face challenges of equipment and facilities

such as inadequate equipment, poor management, and use of outdated curriculum, limited access to technology, inadequate infrastructure, and limited resources (Tuti, 2024).

1.1.1 Inadequate Equipment

Inadequate equipment may refer to the lack of necessary tools and machinery used for practice and experiments during teaching and learning. In a machine shop, engineering training on the machinery can be for metal cutting, such as lathe machines, milling machines, drilling machines, grinders, measuring tools, workbenches and hand tools. Skills development needs practical learning environments with suitable tools, equipment and facilities. Acquiring these resources can be a burden financially, resulting in many institutions failing to provide adequate facilities for their training operations. The effectiveness of instructional operations in a workshop or laboratory setupdirectly depends on the availability of necessary workshop facilities. It's quite a challenge to carry out effective technical training without proper equipment, tools and machinery. Effectively implying that the type of training is hinged on functional workshop tools and relevant equipment. Effective implementation of the curriculum requires relevant and sufficient workshop tools, facilities and machinery (Tuti, 2024). Access to facilities facilitates participation in hands-on demonstrations and practice, resulting in enhanced skills development and learning experiences (Adhikari, 2024). Ndiyamba et al. (2024) outlined the essential equipment for a broad engineering workshop as workbenches and vices, hand tools, drilling, lathe and milling machines, measuring tools such as micrometres, gauges, verniers, rules, CNC milling, CNC lathe, CNC milling, hydraulic and pneumatic equipment, 3D printers and welding bays.

1.1.2 Poor Management/ Poor Governance

Poor management in relation to the teaching and learning of machine shop engineering includes ineffective administration and supervision of the training resources, such as equipment and facilities for training in the engineering workshops or laboratories. That results in inadequate maintenance, insufficient resource allocation, lack of accountability, poor inventory management, poor safety management, failure to upgrade or replace equipment, inadequate budgeting or funding, and poor communication and collaboration among instructors and administrators. The above issues need to be managed well, or the issues will lead to reduced quality of training, decreased student engagement and motivation, high costs of training, high risks of accidents and reduced competitiveness and employability of the graduates (Tuti, 2024).

1.1.3 Inadequate Maintenance

Poor repairs and maintenance to equipment and facilities lead to breakdowns and increased downtime and eventually disrupt teaching and learning operations. Meaningful instructional activities have a heavy reliance on the availability and functionality of necessary workshop facilities. Limited availability of tools, machines and equipment exposes technological trainers to significant challenges in delivering practical training, and this compromises the quality of instruction (Gilbert & Thelma, 2024). Workshops and laboratories for technical education are important aspects of skills development in which the learners may experiment, test, construct, disassemble, repair, design, create, imagine and study (Niiranen, 2021). Tertiary training workshops need to be equipped to the standard required by their training curriculum. Facilities should be in optimal condition to facilitate effective skills acquisition during training (Ndiyamba et al., 2024). It should be noted that the outcome of improper maintenance of workshop facilities results in the malfunction of the tools and equipment, consequently crippling effective teaching and acquisition of skills (Tuti, 2024).

1.1.4 Use of Outdated Curriculum

Institutions of higher learning often take too long to align their curriculum with the needs and expectations of the labour market, leading to a mismatch between the skills acquired by the students and the requirements of the employers. A major contributor to recent graduates' unemployment is the employability skills gap that is a

result of a mismatch between knowledge and skills attained from tertiary institutions and those that are required by employers (El Baradei & Kadry, 2022).

1.1.5 Limited access to Technology

Technical training institutions should have access to technology; if the access is limited, it hinders the exposure of students and their graduates to modern and innovative methods of solving industrial problems when they are employed (El Baradei & Kadry, 2022).

1.2 What are the Contributing Factors to Inadequacy of Teaching and Learning Facilities?

Some of the contributing factors to inadequacy of teaching and learning facilities are rapid technological changes, financial constraints, limited learning space, large or increased enrolments, lack of effective maintenance strategies, lack of prioritisation, lack of industry partnerships, brain drain and ageing infrastructure.

1.2.1 Rapid Technological Changes

Quick technological advancements have the potential of straining training facilities in technical education institutions. This could be due to the high costs involved in upgrading and the need for tutors' specialised training and other developmental programmes that follow. This can create a gap and lead to inadequacy of training resources, consequently affecting skills development (El Baradei & Kadry, 2022).

1.2.2 Financial Constraints

The constraint of financial resources to support the teaching and learning requirements of technical and vocational education and training (TVET) is often one of the most serious of all. Science and technology training programmes are not cheap to run, and TVET is one of the most expensive components of any education system (Pirzada et al., 2022).

1.2.3 Increased Enrolment

Increased enrolment figures can put pressure on existing equipment and facilities, and this can lead to constant breakdowns of training resources and equipment. It can also lead to demotivation for students and instructors (Hassan & Shamsudin 2019).

1.2.4 Lack of Prioritization

Some training programmes may be prioritised ahead of machine shop engineering, and this affects teaching and learning, as every programme needs the support of administrators and policymakers to operate (El Baradei & Kadry, 2022).

1.2.5 Aging Infrastructure

Infrastructure and facilities need to be well maintained for them to stay in the right shape and condition that is conducive for teaching and learning. Buildings, workshops and laboratories require renovations and replacement when the need arises due to ageing or constant usage (Barrett et al., 2019).

1.2.6 Lack of Industry Partnerships

Partnerships between industry and learning institutions are carried out to promote stronger relationships between the two so that teaching and learning is improved, this can be through the enhancement of industrial attachment placement, sharing of training resources to both students and staff or instructors, the provision of a robust human resource base for industry and fulfilling the social responsibility obligation by private sectors (Watters et al., 2016).

1.2.7 Brain Drain

Qualified and experienced engineering instructors can resign and join industry or other opportunities that would have come their way, leaving some critical gaps in the area of teaching and learning. This leads to a lack of experienced expertise in the teaching and learning of practical skills (Jacob & Atobauka, 2021).

1.2.8 Government Policies and Priorities

Government policies may fail to provide sufficient budget allocations to technical education teaching and learning. This will make it difficult for the institutions to operate, as they may not be able to fund themselves through tuition fees, which are also controlled by the government (Mack, 2024).

1.3 What Strategies can be Employed by Tertiary Institutions to Bridge the Gap?

The gap of essential equipment and facilities for teaching

and learning practical courses like machine shop engineering can be reduced through several measures. These include forming partnerships with industries, sharing equipment, providing staff training, using leasing options, promoting public–private partnerships, reviewing the curriculum, maintaining and repairing equipment regularly, offering joint training programs, seeking alumni support, using digital tools, upgrading equipment, and engaging the community (Oviawe, 2018).

1.3.1 Industry Partnerships

Industry partnerships can help in bridging the gap of equipment and facilities inadequacy through collaborative research and development. There is an opportunity for institutional students to get attachment places and internships, and by so doing, the students will get more practical exposure and build on their skills and competences. Training and professional development are also possible through industry partnerships, and this comes as an opportunity for instructors and lecturers to get exposure to up-to-date industry developments and current practices. The partnerships can also provide the opportunity of exposing students to project-based learning, which may be lacking at their institutions (Oviawe, 2018).

1.3.2 Equipment sharing

Equipment sharing is a noble and effective way of bridging the gap of inadequacy of key training equipment and facilities in practical skills teaching of machine shop engineering. This can be achieved in numerous ways that include pooling resources together by educational institutes and sharing equipment, thereby reducing duplication and maximising utilisation. Institutions can also come together or rent equipment from private companies so that they have collaborative laboratories. This will also bring with it shared maintenance and repair costs, thereby reducing the cost of maintenance. Cost savings can also be achieved through purchasing equipment as partners, and this avoids unnecessary duplication of some equipment, and there is also maximum utilisation of the equipment (Oviawe et al., 2017).

1.3.3 Training and development

Training and development enhances continuous development for instructors such that their instruction methods and ability will be up to date with the changing demands of the curriculum and industry. The skills and knowledge gained will benefit the students, instructors and other stakeholders (Burns & Chopra, 2016).

1.3.4 Leasing options Curriculum review

Having leasing arrangements for the use of equipment and facilities during practical learning in machine shop engineering can be a worthwhile strategy to bridge the gap of inadequacy of teaching and learning resources, as it allows institutions to have access to modern equipment and technology without an upfront investment. This can allow training to carry on while resources can be allocated to some other pressing demands within the institution. It also comes with less or no maintenance costs of equipment (Wang & Richardson, 2020).

1.3.5 Good Maintenance Management

Proper maintenance of existing training equipment and facilities ensures the availability of training resources in good working condition and functionality such that training is not disrupted or disturbed. It also prolongs the lifespan of equipment, thereby reducing the cost of eventual or complete breakdowns (Nyemba et al., 2017).

1.3.6 Alumni Support

Alumni support is among the ways of bridging the gap of equipment and facilities inadequacy in training. In some scenarios, alumni can donate funds, equipment and other resources to promote development in the teaching and learning of the institution. Alumni can facilitate connections and networking between the institution and industry partners, internships and job placements, and participate in the teaching and learning through guest lectures and workshops. Many institutions of higher learning receive recognition awards for their best-performing students from alumni networks (Obeng-Ofori & Kwarteng, 2020).

1.3.7 Funding Models for Tertiary Institutions

Technical tertiary universities' funding approaches mix

government support and student fees with revenue-generating ventures like selling trainee goods, corporate and donor funding through investments and skills levies, and student loans and bursaries. Some of these models use performance-based funding to reward efficiency and promote the development of high-quality education and training, while others use Business Development Units to promote industry partnerships and student-led initiatives. Key funding sources include government funding, which includes skills levies, loans and grants. There is student funding which includes tuition fees, bursaries and scholarships as well as study loans (Flores, 2025).

Institutions can also venture into income-generating activities such as production units, where institutions sell goods and services produced by students, and business incubators, where businesses born out of student ideas are incubated to grow and help generate income for the institution. Education with production is an approach that integrates practical, production-orientated activities into training, linking education with real-world work to generate income and experience (Mahmud et al., 2022). Donor funding at tertiary institutions is also another way where institutions can receive grants and financial support from non-governmental organisations to supplement institutional budgets (Gulshat, 2025).

Previous research has shown that inadequate equipment and facilities in technical and vocational education and training (TVET) programmes hinder the quality of teaching and learning (Anindo et al., 2016). The findings of some of the alluded-to previous five researchers are as shown in Table 1.

2. Materials and Methods

Existing literature on machine shop engineering education and training was reviewed. The researcher used survey research where instructors/lecturers and industry experts in the field of machine shop engineering participated through semi-structured questionnaires. Data generated was compiled and analysed through Microsoft Excel, charts and graphs.

2.1 Research Approach

The study employed quantitative and qualitative methods in investigating the functionality and availability of equipment and facilities for use during teaching and learning. Some data was collected through face-to-face and over-the-phone interviews for the quantities and condition of machine tools. Qualitative data was

Topic	Author/Publisher	Main Findings/Lessons learnt
Influence of adequacy of teaching and learning resources on students 'enrolment in technical, vocational education and training institutions in Butula sub-county, Busia County	Ongulu and Ibrahim (2021)	Adequacy of training resources in tertiary institutions has a positive influence on student enrolment. Technical institutions in partnerships with industry in sponsoring student training will attract high student enrolment.
Influences of Inadequate Instructional Materials and Facilities in Teaching and Learning of Electrical/Electronics Technology Education Courses	Ogbu (2015)	Low practical skill acquisition can be influenced by inadequate instructional and facilities.
The Challenges Facing Technical and Vocational Education and Training Institutions in Producing Competent graduates in Zimbabwe.	Erisher Woyo, 2013	Poor exposure for trainees on industrial attachment, lack of training materials, inadequate facilities for learning, large classes and poor economy performance.
The exploring factors that teachers view as hindering quality in teaching and learning at a TVET college	Matabane et al. (2022)	The closer the relationships of industry practices and tertiary institutions, the better the relevance of institutions' curricula and the higher the chances of quality training, hence increasing the possibilities of graduates' employability. It is imperative that technical and vocational trainers continuously work together with industry and learn emerging technologies and equipment to improve their training delivery to ensure graduates meet industry requirements.
The impact of facilities on students' academic achievement	Ramli et al. (2018)	There is a notable relationship that links the quality of institutional facilities and student performance. Effective tertiary education requires adequate facilities, which include classrooms, laboratories and equipment.

Table 1. Snap Overview of Inadequate Equipment and Facilities by Previous Researches

generated through structured and guided questionnaires that were administered to focus groups of recent graduate direct students, instructors/lecturers in the institutes of higher learning and industry experts in machine shop and industrial maintenance engineering.

2.2 Research Design

The study used structured questionnaires which allowed the researchers to get quantitative and qualitative data. This allowed a comprehensive understanding since quantitative data provides a broad overview, and qualitative data brings out in-depth insights from relevant or expert personnel.

2.3 Population

The target population consisted of all recent graduates of machine shop engineering courses with less than two years of postgraduate experience, seasoned machine shop engineering instructors/lecturers in institutions of higher learning that offer training of machine shop engineering at the National Certificate level, and industry experts aligned to machine shop engineering. The researcher could not determine the actual current population size from which participants were drawn.

2.4 Population and Sample

Four institutions out of a possible eight were selected for the study on key equipment condition. Fifteen instructors were selected from any of the tertiary institutions offering National Certificate in Machine Shop Engineering training, and 20 recent graduates from any of the possible institutions. Fifteen industrial experts in the trade at any company in Zimbabwe of machine shop engineering also participated in the research as industrial experts. The population for all the participants could not be determined.

2.5 Data Collection

Questionnaires were administered to recent graduates, industry experts and instructors to get information on the present state of equipment and facilities, training needs and assumed inadequacies. Thirty questionnaires were distributed to industry experts and recent graduates and twenty-two to instructors/lecturers. Final responses were from fifteen industry experts, twenty recent graduates and ten instructors. Observations were conducted in machine shop engineering workshops to assess the condition and usage of training equipment and facilities. Instructors, industrial experts and current recent graduates participated in the survey to gather detailed information on the impact of inadequate equipment and facilities on the teaching and learning of machine shop engineering skills. Key machine shop equipment and facilities surveys were carried out to identify the condition and availability.

2.6 Research Instruments

The research instruments designed and used in this study were as shown in Tables 2, 3, 4 and 5 to generate information for key equipment and responses from industry experts, recent graduates and instructors respectively. Table 2 shows the template that was used in this research to generate data on the key equipment for machine shop engineering education.

2.7 Validity of Findings

Multiple data sources were used to generate data surveys

Equipment	Total Available	Functional	Non Functional	% Functional
Milling machine	-	-	-	-
Lathe machine	-	-	-	-
Drill	-	-	-	-

Table 2. Assessment of Availability of Key Equipment and Facilities for Machine Shop Engineering Teaching and Learning

No	Item Description
1	What is your position in the Machine shop engineering field? (Artisan, Foreman, Technician/ Engineer).
2	Rate the skills competences of machine shop engineering graduates from tertiary institutions (out of 10)
3	Do you think inadequacy of key equipment and facilities affect skills development? YES/NO
4	Do you think one year attachment period is enough to develop a competent class 1 skilled worker? Yes/ No/Not sure
5	Rate the importance of systematic maintenance management in machine shop engineering (out of 10).
6	Suggest the duration of Industrial attachment for Machine shop Direct intake students training
7	Do you think industrial attachment bridges the gap of inadequacy of equipment during teaching and learning? Yes/No
8	Which equipment do you think is key for Machine shop engineering teaching and learning?
9	Indicate by ticking the areas of competence deficiencies you notice in general from polytechnics graduates in machine shop engineering? Machining/ hydraulics and pneumatics/ gearboxes/ Conveyors/Crushers/Bearings/Fitting/All of them
10	What are your brief recommendations?

Table 3. Industry Experts Questionnaire

No.	Item Description
1	Do you see the equipment and facilities for Machine shop engineering training at your institution as adequate? Yes/No
2	Rate the condition of the machine tools at your institution (excellent. good, fair, poor)
3	Do you think acquiring 3D printing skills is necessary? Yes/No/Not sure
4	Rate the availability of training consumables such as steel materials and cutting tools (Excellent, Good, Fair, Poor)
5	Do you think industrial attachment will bridge the gap created by inadequacy equipment? Yes/No
6	Identify any other equipment that you think should be available
7	Select by ticking the areas you think are not covered enough during college but are important? Machining/Fitting/Hydraulics and Pneumatics/Bearings/Conveyors/Gearboxes/ Crushers
8	Was there a shortage of consumables to use for your practical exercises Yes/ No
9	Indicate by ticking how shortage of consumables were solved? Group project/use of demonstrations/abandoned the exercise.
10	Rate the severity of non-availability of training consumables out of 10
11	Suggest the duration of Industrial attachment for Machine shop Direct intake students training

Table 4. Recent Graduate Questionnaire

No.	Item Description
1	Rate the condition of the machine tools at your institution (excellent. good, fair, poor)
2	Identify any equipment that you think needs to be upgraded
3	Have you experienced challenges due to inadequate equipment and facilities? Yes/No
4	How were the challenges managed? (Demonstrations/ abandoned/Group work)
5	Do you think work related learning addresses the problems of inadequate equipment and facilities? (Rate your response out of 10)
6	Do you think one year industrial attachment for Direct students is adequate in developing a class 1 skilled worker for Machineshop engineering? Yes/ No
7	Do you think virtual learning and simulations can bridge the gap of inadequacy of equipment and facilities in teaching and learning of machine shop engineering skills? Yes/No
8	Who carries out the practical demonstrations for students in the workshop? Lecturer/Technician
9	Are the enrolment figures equitable with the facilities for Machine shop engineering? Yes/No.
10	Rate the effectiveness of your equipment maintenance management system out of 10.
11	Do you have a dedicated technical staff that carries out the maintenance of your equipment in Machine shop engineering? Yes/No

Table 5. Instructors' Questionnaire

from students, instructors and industry experts. The face validity of the research instruments claims that the instruments measured what was expected and required of them to measure.

2.8 Reliability of Findings

The research questionnaires were administered to multiple key participants with critical positions in the machine shop engineering field to reduce the influence of personal bias. The accuracy of findings was verified with participants to ensure that the data reflected their experiences, and the researcher could regularly discuss the findings with expert colleagues in the trade in order to gain new insights.

2.9 Ethical Considerations

The researcher obtained informed consent from participants by ensuring that they understood the research purpose and its benefits. Confidentiality was maintained through ensuring anonymity and privacy of participants' personal details and information. During the course of data collection, the researcher strived for objectivity and minimised bias in data collection, analysis, interpretation and presentation. Research procedures were clearly documented, and acknowledgement of cited sources was properly done (Bloch & Geitner, 2012).

While the research reviewed literature of other scholars in this field, it also provided an opportunity for industrialists, students and educators to provide their opinions on how best the challenges of inadequacy of teaching and learning resources can be managed for the betterment of skills acquisition development processes.

- What facilities and equipment challenges are tertiary institutions facing?
- What are the contributing factors to the inadequacy of teaching and learning facilities?
- What strategies are being employed by polytechnics to bridge the gap of inadequate equipment and facilities?

3. Results and Discussion

3.1 Quantitative Findings

The quantitative results of key equipment and their functional conditions of four institutions were presented as in Tables (6 - 10) respectively.

The equipment availability for teaching and learning

Equipment	Total Available	Functional	Non Functional	% Functional
Milling machine	15	11	4	73
Lathe machine	47	28	19	60
Drill	17	9	8	53

Table 6. Key Equipment Inventory and Condition of Institution A

Equipment	Total Available	Functional	Non Functional	% Functional
Milling machine	5	2	3	40
Lathe machine	10	2	8	20
Drill	7	1	6	14

Table 7. Key Equipment Inventory and Condition of Institution B

Equipment	Total Available	Functional	Non Functional	% Functional
Milling machine	10	5	5	50
Lathe machine	40	19	21	48
Drill	20	12	8	60

Table 8. Key Equipment Inventory and Condition of Institution C

Equipment	Total Available	Functional	Non Functional	% Functional
Milling machine	6	3	3	50
Lathe machine	18	4	14	22
Drill	4	2	2	50

Table 9. Key Equipment Inventory and Condition of Institution D

Equipment	Total Available	Functional	% Functional
Milling machine	36	21/336	58
Lathe machine	115	57/115	50
Drill	48	28/48	58

Table 10. Summary of Functional Key Equipment

under the period of study was 58%, 50% and 58% for the milling, lathe and drilling machines, respectively. Therefore the average availability of key machine tools equipment combined was (58 + 50 + 58)/3 = 55.33%. This low percentage of equipment availability for training, coupled with increased enrolments as indicated on instructors' questionnaire item 9, has the potential to put pressure on the few machines available for hands-on skills training and practice. This may lead to more equipment breakdown and also hurrying students to complete their practical exercises. However, this is not good for skills development training and most probably leads to the instructors either using demonstrations of group exercises or abandoning the practical, as indicated in item 9 on the students' questionnaires and item 4 on the instructors' questionnaire.

4. Analysis and Interpretation of Presented Data

The training is hinged on hands-on practice, and this has a correlation with the final skill competences of graduates. When this equipment availability is less than 60%, coupled with the inequitable enrolment figures as indicated by item number 9 on instructor responses and item 7 on recent graduate responses. Those items indicated serious greater challenges for hands-on practice and skills impartment. This key equipment is mainly for machining, and yet there are other critical skill proficiencies required when students go for trade tests, as indicated by item 9 on industry experts and item 7 on recent graduates' responses. So the suggestion by all participants to increase the attachment period to three years requires serious implementation considerations.

4.1 Industry Experts' Responses

Table 11 summarizes the data's relevant to the Industry experts' responses.

Item 1: 8 artisans and 7 foremen participated in the questionnaire.

Item 2: ((60*2 + 50*5 + 40*6 + 30*2))/15 = 49.65% skills competences of direct Machine shop engineering graduates as rated by industry experts.

Item 3: There was a strong agreement as all the 15 participants indicated that inadequacy of key training equipment have negative effect on skills acquisition during training.

Item 4: There was strong agreement as all the 15 participants responded that one year industrial or work related learning was not enough for developing a fully skilled worker in Machine shop engineering.

Item 5: The responses indicated that systematic maintenance has 88.66% effectiveness in the availability of machine tools of Machine shop engineering. Implying that maintenance of training equipment should be prioritised.

Item 6: Twelve participants out of 15 suggested a two year industrial attachment while three participants suggested

No.	Item Description	Response
1	What is your position in the Machine shop engineering field? (Artisan, Foreman, Technician / Engineer).	8- Foremen;7- Artisans.
2	Rate the skills competences of machine shop engineering graduates from Polytechnics (out of 10)	2*6/10; 5*5/10; 6*4/10; 2*3/10
3	Do you think inadequacy of key equipment and facilities affect skills development? YES/NO	15/15 Yes
4	Do you think one year attachment period is enough to develop a class 1 skills worker? YES/ NO/Not sure	15/15 indicated No
5	Rate the importance of systematic maintenance management in machine shop engineering (out of 10).	3*10/10: 7*9/10: 5*8/10
6	Suggest the duration of Industrial attachment for Machine shop Direct intake students training	12/15- 2years; 3/15-3years
7	Do you think industrial attachment bridges the gap of inadequacy of equipment during teaching and learning? YES/NO	15/15 - Yes
8	Which equipment do you think is key for Machine shop engineering teaching and learning?	11/15 - Machine tools: 4/15 - nil response
9	Indicate by ticking the areas of competence deficiencies you notice in general from polytechnics graduates in machine shop engineering? Machining / hydraulics and pneumatics / gearboxes / Coneveyors / Crushers / Bearings / Fitting / All of them	10/15-indicated deficiencies in other areas except Machining 5/15 - indicated deficiencies in all areas listed.
10	What are your brief recommendations?	9-more hands on practice in all areas, 2-recommend more fitting exposure and 1 suggested enhancement of measuring skills, 3 - no comments

Table 11. Industry Experts Survey Responses

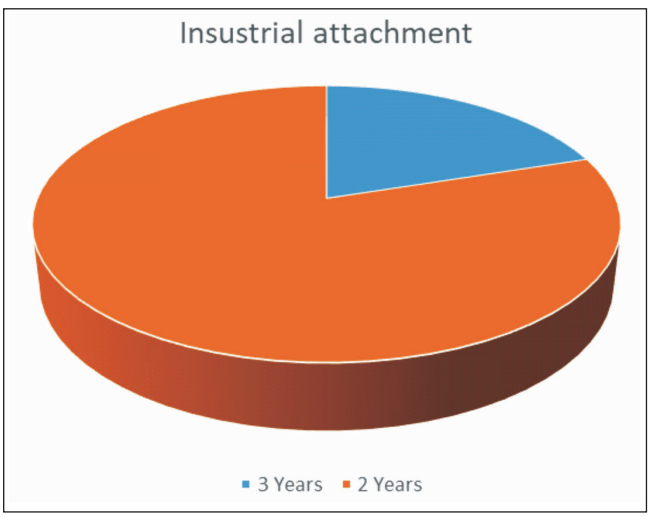

Figure 1. Industrial Attachment Period

a three year industrial attachment for Institutional direct students in Machine shop engineering. This implied that the current one year industrial attachment is not enough (Figure 1).

Item 7: This item had a strong agreement from participant. All the fifteen participants indicated that Work related attachment bridges the gap of inadequacy of equipment during training of machine shop engineering graduates.

Item 8: Eleven responded that Machine tools were key and four did not respond which represent a strong agreement.

Item 9: Ten indicated deficiencies in all other listed areas except machining. Five indicated deficiencies in all areas.

Item 10: On brief comments, nine indicated the need for increased hands on practice in all areas during training. Two indicated the need for more hands on in fitting. One suggested increased hands on practice in the use of measuring instruments. Indicating a strong agreement on emphasis of hands on practicing. All this practice can only be gained through using functional machinery and facilities.

4.2 Recent Graduate Responses

Table 12 summarizes the data's relevant to the Recent graduate responses.

Item 1: A strong agreement as all participants indicated that equipment and facilities were not adequate during teaching and learning.

Item 2: Fifteen percent respondents indicated that the condition of equipment and facilities were good, twenty five percent indicated that they were fair and sixty percent indicated that the condition was poor.

Item 3: Fourteen out of twenty responded with a Yes and six were not sure.

Item 4: Five percent indicated that the availability of training consumables were good, twenty five percent indicated that the availability of consumables was fair. Seventy percent indicated that the availability of training consumables was poor.

No.	Item description	Response
1	Do you see the equipment and facilities for Machine shop engineering training at your institution as adequate	20/20 responded with a No
2	Rate the condition of the machine tools at your institution (Excellent. Good, Fair, Poor)	3-Good: 5-Fair; 12 - Poor
3	Do you think acquiring 3D printing skills is necessary? YES/NO/Not sure	14/20 Yes; 6/20 Not sure
4	Rate the availability of training consumables such as steel materials and cutting tools (Excellent, Good, Fair, Poor)	1/20 Good: 5/20 Fair; 14/20 Poor
5	Do you think industrial attachment will bridge the gap created by inadequacy of equipment? YES/NO	20 /20 Yes
6	Identify any other equipment that you think should be available	7- CNC:, 3-upgrade + CNC: 9-Fitting: 1-3D printer
7	Select by ticking the areas you think are not covered enough during college but are important? Machining/ Fitting/Hydraulics and Pneumatics/Bearings/Conveyors/Gearboxes/ Crushers	9/20 Machining is well covered. 11/20 All areas are not well covered
8	Was there a shortage of consumables to use for your practicals YES/ NO	20/20 Yes
9	Indicate by ticking how shortage of consumables were solved? Group project/use of demonstrations/ abandoned the exercise.	8/20 Group project 6/20 Used demonstration 6/20 Abandoned exercise
10	Rate the severity of non-availability of training consumables out of 10	2*7/10: 2*6/10: 5*5/10; 8*4/10: 3*3/10.
11	Suggest the duration of Industrial attachment for Machine shop Direct intake students training	20 - 2years

Table 12. Recent Graduate Responses

Item 5: All twenty participants indicated that industrial attachment bridges the gap of inadequacy of equipment and facilities.

Item 6: Seven participants indicated that CNC machines should be available for teaching and learning, three indicated that the current machines need upgrade and addition of CNC machines, nine indicated that there is need to upgrade existing equipment and add fitting equipment. These responses indicated that the facilities are not enough and concurring with responses from other participants in the instructors and recent graduates categories as shown on Figure 2. The responses points towards upgrade and inclusion of modern machinery.

Item 7: Forty five percent indicated that machining skills development were well covered and fifty five percent indicated that all categories of Machining engineering training were not adequately covered during teaching and learning at the institutions.

Item 8: A strong agreement of all 20 participants indicated that they experienced some training consumables shortages.

Item 9: Shortage of consumables to carry out some practical training were addressed by either the use of Group projects or demonstrations or by abandoning the exercise as shown in Figure 3. Non availability of training consumables at tertiary institutions led to either abandonment of the practice work, demonstration by the instructor to the group or group work exercises. Which

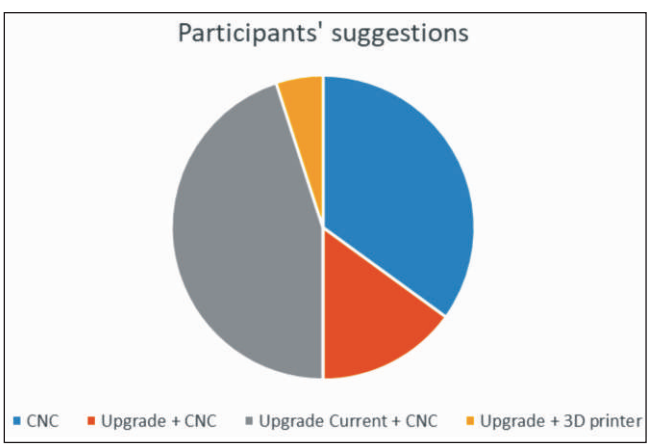

Figure 2. Participants' Suggestions

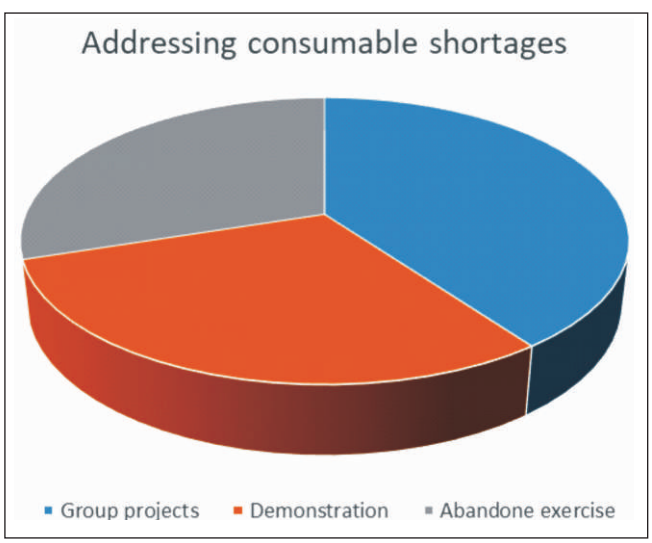

Figure 3. Addressing Consumables Challenges

does not promote practical skills training as learners won't get the chance to fully practice and acquire the hands on skills as demanded of their training.

Item 10: The severity of non-availability of training consumables was rated at = ((70*2) +(60*2)+ (50*5) + (40*8) + (30*3))/20 = 44.75%. Implying that availability of training consumables was 65%.

Item 11: All participants indicated that industrial attachment should be at least two years. This strong agreement is a good reference point to consider increasing the duration of industrial attachment since it is coming from the recent graduates of the training program who are now facing reality in the work places or during employment seeking.

4.3 Instructors' Responses

Table 13 summarizes the data's relevant to the Instructors' responses. The interpretation for each of the analysed items are presented in detail and in line with the relevant research question on Interpretation of findings subheading.

Item 1: One responded that the condition of training was good. Ten indicated that the condition was fair. Four indicated that the condition was poor.

Item 2: Thirteen instructors indicated that all machines needed upgrading and two indicated that CNC machines needed to be made available. And this was a strong agreement in support of modern equipment.

Item 3: All the fifteen instructors under the study indicated that they experienced delivery challenges due to inadequacy of training equipment and facilities and this was a strong agreement.

Item 4: 53.3% respondents used demonstrations, 26.6% of the respondents used group work and 20% abandoned the exercise. Once the exercises are abandoned without other effective alternatives leads to serious training and skills acquisition challenges.

Item 5: Of the 15 respondents, seven indicated that work related learning addresses the challenges of equipment and facilities by 50%, four indicated a 60% and three indicated a 70% and 2 indicated an 80%. This brought to the average response of 64% contribution of work related learning in addressing equipment and facilities challenges. This aligns to the conclusions made by Dondofema et al. (2020) that industrial attachment enhances training and chances of employability.

Item 6: There was strong agreement on this item. All the fifteen respondents indicated that 1 year industrial attachment was not enough to develop a fully skilled artisan in Machine shop engineering.

Item 7: 86.66% of the respondents indicated that virtual learning partially bridges the gap of inadequacy of training equipment and facilities and 33.33% disagreed.

Item 8: A strong agreement of 80% of the respondents indicated that practical demonstrations to students were

No.	Item Description	Response
1	Rate the condition of the machine tools at your institution (Excellent. Good, Fair, Poor)	1-Good: 10- Fair: 4- Poor
2	Identify any equipment that you think needs to be upgraded	13 - All machines; 2 - CNCs
3	Have you experienced challenges due to inadequate equipment and facilities? YES / NO	15 - Yes
4	How were the challenges managed? (Demonstrations/Abandoned/Group Work)	8/15 - demonstrations: 3 / 15 - abandoned: 4/15 - group work
5	Do you think work related learning addresses the problems of inadequate equipment and facilities? (Rate your response out of 10)	7-5/10: 4 - 6/10: 3 - 7/10; 2 - 8/10
6	Do you think one year industrial attachment for Direct students is adequate in developing a class 1 skilled worker for Machine shop engineering? YES/ NO	15 - No
7	Do you think virtual learning and simulations can bridge the gap of inadequacy of equipment and facilities in teaching and learning of Machine shop engineering skills? YES / NO	13/15- Yes: 2/15- No
8	Who carries out the practical demonstrations for students in the workshop? Lecturer/Technician	15/15 - Lecturer; 0/15 - Technician
9	Are the enrolment figures equitable with the facilities for Machine shop engineering? YES / NO.	15 - No
10	Rate the effectiveness of your equipment maintenance management system out of 10.	1 - 2/10: 6 - 3/10: 6 - 4/10; 1 - 5/10: 1 - 6/10
11	Do you have a dedicated technical staff that carries out the maintenance of your equipment in Machine shop engineering? YES / NO	15 - No

Table 13. Instructors' Responses

carried out by lecturers and 20% indicated that demonstrations were done by a technician.

Item 9: All the fifteen respondents indicated that enrolment figures were not equitable with the available equipment and facilities. Indicating a strong agreement.

Item10: The respondents' mean effective rating of the institutions maintenance management system = ((2*20) + (6*30) + (6*40) + (1*50) + (1*60))/15 which came to 38%. This is far way below the general plant availability figure of 90% in an industrial and manufacturing set ups.

Item 11: There was strong agreement on this item. All the fifteen participants indicated that there was no dedicated technical team that services and repair equipment and facilities for teaching and learning.

4.4 Interpretation

4.4.1 What Facilities and Equipment Challenges are Institutions Facing?

As indicated by responses to items 1 to 3 by instructors, institutions are facing challenges with key training equipment. This was also echoed by responses on items 1 to 4 from students'/recent graduates' questionnaires, where shortage of equipment recorded a 100% inadequacy and the condition of machines was rated between poor and fair. Industry experts also concurred 100% on questionnaire item 3 that inadequacy of key equipment and facilities has a negative effect on skills development and acquisition. Institutions lacked equipment for fitting and maintenance on components like bearings, gearboxes, crushers, pumps, and conveyors, as indicated by responses from industry experts on item 9 and students' question item 7. The components are critical skills that are examinable on trade tests for national certificate holders to be accorded skilled worker class. Institutions are facing challenges of functional basic equipment, modern equipment such as CNCs and 3D printers, as well as upgrading of conventional equipment.

4.4.2 What are the Contributing Factors to Inadequacy of Teaching and Learning Facilities?

Some of the major contributing factors, according to the responses of instructors on item number 10, were poor maintenance strategies, where the effectiveness of maintenance management systems was rated at 38%. Failure to upgrade existing equipment item number 2 on the instructor's questionnaire was another contributor to the inadequacy of key teaching and learning facilities. On item number 9 of the instructor's questionnaire, the responses indicate that student enrolment figures do not tally or match the existing facilities, and this causes congestion and pressure on the few available facilities; hence, they were prone to breakdowns. Lack of technical demonstrators or technicians to assist instructors may result in increased breakdowns of equipment, as reflected in item 11 on the instructors' survey questionnaire. Failure to upgrade current old equipment and procure modern machinery such as CNCs and 3D printers.

4.4.3 What Strategies can be Employed to by Institutions to Bridge the Gap of Inadequate Equipment and Facilities?

There is a need for institutions to employ a functional maintenance management system, probably by having dedicated technical personnel that service and repair their equipment and facilities so as to increase the equipment availability for training and skills acquisition. Item number 11 responses of 64% by instructors indicated that maintenance was not done in a systematic way. From the responses of former students/recent graduates in questionnaire item 5, instructors in questionnaire item 5 (64% indicated that industrial attachment contributes greatly in addressing the challenges of inadequacy of equipment and facilities) and item 6 (100% indicated that one year is not enough for industrial attachment), and industry experts in questionnaire item 4 (all responses indicated that one year of industrial attachment is not adequate for adequate skills development). On item 11 on the recent graduates' survey, a 100% participants' response indicated that industrial attachment should be at least three years. Implying that increasing the industrial attachment period from the current one year can be used to bridge the gap. Item 7 on recent graduates and item 9 on industry experts point to the same problems

on gearboxes, crushers, conveyors, hydraulics, pneumatics and bearings, which can be acquired through industrial exposure or attachment. This may also bridge the gap in skills acquisition, as students may have an opportunity to learn and practise while in a training setup.

Conclusion

The closer the relationships of industry practices and tertiary institutions, the better the relevance of the institutions' curricula and the higher the chances of quality training, hence increasing the possibilities of graduates' employability. Conclusions were drawn based on the reviewed literature and views of industry experts, instructors and recent graduates, and this triangulation reduced the risk of bias from participants and increased the validity of the findings.

The following conclusions were drawn from the study based on each of the research questions of the study:

What facilities and equipment challenges are institutions facing?: Institutions faced equipment for fitting and maintenance on components like bearings, gearboxes, crushers, pumps, and conveyors, as indicated by responses from industry experts on item 9 and students' item 7. These are key components of skills development in the training of machine shop engineering students. The areas are also examinable on trade tests for the graduates to be accorded skilled worker class. Institutions also had little or no modern or cutting-edge technology machinery and equipment for training, like CNCs and 3D printers.

What are the contributing factors to the inadequacy of teaching and learning facilities?: Increased enrolments are putting pressure on the already inadequate and dilapidated equipment and facilities, which comes with increased breakdowns coupled with a poor maintenance management system. Increased enrolments have the effects of a bigger lecturer/student ratio and eventually affect effective delivery and skills impartment to learners (Davas & Palmer, 2014; Hassan & Shamsudin, 2019). Failure to maintain the current equipment and facilities in good working condition, coupled with failure to re-equip and upgrade to modern machinery and facilities, is contributing to the inadequacy of training facilities.

What strategies can be employed by institutions to bridge the gap of inadequate equipment and facilities?: The use of demonstrations, group work and work industrial attachment, as well as equipment leasing and sharing among institutions. 80% of industry experts responded with an increase of industrial attachment from the current one to two years. 20% of them even advocated for industrial attachment to be increased from the current one year to three years. Responses on item 11 for recent graduates also concurred with this option 100%. As indicated by Dondofema et al. (2020), 88% of students who go through industrial attachment are absorbed in the work marketplaces, implying that industrial attachment is effective in equipping trainees with employable skills. This was in the study for the agricultural diploma training programme and can still be applied to engineering training programmes. There is a need to consider further modifying the machine shop engineering on industrial placement duration to suit employers' needs through consultation with employer organisations as recommended by Chundu et al. (2021).

Implications for practice: The study underscored the need to put in place robust measures and policies that promote and enhance acquisition of employable skills for the benefit of all stakeholders in machine shop engineering training. The findings are also applicable to other engineering trades within the tertiary institutions and may lead to curriculum review and an increase in industrial attachment duration for learners.

References

[1]. Adhikari, T. (2024). Enhancing quality of basic level education through demonstration method. *Triyuga Academic Journal,* 3(1), 190-207.

https://doi.org/10.3126/taj.v3i1.71980

[2]. Akintayo, O. T., Eden, C. A., Ayeni, O. O., & Onyebuchi, N. C. (2024). Evaluating the impact of educational technology on learning outcomes in the higher education sector: A systematic review. *International Journal of Management &*

Entrepreneurship Research, 6(5), 1395-1422.

https://doi.org/10.53022/oarjms.2024.7.2.0026

[3]. Alenezi, M., Wardat, S., & Akour, M. (2023). The need of integrating digital education in higher education: Challenges and opportunities. *Sustainability,* 15(6), 4782.

https://doi.org/10.3390/su15064782

[4]. Anindo, I., Mugambi, M., & Matula, D. (2016). Training equipment and acquisition of employable skills by trainees in public technical and vocational education and training institutions in Nairobi County, Kenya. *Training,* 3(4), 103-110.

[5]. Barrett, P., Treves, A., Shmis, T., & Ambasz, D. (2019). *The Impact of School Infrastructure on Learning: A Synthesis of the Evidence.* World Bank Group.

[6]. Bloch, H. P., & Geitner, F. K. (2012). *Machinery Failure Analysis and Troubleshooting: Practical Machinery Management for Process Plants.* Butterworth-Heinemann.

[7]. Burns, C., & Chopra, S. (2016). A meta-analysis of the effect of industry engagement on student learning in undergraduate programs. *The Journal of Technology, Management, and Applied Engineering,* 33(1), 1-10.

[8]. Chipfakacha, R. (2019). *The Role of Technical and Vocational Training in Developing Countries.* SSRN.

[9]. Chundu, M., Ndavambi, R., & Mamukwa, E. (2021). An investigation of university graduates employability: A case of mechanical engineering students from two tertiary institutions in Zimbabwe. *Zimbabwe Journal of Educational Research,* 33(3), 149-162.

[10]. Dondofema, J., Mwenje, J., & Musemwa, L. (2020). The industrial attachment programme-history, benefits, challenges and its adoption in Zimbabwe: A Review. *Asian Journal of Education and Training,* 6(3), 412-420.

[11]. El Baradei, L., & Kadry, M. (2022). *Bridging the Employability Skills Gap in Higher Education.* Retrieved from

https://www.voced.edu.au/content/ngv:95749

[12]. Flores, H. P. (2025). *Strengthening the Financing of State Universities and Colleges: Challenges and Opportunities.* Philippine Institute for Development Studies.

[13]. Gilbert, M. M., & Thelma, C. C. (2024). An assessment of the effectiveness of the preventive maintenance policy in enhancing quality assurance in education provision: A case of selected primary schools in Chibombo District, Zambia. *World Journal of Advanced Research and Reviews,* 21(1), 1788-1797.

https://doi.org/10.30574/wjarr.2024.21.1.0221

[14]. Goffar, A., & Agustin, L. (2021). Management of facilities and infrastructure in improving quality of graduates. *International Journal of High Education Scientists (IJHES),* 2(2), 36-47.

[15]. Gulshat, K. (2025). Financing higher education: Insights from global practices. *Central Asian Journal of Innovations on Tourism Management and Finance,* 6(4), 1243-1252.

https://doi.org/10.51699/cajitmf.v6i4.985

[16]. Hassan, S., & Shamsudin, M. F. (2019). Measuring the effect of service quality and corporate image on student satisfaction and loyalty in higher learning institutes of technical and vocational education and training. *International Journal of Engineering and Advanced Technology,* 8(5), 533-538.

https://doi.org/10.35940/ijeat.E1077.0585C19

[17]. Ibrahim, R., & Aslam, R. (2025). Inadequate facilities and their impact on learning: Voices of university students in district Gwadar. *Indus Journal of Social Sciences,* 3(2), 571-586.

https://doi.org/10.59075/ijss.v3i2.1412

[18]. Jacob, O. N., & Atobauka, I. S. (2021). Effects of brain-drain on higher institutions' administration in Nigeria. *Pindus Journal of Culture, Literature, and ELT,* 8(1), 33-41.

[19]. Mack, A. J. (2024). Funding and its impact on the administration and organisational efficiency of technical vocational education and training institutions. *Discover Education,* 3(1), 221.

https://doi.org/10.1007/s44217-024-00305-5

[20]. Mahlahla, J. (2025, July 10). *Hon Min Mavima outlines Zimbabwe's skills transformation plan. Ministry of Skills Audit and Development.* Retrieved from

https://www.zimskills.gov.zw/4296-2/

[21]. Mahmud, A., Nuryatin, A., & Susilowati, N. (2022). Income generating activity in higher education: A case study of a public university in Indonesia. *International Journal of Evaluation and Research in Education,* 11(1), 303-312.

[22]. Matabane, M. E., Matabane, R. B., Moloi, T. J., & Sibaya, K. T. (2022). The exploring factors that teachers view as hindering quality in teaching and learning at a TVET college. *Research in Educational Policy and Management,* 4(1), 51-64.

https://doi.org/10.46303/repam.2022.9

[23]. Ndiyamba, D., Murena, E., Zendera, W., Mafuratidze, F., & Madzudzo, E. (2024). Enhancing mechanical engineering education in Zimbabwe through identifying critical equipment, facilities, and maintenance strategies for effective training at universities. *i-manager's Journal on Mechanical Engineering,* 14(3), 1-18.

https://doi.org/10.26634/jme.14.3.21225

[24]. Niiranen, S. (2021). Supporting the development of students' technological understanding in craft and technology education via the learning-by-doing approach. *International Journal of Technology and Design Education,* 31(1), 81-93.

https://doi.org/10.1007/s10798-019-09546-0

[25]. Nyemba, W. R., Mashamba, A., & Mbohwa, C. (2017). Equipment maintenance challenges and solutions for capacity building and sustainability in the training of engineers: The case for the University of Zimbabwe. *Procedia Manufacturing,* 7, 303-308.

https://doi.org/10.1016/j.promfg.2016.12.075

[26]. Obeng-Ofori, D., & Kwarteng, H. O. (2020). Enhancing the role of alumni in the growth of higher education institutions. *International Journal of Multidisciplinary Studies and Innovative Research,* 4, 40-48.

[27]. Ogbu, J. E. (2015). Influences of inadequate instructional materials and facilities in teaching and learning of electrical/electronic technology education courses. *International Journal of Vocational and Technical Education,* 7(3), 20-27.

[28]. Ongulu, M., & Ibrahim, K. (2021). Influence of adequacy of teaching and learning resources on students 'enrolment in technical, vocational education and training institutions in Butula sub-county, Busia County. *International Research Journal of Social Sciences, Education and Humanities,* 2(1), 1-14.

[29]. Oviawe, J. I. (2018). Revamping technical vocational education and training through public-private partnerships for skill development. *Makerere Journal of Higher Education,* 10(1), 73-91.

https://doi.org/10.4314/majohe.v10i1.5

[30]. Oviawe, J. I., Uwameiye, R., & Uddin, P. S. (2017). Bridging skill gap to meet technical, vocational education and training school-workplace collaboration in the 21st century. *International Journal of Vocational Education and Training Research,* 3(1), 7-14.

https://doi.org/10.11648/j.ijvetr.20170301.12

[31]. Paton, R. A., Wagner, R., & MacIntosh, R. (2012). Engineering education and performance: The German machinery and equipment sector. *International Journal of Operations & Production Management,* 32(7), 796-828.

https://doi.org/10.1108/01443571211250086

[32]. Pirzada, G., Muhammad, Y., & Mahmood, A. (2022). Assessment challenges faced by technical vocational education (TVET) stakeholders in Pakistan: Stakeholders' perspectives. *Research Journal of Social Sciences and Economics Review,* 3(4), 17-26.

https://doi.org/10.36902/rjsser-vol3-iss4-2022(17-26)

[33]. Ramli, A., Zain, R. M., Campus, C., Chepa, P., & Bharu, K. (2018). The impact of facilities on students' academic achievement. *Scientific International (Lahore),* 30(2), 299-311.

[34]. Tuti, M. D. (2024). *Effective Utilization of Workshop Facilities for Skills Acquisition in Public Technical and Vocational Education and Training Institutions in Nairobi County, Kenya* (Doctoral dissertation, University of Eldoret).

[35]. Wang, Y., & Richardson, D. S. (2020). To buy or to

lease: The advantages and costs of leasing versus buying scientific instruments for academic core facilities. *EMBO Reports,* 21(5), e49971.

[36]. Watters, J., Pillay, H., & Flynn, M. (2016). *Industry-School Partnerships: A Strategy to Enhance Education and Training Opportunities.* Retrieved from https://eprints.qut.edu.au/98390/

[37]. Wettaka, J. (2020). *Improving Hands-On Training for Skill Acquisition of Engineering Students at the Department of Mechanical and Production Engineering, Kyambogo University* (Doctoral dissertation, Kyambogo University).

[38]. Zimbabwe Council for Higher Education. (2018). *National Skills Audit Report.* Retrieved from https://www.zimche.ac.zw/blog/2018-national-skills-audit-report/

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