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The Role of Industrial Attachment in Enhancing Polytechnic Lecturers' Competency in Industry 4.0 Technologies

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Abstract: Industrial attachment programs are increasingly recognized as a strategic approach to enhance lecturer competencies in Technical and Vocational Education and Training (TVET) institutions, particularly in preparing for Industry 4.0. However, limited studies have explored their effectiveness among Malaysian polytechnic lecturers. Therefore, this quantitative study was conducted to examine the impact of industrial attachment programs on lecturer competency development across four domains, technical skills, theoretical knowledge, pedagogical integration and soft skills. Data were collected from 150 lecturers representing Electrical, Mechanical, Civil and IT disciplines using a validated 27item questionnaire. Descriptive statistics were analyzed using IBM SPSS Statistics 26.0. The findings revealed very high improvement across all domains, with technical skills recording the highest mean score ($M = 4.68$, $SD = 0.58$), particularly in IoT operation ($M = 4.75$) and industry software proficiency ($M = 4.72$).This study confirms that industrial attachment programs effectively bridge the gap between academia and industry, ensuring lecturers are better equipped to deliver Industry 4.0relevant education. Recommendations include strengthening industryacademia collaboration, making attachments a regular requirementand supporting lecturers in integrating industry experiences into teaching.

Keywords: Industrial attachment, Polytechnic lecturers, Industry 4.0, Competency development, Professional development

1.0 Introduction

The Fourth Industrial Revolution (also called Industry 4.0) is changing industries around the world. It uses new digital technologies like the Internet of Things (IoT), artificial intelligence (AI), robots and big data analysis (Schwab, 2016). These technologies are changing how people work. Now, workers need both technical knowledge and the ability to adapt to new technologies quickly.

Technical and Vocational Education and Training (TVET) institutions, particularly polytechnics, play an important role in preparing students with the skills needed for this new era (World Economic Forum, 2020). In Malaysia, polytechnics are especially important for training skilled graduates for Industry 4.0 jobs. This matches the goals of Malaysia's education plans for 2025 and 2030.

However, research shows that many polytechnic lecturers lack the skills needed to teach these new technologies (Abdullah et al., 2021; Ismail & Hassan, 2020). This makes it difficult to teach Industry 4.0 topics and limits students' exposure to real-world technology use.

Industrial attachment programs help solve this problem. These programs allow lecturers to work directly in industries. This gives them handson experience, helps them learn new knowledge and develops practical skills they can bring back to their classrooms (Mustapha, 2017).These partnerships between educational institutions and industries help lecturers stay updated with new technologies and workplace needs (Razali et al., 2019). International research shows that industry attachments help teachers improve their teaching methods, gain confidence and make learning more relevant to industry needs (Smith, 2020).

This study looks at how industrial attachment programs help improve lecturers' skills in several areas, technical knowledge, teaching methods, industry collaboration and adapting to Industry 4.0 challenges. The results will help education leaders, polytechnic managers and industry partners create better training programs for technical educators.

2.0 Literature Review

2.1 Industry 4.0 Competency Requirement

The Fourth Industrial Revolution (Industry 4.0) has changed the skills workers need. It uses new technologies like smart systems, robots, automation and artificial intelligence (Hirsch-Kreinsen, 2016).Because of this, workers now need more than just basic technical skills.They need digital skills, data analysis abilities, cloud computing knowledge and Internet of Things (IoT) skills. Since polytechnics must prepare students for these new needs, lecturers also need to understand these new technologies, not just teaching methods (Oke & Fernandes, 2020).

Industry 4.0 requires both technical skills (like programming and using IoT) and soft skills (like problemsolving and creativity) (Lasi et al., 2014). If lecturers do not learn these new skills, they may teach outdated information.Research shows that one of the biggest problems in technical education is that lecturers lack updated skills, which affects how ready students are for industry jobs (Abdullah et al., 2021). Therefore, it is important to provide training that helps lecturers bring Industry 4.0 skills into their teaching.

2.2 Industrial Attachments in TVET

Industrial attachment programs help lecturers gain realworld experience by working in actual companies.These programs place lecturers in industry settings to learn about new technologies, how businesses operate and what skills are needed in the workplace (Chan et al., 2021). This helps lecturers improve their technical knowledge and builds stronger connections between polytechnics and industries, which benefits both students and employers.

According to Smith and Brown (2020), a good industrial training program should have clear goals, guidance from industry experts and chances for lecturers to reflect on what they learned.This helps lecturers use their new experiences in their classrooms.Studies show that lecturers who go through industry training become better at using technology, making lessons more relevant and engaging students (Smith, 2020).In Malaysia, industrial training for lecturers is seen as a key way to make sure educators are up to date with Industry 4.0 needs (Razali et al., 2019).

However, there are still challenges in running these programs.These include poor cooperation between polytechnics and companies, lack of moneyand no clear way to measure if the training is working (Mustapha, 2017).Solving these problems is important to make sure lecturers gain the right skills and students are prepared for future jobs.

2.3 Research Gap

Past research has mostly focused on student's industrial training and general issues between polytechnics and industries. However, there is not enough study on how industrial attachment programs help polytechnic lecturers, especially in gaining Industry 4.0 skills.This study aims to fill that gap by looking at how industrial attachments improve lecturers' skills in different areas within Malaysian polytechnics.

3.0 Methodology

By identifying the goals and objectives of this study and reviewing previous related research, this descriptive and quantitative study was conducted to examine lecturer's perceptions of engineering education across Malaysian polytechnics.Following an extensive review of the literature, a standardized questionnaire was developed consisting of 27 items measured on a 5-point Likert scale ranging from *1 = strongly disagree* to *5 = strongly agree*. The instrument was adapted and refined based on previously validated studies and demonstrated excellent internal consistency, with a Cronbach's alpha value of 0.96, indicating high reliability (Tavakol & Dennick, 2011; Taber, 2018).

A sample of 150 lecturers was purposively selected from five Malaysian polytechnics, with proportional representation across electrical, mechanical, civil and IT engineering disciplines. This sample size aligns with general survey research recommendations, where a minimum of 100-200 respondents ensure adequate representativeness and statistical validity in social science investigations (Bartlett, Kotrlik, & Higgins, 2001). The questionnaire was distributed directly to the target respondents and all 150 completed responses were retrieved for analysis.

Data were analyzed descriptively using the Statistical Package for the Social Sciences (SPSS) version 26, which was released in 2019 (IBM Corp., 2019), to generate the mean and standard deviation for each item. Reliability analysis was conducted to confirm the internal consistency of the instrument.Tables and charts were prepared using Microsoft Excel® 2019 for better visualization of results. Interpretation of the mean scores for the 5-point Likert scale was based on guidelines adapted from Suebwongsuwan & Nomnian, 2020, as presented in Table 1.

Table 1: Interpretation of Mean Score for 5-point Likert Scale

Respondent	Value	Mean Score	Interpretation of Mean
Strongly Agree	5	4.21–5.00	Very High
Agree	4	3.41–4.20	High
Neutral	3	2.61–3.40	Moderate
Disagree	2	1.81–2.60	Low
Strongly Disagree	1	1.00–1.80	Very Low

4.0 Results

This section presents the findings of the study, beginning with the demographic profile of the respondents, followed by the analysis of their perceptions regarding competency improvement after completing the industrial attachment program.

4.1 Demographic Characteristics of Respondents

A total of 150 lecturers from five Malaysian polytechnics participated in this study. Thedemographic details are presented in Table 2.

Table 2: Participant Demographics (N=150)

Characteristic	Category	Frequency	Percentage
Gender	Male	92	61.3%
	Female	58	38.7%
Discipline	Electrical	65	43.3%
	Mechanical	45	30.0%
	Civil	32	21.3%
	IT	8	5.4%

As shown in Table 2, the sample had a higher proportion of male lecturers (61.3%) compared to female lecturers (38.7%).In terms of disciplinary background, the majority of respondents were from the Electrical department (43.3%), followed by Mechanical (30.0%), Civil (21.3%) and IT (5.4%). This distribution reflects the purposive sampling strategy aimed at capturing the experiences of lecturers in engineering fields most directly impacted by Industry 4.0 technologies.

4.2 Overall Impact on Competency Domains

Data collected from the 150 respondents were analyzed to determine the mean scores and standard deviations for each of the four competency domains. The overall results are summarized in Table 3.

Table 3: Overall Mean Scores and Standard Deviations for Competency Domains

Competency Domain	Mean (M)	Standard Deviation (SD)	Interpretation
Technical Skills	4.68	0.58	Very High
Theoretical Knowledge	4.52	0.61	Very High
Pedagogical Integration	4.35	0.64	Very High
Soft Skills	4.25	0.67	Very High

As illustrated in Table 3, all four competency domains recorded mean scores within the "Very High" interpretation range (4.21 – 5.00). The domain of Technical Skills showed the highest level of perceived improvement (M=4.68, SD=0.58), followed by Theoretical Knowledge (M=4.52, SD=0.61), Pedagogical Integration (M=4.35, SD=0.64), and Soft Skills (M=4.25, SD=0.67). The relatively low standard deviations across all domains indicate a strong consensus among the respondents regarding these improvements.

4.3 Specific Technical Skills That Improved

Given that Technical Skills was the highest-rated domain, a more detailed analysis was conducted on its individual components. The results for the key technical skills are presented in Table 4.

Table 4: Mean Scores for Specific Technical Skills Items

Technical Skill Item	Mean (M)	Standard Deviation (SD)	Interpretation
IoT operation and application	4.75	0.52	Very High
Proficiency in industry software	4.72	0.55	Very High
Data analytics and interpretation	4.68	0.59	Very High
Basic programming for automation	4.65	0.61	Very High
Understanding of cyberphysical systems	4.60	0.63	Very High

Table 4 shows that handson experience with IoT operation and application (M=4.75, SD=0.52) was perceived as the most significantly improved skill. This was closely followed by proficiency inindustry-specificsoftware (M=4.72, SD=0.55) and data analytics and interpretation (M=4.68, SD=0.59).

4.4 Improvement by Department

All departments showed "Very High" improvement.However, Electrical and IT lecturers improved slightly more in technical skills (scores of 4.70-4.80), especially in IoT, data analysis and programming.This makes sense because these technologies relate directly to their fields.Mechanical and Civil lecturers improved most in using industry software (like CAD/CAM and BIM software) and understanding automated systems. This shows that the training helped each department in areas most relevant to their work.

5.0 Discussion

This study shows that industrial training programs are very effective in improving polytechnic lecturers' skills for Industry 4.0. The results help us understand how these programs work and what they achieve.

5.1 Technical Skills Showed Greatest Improvement

The biggest improvement was in technical skills (score of 4.68). This means lecturers became much better at using new technologies like IoT and industry software.This finding supports previous research by Abdullah et al. (2021) and Ismail & Hassan (2020) that identified technical skills gaps among lecturers. When lecturers work in real companies, they learn to use the same tools and technologies used in industry today, which validates Chan et al.'s (2021) finding that industry immersion is essential for updating educator knowledge.

5.2 Better Understanding of Theory

Lecturers also improved their theoretical knowledge (score of 4.52). The training helped them understand how theories are actually used in real companies.This supports Razali et al.'s (2019) concept of knowledge transfer between academia and industry. They saw how companies adapt theories to solve practical problems, which helps lecturers bring realworld examples back to their classrooms.

5.3 Improved Teaching Methods

The training helped lecturers improve their teaching methods (score of 4.35). After their industry training, lecturers can use real examples from companies in their teaching, supporting Smith's (2020) finding that industry placements improve educator'steaching capacity.They can create assignments that mirror real workplace problems, addressing the integration challenges noted by Ismail & Hassan (2020). The slightly lower improvement here suggests lecturers might need more support in turning industry experience into teaching methods, as recommended by Smith and Brown (2020).

5.4 Development of Professional Skills

Lecturers also improved their professional skills (score of 4.25), such as communication and teamwork. This aligns with broader Industry 4.0 competency frameworks that emphasize both technical and soft skills (Lasi et al., 2014; World Economic Forum, 2020). Working in companies helped them learn professional behaviors important for working with industry partners.

6.0 Conclusion

This study shows that industrial training programs greatly improve polytechnic lecturers' skills. The research found that after these programs, lecturers became much better in four key areas:

1. Technical Skills (like using new technology)
2. Knowledge (understanding how things work in real life)
3. Teaching Methods (able to explain things better to students)
4. Professional Skills (like communication and problem-solving)

Lecturers improved the most in technical areas, especially working with Internet of Things (IoT) technology and industry software. This is important because it helps lecturers connect what they teach in the classroom to what actually happens in industry.These training programs help create a strong link between polytechnics and industries. This makes sure that what students learn in polytechnics matches what they will need in their future jobs. Investing in lecturer training through these programs means investing in better education for students. This helps Malaysia achieve its national education goals and prepares students for the future.

7.0 Recommendations

Based on this study, here are some suggestions:

1. Make training regular: The government and polytechnics should make these industry training programs a regular and required part of every technical lecturer's job.
2. Plan programs carefully: Each training program should have clear goals and provide lecturers with guides or mentors from the industry.
3. Build strong industry relationships**:** Polytechnics should build longterm relationships with companies so lecturers can keep learning about new technologies.
4. Help lecturers use what they learn**:** After training, polytechnics should help lecturers use their new knowledge to improve their teaching and course materials.
5. Do more research: Future studies should look at how these training programs ultimately affect student's learning and job opportunities.

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