Assessing the Need for Professional Development of High-Speed Machine Technology Teachers in Ethiopian Higher TVET Institutions

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This study aims to conduct a need assessment of high-speed machine technology teachers' professional development in Ethiopian higher technical and vocational education and training (TVET) institutions. Well-qualified and trained technicians in modern and advanced manufacturing machinery have become widely demanded in Ethiopia's industry sectors. Now the country focuses on the industry sector to modernize and to become competitive in the local and global market as well as substitute the imported materials through local industry. These archives with the TVET institutes are equipped with qualified trainers and training resources. The professional development of trainers has been identified as a critical component in the success of TVET in Ethiopia. Currently, in most TVETs the training resources and workshops are traditional and aged in addition, not enough for training the students.

INTRODUCTION

The rapid growth and spread of science and technology forced industries to upgrade or change their production machinery, systems, services, and human capacities to compete in the global market by providing quality products or services at a reasonable cost. The created, highly skilled or qualified workers demand in several work fields and the complex work systems aspire new solutions and concepts for vocational training.

Technical vocational education and Training (TVET) have been performing well in several aspects for several years. This institution is responsible for producing skilled and semi-skilled fulfilling employment in the industrial sectors.

Technical and Vocational Education and Training (TVET) is defined as a combination of education, training, and skills development that relate to multiple occupational fields (Dawe, Miller, & Diop, 2020). TVET refers to a range of learning experiences that are relevant to the world of work and that occur in various training contexts, including educational institutions and the world of the workplace (UNEVOC, 2006). It involves formal, non-formal, and informal learning and training mechanisms that provide knowledge and skills for employment (Khan, Siddiqui, & Abbasi, 2020). The skills not only help students but also assist teachers in enhancing their professional.

The highly skilled workforce demand that emerged in industries could be reflected as a new challenge for TVET sectors. Within learning environments, rapid changes have placed new demands on vocational teachers to continuously update their competence (Fejes & Köpsen, 2014). This global trend combined with the multiple roles played by vocational teachers, such as tutors, mentors, and practitioners (Mahlamäki-Kultanen et al., 2006), raises questions about which competence they should develop and how. It will also produce new jobs that have yet to be invented. The critical challenge for skills development is serious skills mismatches despite growing investments in TVET.

Training students in career skills is the goal of vocational education, career development, and technical education teachers. These teachers are often called vocational teachers or trainers, and they require two professional skills. Firstly, they need to be experts in teaching and learning, including pedagogical approaches. Secondly, they need to be experts in their specialty area. As such, vocational teachers and trainers are considered 'dual professionals.' To maintain a balanced dual identity in line with workplace changes, vocational teachers and trainers require continued professional development. This will enable them to keep both professional expertise up-to-date and improve their skills. Therefore, ongoing professional development is crucial for vocational teachers and trainers. This is to ensure that they can provide students with the necessary knowledge and skills required for their future careers.

The effectiveness of technical and vocational education and training (TVET) in a country largely hinges on the proficiency and instructional techniques of its teachers, as well as the availability of adequate resources. To stay competitive in the international market, these teachers must maintain current competencies that are in line with modern industrial requirements and human capacities. As TVET institutions place significant emphasis on equipping their students with practical skills, knowledge, and attitudes, their teachers must acquire comprehensive new proficiencies. This will enable their graduates to meet current industrial demands.

Technical and vocational education and training (TVET) in Ethiopia heavily relies on its teachers' proficiency and instructional techniques, as well as adequate resources. To remain competitive in the international arena, TVET teachers must possess relevant qualifications and stay up-to-date with up-to-date competencies that align with present-day industry requirements and human capabilities, particularly in the field of High-Speed Machining Technology. Acquiring teachers' professional competencies in this area has shown promising results in terms of providing highly qualified training and employment opportunities in global industries. The

competence of teachers in this specialized area plays a crucial role in ensuring effective instruction and training for students pursuing careers in High-Speed Machine Technology. Ethiopian TVET institutes strive to provide quality education and training that aligns with industry demands and promotes economic development. However, there is a need to examine and enhance the professional competence of teachers specifically in the High-Speed Machine Technology field. This study aims to address this gap by investigating the current level of teachers' professional competence and exploring ways to improve their effectiveness in delivering instruction and training.

This assessment study explores the professional competence of teachers in Ethiopia's higher technical and vocational education and training institutions that offer high-speed machine technology programs. By assessing teachers' skills, knowledge, and pedagogical approaches, we seek to gain insights into the alignment between educational training with industry demands. Understanding the strength and skills gap of TVET trainers' competency is crucial to enhance the quality of training given in the TVET institute as well the graduates are highly qualified and suited into the industry. The need for professional development and lifelong learning is a necessity for effectively providing quality training for trainers. A better understanding of the problem of TVET teachers' learning and professional development in the current system helps the effort to improve the status professional abilities of teachers.

The competence of teachers goes beyond subject knowledge and encompasses a wide range of skills, attitudes, and qualities necessary for effective teaching in the High-Speed Machine Technology field. These competencies include a solid understanding of industry trends, occupational standards, emerging technologies, and the ability to integrate practical applications into the curriculum. Furthermore, effective teachers in this field should possess strong communication and interpersonal skills, critical thinking abilities, assessment and feedback strategies, and a commitment to continuous professional development.

Overall, the results from this study focus on teachers' professional competence development in High-Speed Machine Technology, to contribute to the enhancement of TVET education and training in Ethiopian Higher TVET institutes. It seeks to identify the areas where teachers may require further support and development in their competence. The findings of this study can inform the design of targeted professional development programs, curriculum enhancements, and instructional approaches that effectively prepare students for successful careers in High-Speed Machine Technology.

Background Of The Respondents

With a well-balanced representation across gender, age, education level, and department, the data respondents' demographic shows a commendable level of inclusion. In this study, Male respondents made up 75.2% of the total respondents, while female respondents made up 24.8%. This shows that both male and female respondents had an equal opportunity to participate in the survey.

A Master's degree was the most frequent level of education (59.7%), followed by a Bachelor's degree (35.7%), and a Ph.D. (4.7%). A significant number of respondents (82.9%) came to the Department of Manufacturing Technology, while only 17.1% were from the Department of Mechanical Engineering. According to professional status, teachers (47.3% of responders) and trainers (34.9%) had the highest numbers, while assistant professors, case team leaders, department heads, and division directors had lower percentages. In regards to specialization, the majority of the participants (69.8%) had familiarity with Manufacturing Technology.

Survey Design And Measurements

The quantitative method is used in this research study to gather and examine numerical data. It chooses participants based on predetermined quotas using a non-probability sampling method known as quota sampling. The non-experimental design concentrates on the observation and measurement of variables as they emerge naturally. Cross-sectional surveys, which are the data gathering approach, offer a snapshot of data on a certain population at a specific period, enabling researchers to acquire insights into the current situation.

A 5-point Likert scale was employed as the response scale to gauge the level of agreement concerning the specific items presented in the questionnaire. The scale was structured as follows: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree. Respondents were asked to select the option that best reflected their agreement with each item.

During the third step of questionnaire design, a comprehensive approach was taken to identify 8 core domains related to High-Speed Machine Technology competencies and TVET teachers' competence attributes. Through a thorough review of relevant literature and books on the subject matter, a total of 40 main-scale items were generated. This meticulous process ensured that the questionnaire encompassed a broad range of relevant topics and accurately captured the key dimensions of High-Speed Machine Technology competencies and TVET teachers' attributes, as supported by the existing body of knowledge in the field.

Table 3.1 The questions designed for the questionnaire on the importance of core competencies

The Importance of Core Competencies	Number of Items
1. Technical Proficiency	8
2. Digital Literacy	4
3. Curriculum Development	5
4. Industry Partnerships	5
5. Project-Based Learning	4
6. Soft Skills Development	6
7. Safety and Risk Management	4
8. Additive manufacturing competencies	4
Total Item	40

Necessary Technical Competencies For Teachers High-Speed Machine Technology Raining

A Different kind of competency is crucial for success in high-speed machine training in vocational college. they are trying to cover the data that was provided for the analysis need of teachers' professional competence in the high-speed machine technology field in the Ethiopian higher TVET institute

For the ability to read and understand drawing dimensions, tolerances, and work markings, the majority of respondents (64.3.0%) selected it as most important, indicating that it is an important competency for teachers to teach the subject. The remaining 23% of respondents chose it as important, while the remaining 23% chose it as not important, indicating that drawing skills are very important for teaching HSM and therefore there is a need to improve this competency among teachers.

For manufacturing design software, 73% of respondents chose it as important and only 15.5% chose it as not important, showing that teachers' ability to use design software is very important for HSM education, indicating that HSM education and design software are highly correlated competencies that teachers should have.

According to the survey, the majority of respondents, 64.3%, thought that the ability to diagnose problems with CAD and CAM design software was very important for teaching. However, 21% thought it was important and 8.5% thought it was moderately important, suggesting that the ability to troubleshoot design software is very important in high-speed machine tool education.

The survey shows that a significant number of respondents' rate 58.9% to operating high-speed machines is highly important and 19.4% agree to an important ability for teachers. However, a smaller number of respondents 9.3% have low important required ability for HSM. This implies that the ability to operate HSM is a solid foundation for teachers to provide training for students. Teachers should develop their competency related to operating machines.

The survey shows proficiency in using programming software majority of teachers' responses of 77.5% are highly important skills for teachers to deliver quality training. However average number of 11.6% of respondents are important skills for HSM. The remaining small respondents are 2.3 % and 1.6% are related to less important skills. This indicates teachers who teach in the HSM field should be able to use proficiently designed software simulation.

The ability to perform routine maintenance 19.4 % according to the respondents is highly important for teachers to deliver training. According to the survey data, a significant portion of the rate 50.4% of respondents agree that this area is moderate. Additionally, smaller respondents rated their abilities are very low 3.1%, low 8.5%, and average 18.6%. This indicates the practical ability of machine maintenance for teachers is crucial to train students for hands-on job training and giving real-world scenarios.

Survey results show that 56.6% of respondents rated the ability of teachers as medium, indicating that the ability to work with industry partners and professionals to integrate real-world experiences and opportunities for students is important. In addition, a very small number of respondents rated it as very low, 1.6%, 17. 8%, and 7.8%, respectively, indicating that the ability of teachers to need to practice and bring into the classroom to teach students is very important. Collaborating with industry partners is the most important activity for teachers to prepare students for the real world.

The overall results show the importance of teachers' technical competencies in teaching high-speed mechanical technology. The data revealed a comprehensive approach, strengths, and areas for improvement in various competency areas. Technical competencies should be viewed as key competencies for providing a quality, competitive education in the field, with drawing reading, manufacturing design software operation, and software programming being the most important. Strengthening teachers in these competency areas will ensure that they provide quality education and that students receive an education oriented to the needs of industry.
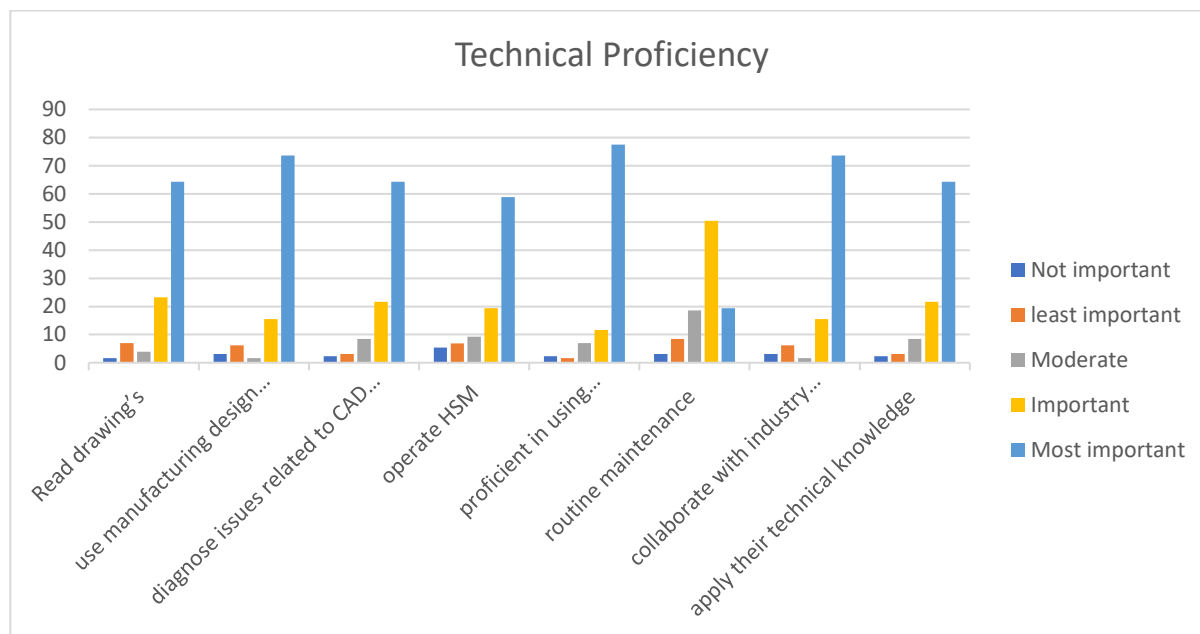
Figure 1-1 Respondents on Technical Proficiency Competency

Importance Of Digital Literacy For Hsm Training

The survey's findings on the importance of digital literacy for teachers in delivering HSM training can provide meaningful insights into how digital literacy competency is important for future careers. The nation's engineering education is doing right now. We can assess the teacher's abilities for digital literacy based on their responses to the survey questions.

The majority of respondents 75.2% rated their competence in computer software and applications as relevant to HSM operation views as the most important. While 11.6% responded it is an important competency. The significant emphasis on digital literacy competence in HSM is used to integrate technology into classroom teaching methods and real-world scenarios.

In terms of utilizing a digital significant number of respondents, 39.5% rated this competency as important. While 35.7% of respondents rated the ability us digital resources as the most important. Additionally, small smaller percentages of respondents rated their abilities as moderate 14% and very low 5.4%.

According to the result, 52.7% of respondents on the ability to support students in developing their digital literacy is rated the most important. Furthermore, smaller percentages of teachers respond to their abilities as important 25.6%, low 5.4%, and 6.2%. this emphasized the importance of supporting students in developing ICT tools is most important in teaching-learning methods and students also learn and align them with current technology.

As per the respondent's survey, a significant majority 54.3% rated the importance ability for teachers to seek professional development opportunities. However small number of respondents 13.1% rate this ability as the most important for teachers and similarly 25.6% rated their ability for teachers as moderate ability. From the result, professional development opportunity-seeking ability is one of the teachers should possess in their carry to stay updated with the latest technology and to be competent teachers.

The overall survey from the respondents suggests the importance of digital literacy competency is the necessary ability for teachers in teaching methods such as the ability to use computer software, the ability to utilize digital resources, and the ability to find professional development opportunities when teachers reach in digital literacy competence, he is an active player in adapting technology advancement and teaching methods in addition useful for preparing students for success in the digital world.
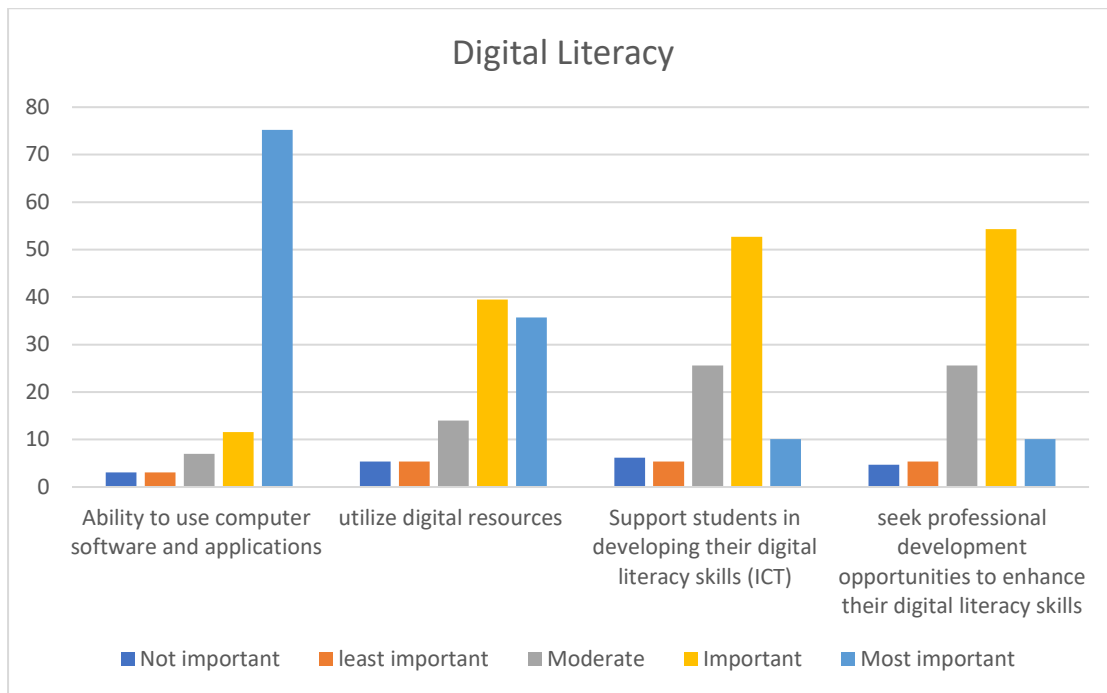
Figure 1-2 Respondents on Digital Literacy Competency

Importance Of Curriculum Development Competencies For Hsm Training

The survey's findings on the Importance of curriculum development competencies for teachers to train HSM technology can offer an important understanding of preparing quality HSM technology curricula to deliver industry-demand training. It asses the necessary abilities of teachers in curriculum development for TVET based on the result of their survey questions.

The survey data highlighted the Ability to design a comprehensive curriculum that covers all aspects of HSM training a strong consensus, with 66.7% of respondents emphasizing the importance of this competency. A sizable portion of respondents 13.2% rated important ability for teachers. Well-structured curriculum has a high impact on student performance and it well organizes the student's theoretical and practical education to be successful in future careers.

In terms of the Ability required to design a curriculum that aligns with industry standards 63.6% of the respondents rated it the most important ability, while 17.1% of respondents rated it the important ability required for designing a curriculum and 7% of respondents rated moderate ability, from this suggestion teacher's ability required considering industry standard in the curriculum is essential skills to prepare student effectively real-world application.

A significant number of respondents rated, 46.5% of the respondents on the ability to design a curriculum to enhance learners' knowledge and skills, while another 23.3% consider it the most important. Whereas 18.6% of respondents rated moderate ability for teachers and 8.5% as low. The result

suggests that teachers should have this ability to help students be well-prepared and equipped for what the current industry demands.

Regarding the ability to consider their curriculum to meet diverse needs, the responses reveal that the majority of participants 54.3% are rated as having important competence. Additionally, 11.6% of respondents rated the most important competency for teachers and 19.4% of respondents rated it as a moderate ability required by teachers, indicating the necessity of curriculum content to accommodate the varying needs, backgrounds, and learning styles of students. Teachers Adopting skills to prepare inclusive curricula will help the students compete in the global market.

Ability to design a curriculum that incorporates learning by doing and projects related to high-speed machines, the majority of respondents 45% rated it as an important ability for teachers, and 20.9% rated it the most important ability. Additionally, 17.1% rated moderate, and 11.6% rated low important. As a result, incorporating the ability to learn by doing and projects in the curriculum helps students take practical-oriented training.

The overall result shows teachers are better at designing a comprehensive curriculum and a curriculum that aligns with industry standards helps to deliver quality training and build teacher performance. Thus, the ability to develop a curriculum aligns with current technology and industry demands fostering students' practical ability and adding hands-on learning opportunities. Capacitated teacher curriculum development ability can provide Ethiopian TVET teachers able to deliver worldwide training with modern technology.
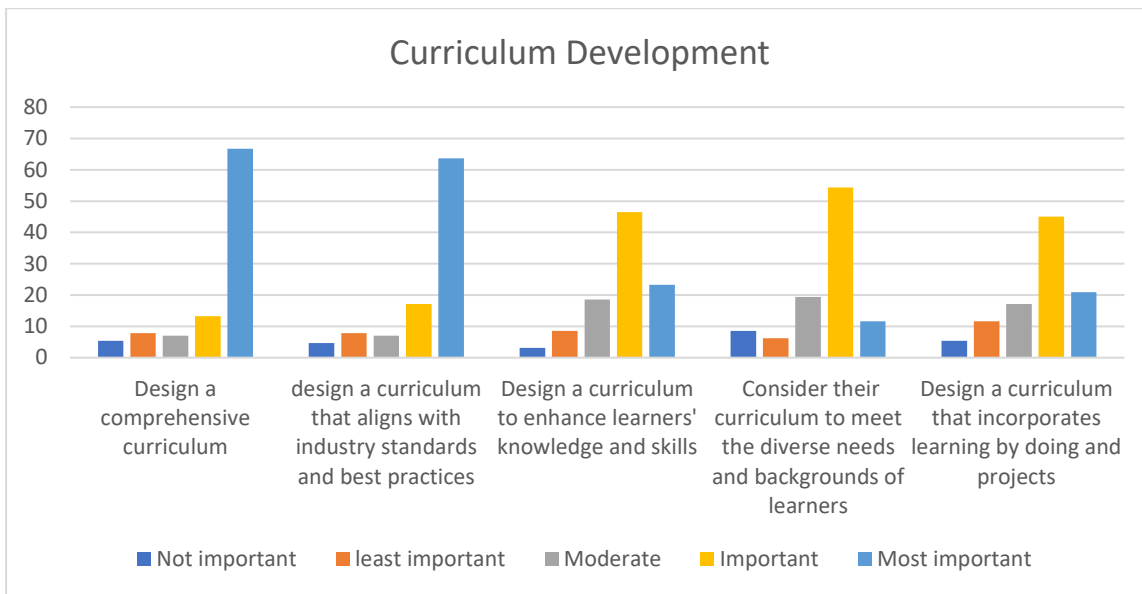
Figure 1-3 Respondents on Curriculum Development Competency

Importance Of Industry Partnerships Competencies For Hsm Training

The survey's findings on the importance of understanding ability the needs of local manufacturers can provide teachers with skills and knowledge to integrate industry partnerships in the learning curriculum this provides students with a good and safe working place and gain actual or real work experiences.

According to the respondents, the ability to understand the needs of local manufacturers is 69.8% rated as the most important ability for teachers. While 15.5% of respondents rated important and 4.7% moderate ability. The result suggests teachers should have this ability to understand the industry it helps to establish strong collaboration with the industry.

In terms of collaboration ability with industry partners to develop curriculum and training programs, 63.1% of the respondents rate it the most important ability and 8.5% of respondents rate important ability for teachers. This high score indicates teachers should have developed this ability to closely work with industry partners.

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To effectively collaborate ability with industry partners to stay updated on advancements questions, the significant respondents 58.1% rated an important ability for collaboration, and 12.4% of respondents rated the most important ability to collaborate with industry partners. Similarly, 24.8% of the respondents are rated as moderate ability for teachers and a small number of respondents rated less important ability. From the results, teachers are encouraged to develop the ability to cooperate with an industry partner for ongoing professional development as well as it helps students to deliver practical-oriented learning and students get the chance to learn in industry.

The data revealed that teachers' ability to facilitate internship and work-based learning opportunities, significant respondents rated 53.5% as an important ability and only 10% of respondents rated it the most important ability. Similarly, 24% of teachers are rated moderately and 10.6% of respondents are rated less important. This suggests that the teacher should exercise this ability to students get hands-on experiences and real-world exposure to HSM technology
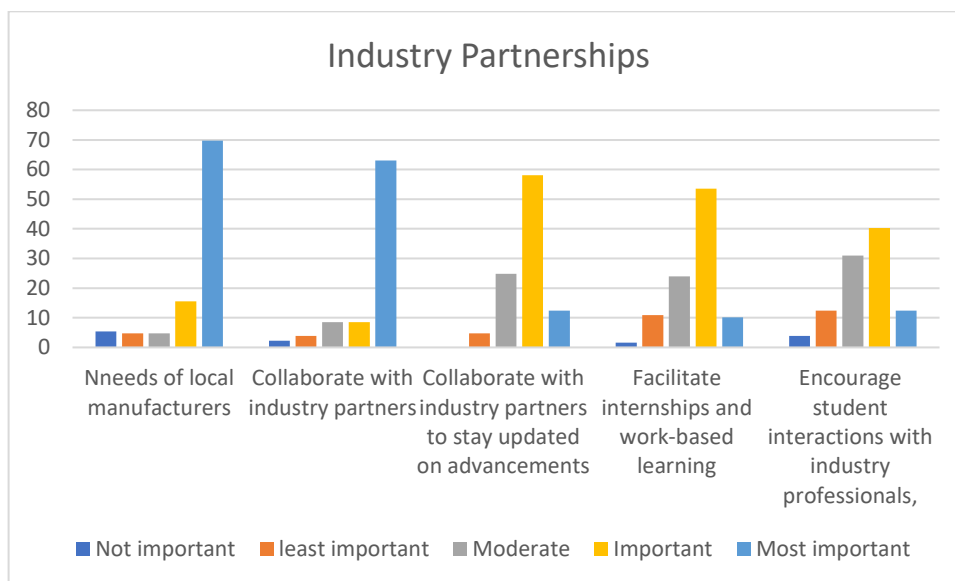
Figure 1-4 Respondents on Industry Partnerships Competency

Importance Of Design And Practice Project-Based Learning Competencies For Hsm Training

The ability to design and practice project-based learning for teachers provides great excitement for teaching and discovering, and students align themselves with real-world technology. The ability to design Project-Based Learning competency comprises four teachers' ability to practice in the HSM technology field.

The first question was on how the importance of the ability to design projects that incorporate high-speed machine concepts and technologies. According to the majority of respondents, 62.8% of teachers rated the most important ability to teach HSM technology. Additionally, 19.2% rated it important and 9.3% rated it less. This can be a sign that teachers should have the ability to design projects incorporated into HSM technology so that students get a deep understanding of the subject area and be competently demanded by the industry.

The second inquiry focused on the ability to support students in developing technical skills in the subject. Once more, the majority of respondents 45% responded it's the most important ability and 36.4% of the respondents rated supporting students' important ability. This suggests teachers capacitate this ability to support students to apply technical skills in projects and help to develop confident students in the subject.

The third question asked about the ability to differentiate project-based learning activities to meet the needs of diverse learners. A significant number of respondents 52.7% rated important ability and 14.7% rated it the most important ability for teachers. however, 22.5% rated moderate, and 9.3% rated less important. This suggests that teachers can differentiate project-based learning it helps to meet the needs of diverse learners. HSM technology teachers should incorporate this ability in the classroom to train and differentiate the understanding level of different students in the classroom.

The fourth query focused on the importance of the ability to effectively assess students. The majority of teachers responded by 51.9% important ability to assess students and 19.4% rated. This suggests a assessing quality ability helps to know the performance towards how to deliver learning to students and ensure they are well understand the subject. Finally, teachers update themselves to know different types of evaluation methods to assess students properly.

Overall, these competencies are vital for teachers, to improve their knowledge and skills in the subject matter, and prepare students with the skills needed for successful careers in the manufacturing sector. To address the issue-related problems teachers should undergo professional development training and align themselves with technology on how to design projects incorporated with the subject and consider the different understanding levels and how-to ass students effectively. By practicing these competencies, teachers can create effective and engaging learning experiences that allow students to succeed in their professional pursuits.
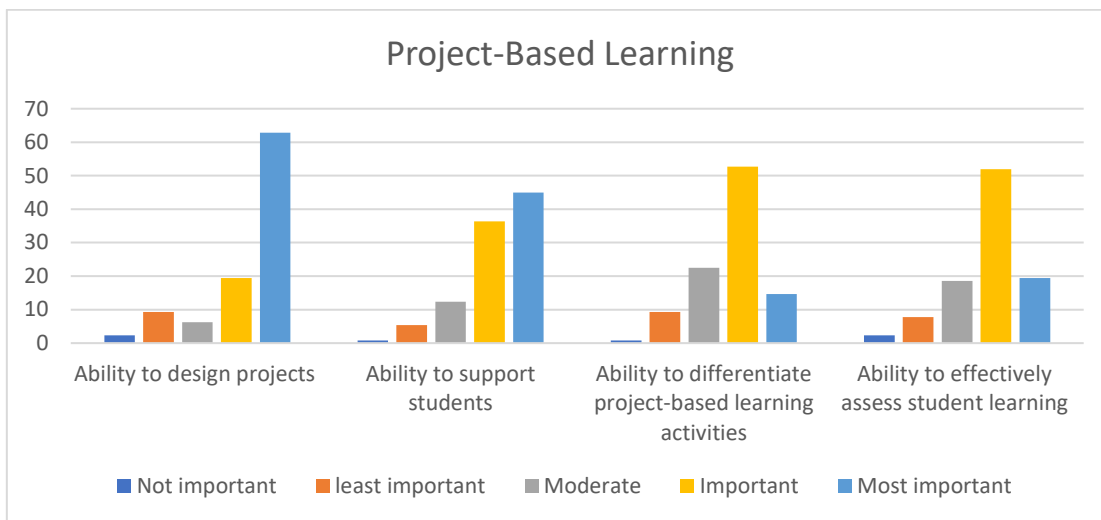
Figure 1-4 Respondents on Project-Based LearningCompetency

Importance Of Soft Skills Development Competencies For Hsm Training

Vocational teachers' competency development in Soft Skills became a crucial factor in improving the way of delivering teaching methods to students. Soft skills are an important skill for teachers and administrators during the 21st Century. The questionaries consist of four soft skills teachers should be focused on to improve their ability to become more effective in teaching the HSM technology field.

The question was on how the importance of the ability to encourage effective communication skills and technologies. The data reveals that 48.1% of respondents rated recognizing ability as the most important and 33.1% rated important ability for teachers. Similarly, 10.9% and 7% rated less important ability. This suggests that teachers' practice encourages communication skills is important for delivering lessons to students and can prepare students for future career communication.

According to the data survey, the significant respondents rated 51.2% important ability to support the development of teamwork skills, and 25.6% rated it as the most important. Whereas, 14.7% and 4.7% rated less important abilities for teachers. Teachers play a significant role in facilitating and providing guidance in teamwork when students participate in project work to foster the sharing of knowledge and skills among them.

The majority of teachers respond on critical thinking ability rated 61.1% as important for teachers and 17.1% rated the most important ability. Additionally, 26.4% of respondent's teachers rated it moderately important for teachers. This observation reveals promoting critical thinking ability should be an important skill for teachers. The teacher can promote critical thinking among the students to help for analyze complex problems, the teacher should promote critical thinking skills by designing projects.

In the ability to promote problem-solving skills, the survey data revealed that a significant number of respondents comprised important abilities 54.3%, and 18.6% rated as the most important. Teachers have good problem-solving skills and by incorporating real-world situations into the classroom, they push students to think outside the box and apply what they have learned to solve real-world problems they may face later.

Overall, the results indicate the importance of soft skill development TVET teacher to learn HSM technology, particularly in communication skills, teamwork, critical thinking and problem-solving skills. These skills are helps teachers to prepare well in subject area and delivery effectively the course. The teacher is qualified in this ability, they can support student in learning and enhance their success in the subject and future careers.
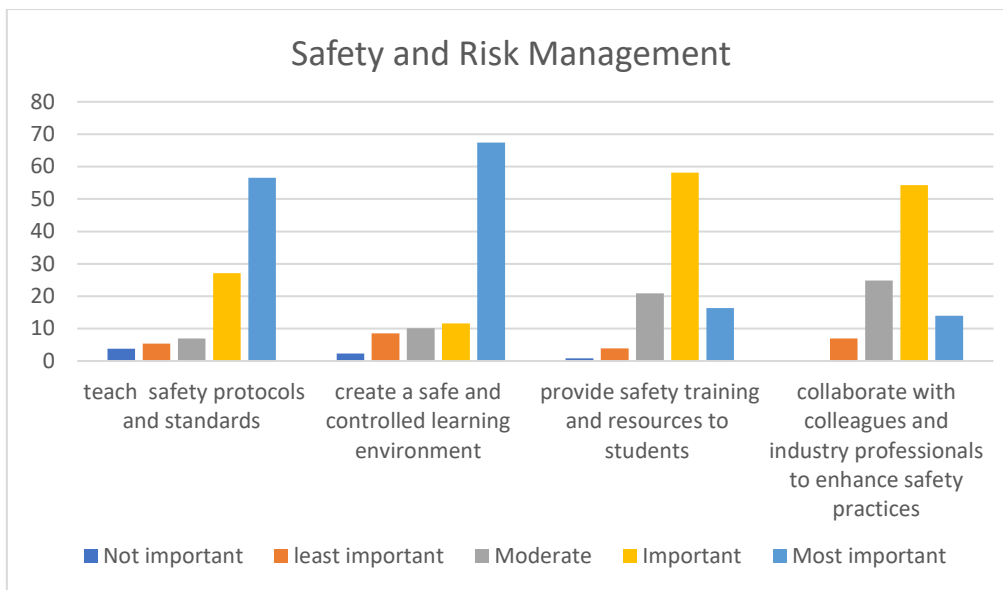
Figure 1-5 Respondents on Safety and Risk Management Competency

Importance Of Safety And Risk Management Competencies For Hsm Training

Vocational teachers are using multi-variety machinery use for training students. If not used properly this machine causes accidents and injury. Teachers should practice the ability of safety and risk management to ensure the safety of trainers and students and help to create a safe learning environment. By developing this competency, teachers can identify and minimize the hazardous situation in the training area.

The first question was on how the importance of the ability to teach safety and standards effectively to students is relevant to HSM technology, according to the results of respondents 56.6% rated this ability as the most crucial, while 27.1% deemed it important, and 7.0% considered it less so. This result reveals how teachers should have safety and related abilities related to the field and the significance of imparting knowledge to the students.

The second inquiry focused on the ability to create safe and controlled areas that are necessary for the classroom. the results indicate that 67.4% of respondents rated this ability as the most crucial, while 11.6% deemed it important, and 10.1% considered it less. This suggests working on creating a safe learning environment is an undebatable question for securing the safety of students.

The third question asked about the ability to provide appropriate safety training and resources for students regarding HSM technology. Findings show that 58.1% of respondents rated this as the important ability for teachers to create a safe learning environment, whereas 16.3% of respondents rated it as the most important, and 20.9% considered it less so. This suggests that teachers should be providing safety training and resources for students to ensure the training classes and workshops are free from accidents it enhances the safety knowledge of students and well prepares them for future careers.

The last question centered on the ability to work with colleagues and industry professionals help to enhance safety practice and risk management on HSM technology. The results show that 54.3% of respondents rated it as the important ability of teachers to enhance safety practice, while 14.0% deemed it the most important, and 24.8% considered it less. This suggests that teachers should collaborate with industry professionals to learn more about safety to practice in the classroom and students also gain broad knowledge and skills on industrial safety.

Overall, the results indicate the importance of soft skill development for TVET teachers to learn HSM technology, particularly in communication skills, teamwork, critical thinking, and problem-solving skills. These skills help teachers to prepare well in the subject area and deliver effectively the course. The teacher is qualified in this ability, they can support students in learning and enhance their success in the subject and future careers.

CONCLUSION

This study examined the core competencies required of teachers in high-speed machine (HSM) technology education. The study emphasized the importance of technical competencies such as reading diagrams, operating machinery, using design software, diagnosing software problems, and performing routine maintenance. These competencies are fundamental to providing students with a high-quality, competitive education. The study also highlights the critical role of digital literacy, and illustrates the need for teachers to effectively integrate technology into their teaching, prepare students for the digital age, and continually seek professional development opportunities in digital skills.

In addition to technological and digital competencies, the study highlights an important aspect of curriculum development: teachers need to be equipped to design an integrated curriculum that meets industry standards, enhances learners' knowledge and skills, and incorporates real-world learning experiences. A well-structured curriculum not only improves student achievement, but also ensures relevance to industry and prepares students for real-world challenges.

Moreover, the study shed light on the importance of fostering strong industry partnerships. Teachers should understand the needs of local manufacturers, collaborate closely with industry partners to develop relevant curriculum and training programs, stay updated on technological advancements, and facilitate internship opportunities. These partnerships bridge the gap between classroom learning and industry demands, providing students with invaluable real-world experiences and enhancing their employability.

In addition, soft skills development has become a major area of focus. Effective communication, teamwork, critical thinking, problem solving, safety and risk management are essential skills for instructors to teach HSM. These skills not only improve teaching methods, but also create a safe and conducive learning environment for students, contributing to their overall development and future success in manufacturing.

In conclusion, this research highlights the multifaceted competencies required for effective HSM education, including technical expertise, digital literacy, curriculum design, industry collaboration, soft skills development, and safety management. Instructors with these competencies can provide quality education that prepares students for the challenges of the digital age and manufacturing, and can contribute significantly to student success and career readiness.

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