Motivational Factors for Students to Learn a TVET Subject using the Learning Factory (LF) Facility

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Abstract
Purpose: The purpose of this research is to discuss the learning experience of students using the learning factory (LF) facility to learn a TVET subject at Universiti Malaysia Pahang, Al-Sultan Abdullah. Two research objectives were established in the research. Firstly, to measure the level of students' motivation in using LF facilities. Secondly, to identify to what extent factors such as practical engagement for hands-on experience (PEH), Self-directed learning (SDL), and soft skill development (SSD) drive students' motivation in using LF facilities to learn a TVET subject.
Design/methodology/approach: A quantitative research cross-sectional methodology through an online survey was adopted. Questionnaires were sent to 70 undergraduate students who had completed their course in Lean Manufacturing, a TVET subject, during the semester 1 session 2022/2023 at Universiti Malaysia Pahang. However, only 60 students have responded to the survey, giving an 85.7% response rate.
Findings: This study has found several motivating factors for students to utilize the learning factory facility, such as the ability to engage in hands-on learning experience, the ability to be involved in self-directed learning and the ability to develop soft skills competencies.
Research limitations/implications: This study was limited to one small group of students in semester 1, 2022/2023.
Practical implications: This study can be used to assist higher education institutions (HEIs) in developing the needed competencies required by the industry.
Originality/value: This empirical study evaluated the motivation level of students in using the learning factory facility to teach a TVET subject to undergraduate students.

Keywords: Lean Manufacturing, Learning Factory, Hands-on, Motivation, Quantitative

Introduction

Manufacturing firms in Malaysia are facing competitive market conditions resulting from the effects of globalization. The market for products is becoming complex as it is characterized by an increase in digitalization, advanced manufacturing technology, an increase in customized products, and shorter product life cycles. Such challenging market conditions require a highly competent workforce to work in the industry. Therefore, future engineers should acquire such competencies and hands-on working experience to meet new market demand (Mourtzis et al., 2020).

One possible way to train young and new engineers to meet industry expectations is by using the learning factory (LF) concept at higher education institutions (HEIs). LF concept focuses on bringing an industry work environment to the classroom, enabling the transfer of hidden technical and soft skill capabilities to the learners. Furthermore, the LF concept blends both the transdisciplinary hands-on engineering concepts with actual operation management systems based on actual industrial machines and production settings (Maarof & Bohari, 2023). This allows students to turn abstract ideas into practical learning through assimilation and adaptation processes.

Based on the Sustainable Development Goals (SDGs), HEIs play an important role in promoting independent thinking among their learners. HEIs ought to prepare students to face global technological and economic challenges before they graduate. However, lack of technical expertise and poor human capital development are among the shortcomings often found among young university graduates (Sadaj et al., 2021). It was also found that in most Asian countries, including Malaysia, only 15% to 20% of their educational content is relevant to the industry (Jing et al., 2023). Such non-harmonized relations have had a significant impact on the inefficient development of locally skilled workers in a variety of TVET areas (Jamaludin et al., 2023). Formal, non-formal, and informal learning are all part of technical and vocational education and training (TVET), which equips young people with the information and abilities needed in the workforce. Therefore, an urgent improvement is needed to change the delivery method used to train young university graduates in the TVET subjects to meet the IR4.0 challenges (Mat Jam & Puteh, 2020).

The purpose of this research is to discuss the learning experience of students using the learning factory (LF) facility to learn a TVET subject at Universiti Malaysia Pahang, Al-Sultan Abdullah. The following two research objectives have been established for this research. Firstly, to identify the level of students' motivation in using LF facilities. Secondly, to measure to what extent factors such as practical engagement for hands-on experience (PEH), Self-directed learning (SDL), and soft skill development (SSD) drive students' motivation in using LF facilities to learn a TVET subject.

Literature Review

1.1 Learning Factory Concepts in Universiti Malaysia Pahang Al-Sultan Abdullah

Learning Factories have genuine, hands-on reproductions of actual production processes and value chains, thus allowing participants to learn via experience (Lindvig & Mathiasen, 2020). This concept offers a viable strategy for competency development by establishing an environment where simulated cases are customized to reflect actual business concerns. In such cases, learning factory concepts is often used for training, education, and research. Furthermore, past research works have also found various effects of the learning factory concept in improving new graduates' employability skills, such as technical knowledge, interpersonal skills, communication, and management abilities (Maarof, 2020).

The learning factory concept developed at the Universiti Malaysia Pahang Al-Sultan Abdullah consists of several supply chain management elements such as a small fabrication workshop, a manually operated assembly line, an inspection process, packaging, and warehousing. It functions to resemble what is often found in a small electrical and electronic manufacturing company's supply chain process. Most of the process structure employs a reconfigurable, adaptable, and flexible production system.

Students were allowed to use the learning factory during lab hours and after lab hours with the supervision of a lab assistant. However, before the lab session, the students will be attending a series of class lectures in the normal classroom setting. Assignments were given to the students, and they need to produce their project based on the assignment given in the learning factory. Students were divided into smaller groups, with five to six students in each group. This small group is to enable students the chance to experience working on the task given to them to solve in the learning factory. The assignments given to the students were tailored in line with the subject syllabus and modules. The students are expected to apply what they have learnt in class to solve significant business challenges that are similar to what is being practiced in the industry. At the end of each module, the students are expected to present their group projects to their lecturer. All of these activities were done in the learning factory, which acts as a platform for technological experimentation. Figure 1 shows the teaching framework that was used in the learning factory. Figure 2 shows photos of the learning factory.

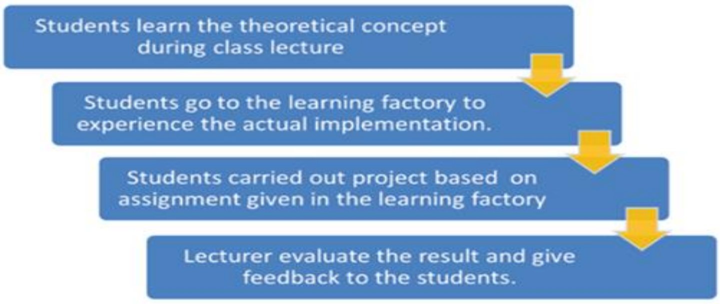

Figure 1: Learning Factory Teaching Framework

Figure 2: Learning Factory Facilities

1.2 Concept of motivation and learning motivation

Motivation describes the reasons behind an individual's actions and drives people to act the way they do in a specific way. It involves factors that direct and sustain actions. Often acts as an incentive for people to pursue in setting a goal and achieve it. Numerous theories were introduced to explain how motivation arises in humans, either extrinsic or intrinsic.

Extrinsic motivation is when a person is motivated by a goal rather than by the enjoyment of the activity. Extrinsic motivation is often driven by external rewards, tangible or intangible rewards, that serve as a force that drives positive behavior (Hattie et al., 2020). However, offering rewards can increase motivation in certain situations but not for long-term motivation

(Tranquillo & Stecker, 2016). If rewards are not enhanced over time, a saturation point, also known as the over justification effect, will be reached, and their effectiveness will deteriorate. Intrinsic motivation refers to the desire to do something because it is fascinating, pleasurable, or natural without the prospect of getting any obvious external rewards. Often it is viewed as the most powerful form of motivation to support human learning, resulting in increased engagement and achievement (Toste et al., 2020). Unfortunately, some traditional teaching methods are perceived as being dull and boring, making the students feel that they are forced to participate in educational activities (Xie, 2021).

When people can take the initiative, believe that their work matters, and experience a sense of accomplishment from improving their abilities, they are intrinsically motivated. Five factors that can increase intrinsic motivation are challenge, control, cooperation and competition, curiosity, and recognition (Malone & Lepper, 1987). In this case, intrinsic motivation can be garnered through the self-determination theory (SDT). This theory stipulates that two assumptions can be made. First, the need for growth drives behavior and people are actively working towards their development. The second autonomous motivation is that the internal sources of motivation, such as the need to gain knowledge or independence, drive the intrinsic motivation.

The hierarchy of motivation in learning consists of three constructs: goal orientation, beliefs, and disposition (Conradi et al., 2014). Goal orientation refers to an individual's habitual approaches toward learning and the intentions they set related to their reading actions, which also include performance and mastery goals. Beliefs refer both to beliefs about self, an individual's perceptions and judgments related to their competence, abilities, and capacity. Finally, disposition refers to an individual's feelings about their positive orientation toward learning about a particular topic, such as attitudes and interests. Despite the importance of motivation in understanding the learning process, current research that looks into a comprehensive study on learning motivation is still lacking (Toste et al., 2020). This is particularly important as motivation has been agreed by some researchers to have a multidimensional (Hattie et al., 2020).

Theoretical Framework

To fulfil the objective of this study, which is to measure the level of students' motivation in using LF facilities, the following conceptual framework was proposed as shown in Figure 3. Three constructs were chosen in this study: practical engagement for hands-on experience, self-directed learning, and soft skill development. These factors were chosen about the hierarchy of motivation in learning, which consists of consists of three constructs: goal orientation, beliefs, and disposition (Conradi et al., 2014).

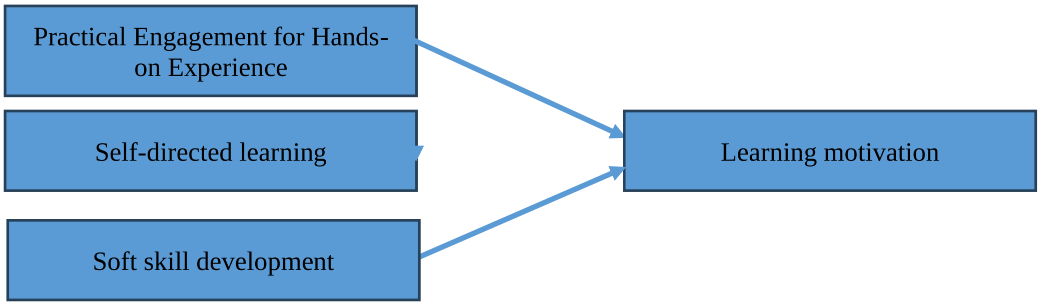

Figure 3: Research Framework

Hands-on experience allows students and professionals to convert theoretical information into practical skills that can ensure proficiency and confidence in real-life situations. Self-directed learning is an instructional strategy where the students, with guidance from the teacher, decide what and how they will learn. Soft skills refer to the personal qualities and social abilities that define an individual's capacity for productive communication with others. Soft skills are seen as an addition to hard skills in the workplace, which include an individual's knowledge and professional abilities.

Methodology

This study adopted a quantitative cross-sectional study approach using survey methodology to gather data. Questionnaires were sent using an online survey to 70 undergraduate students who have completed their course in Lean Manufacturing subject, a TVET subject, during the semester 1 session 2022/2023 at Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA). Out of 70 students, 60 students have responded to the survey giving an 85.7% response rate. Also, a measurement tool was developed to measure the motivation factors for students to utilize the learning factory to learn a TVET subject. These measurements were created by adopting or adapting from the past literature on learning factories and learning methodology. The self-reported questionnaire contains closed questions that were sent to the respondents through an online survey. All the respondents' answers were recorded using a 5-point Likert scale. Table 1 describes the questions used for the measurement items.

Table 1: Measurement Items

CONSTRUCTS	CODE	MEASUREMENT ITEMS
Practical Engagement for Hands-on Experience	PEH1	Learning Factory usage has enabled me to apply theoretical knowledge to solve real industry problems.
	PEH2	Learning Factory usage has enabled me to do role play of what is expected in the industry.
	PEH3	Learning Factory usage has opened a chance for me to practice solving problems in an industry context.
	PEH4	Learning Factory usage has allowed me to link what I have learned in class lectures with practical usage.
	PEH5	Learning Factory usage has allowed me to practice the skills that I've already learned during class lectures.
	PEH6	Learning Factory usage has allowed me to experience something "real" about the industry.
	PEH7	Learning Factory activities give me more opportunities to exercise my creative skills.
Self-directed learning	SDL1	Learning Factory usage has helped to develop continual improvement or a Kaizen mindset in me.
	SDL2	Learning Factory usage has helped to stimulate my interest in learning new things.
	SDL3	Learning Factory usage has helped to create the desire to learn a TVET subject.
	SDL4	Learning Factory usage has initiated an interest in me to conduct learning in my environment.
	SDL5	Learning Factory usage helps me to repeat and practise the lessons that I have learned during classroom lectures by myself.
	SDL6	Learning Factory activities give opportunities to actively create knowledge.

CONSTRUCTS	CODE	MEASUREMENT ITEMS
	SDL7	Learning Factory activities enable me to explore more of what I have learned during the class lecture.
Soft skill development	SSD1	Activities conducted in the Learning Factory have helped me to strengthen my teamwork skills.
	SSD2	Activities conducted in the Learning Factory have helped me to enhance my problem-solving skills.
	SSD3	Activities in the Learning Factory have facilitated my practice of critical thinking.
	SSD4	Activities in the Learning Factory have helped me manage time better.
	SSD5	Activities in the Learning Factory have helped me develop better communication skills.
	SSD6	Activities in the Learning Factory have helped to improve my negotiation skills
	SSD7	Activities in the Learning Factory helped to sharpen my leadership skills
Learning motivation	LM1	I feel excited to learn the TVET subject when using the Learning Factory facility.
	LM2	I am eager to learn new knowledge when I do the activity in the Learning Factory.
	LM3	I always feel happy to take part in the activities conducted in the Learning Factory.
	LM4	I feel excited to attend the session conducted in the Learning Factory
	LM5	I often say good things about the Learning Factory to my team members
	LM6	I always look forward to attending sessions conducted in the Learning Factory
	LM7	I am eager to work above and beyond what is expected to complete the activities in the Learning Factory

60 students out of 70 students have responded to the survey resulting in an 85.7 percent response rate. Results were then analyzed and summarized using SPSS software to investigate students' opinions as to what motivated them to learn using the learning factory facility.

Results and Discussion

Results show that 44 (73.3%) of the respondents are female, whereas 16 (26.7%) are male. Figure 4 shows the frequency distribution of the gender among the participants.

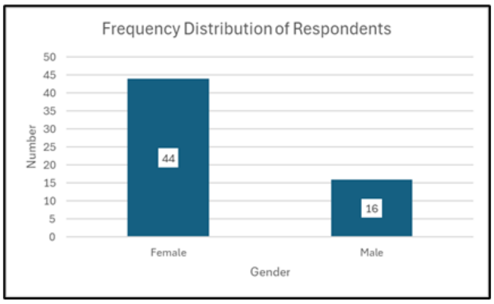

Figure 4: Frequency distribution of the participants

All the respondents have reported having the experience of working in some activities in the learning factory. Distribution of the questionnaires was done at the end of the semester to allow the students to experience one full cycle of the learning factory experience. The survey form requires the students to give their responses before they can move to the next question to reduce the risk of incomplete responses. The descriptive statistics of the variables involved in this study are explained in Table 2. It is important to conduct such a statistical analysis to judge the general state of learning factory concept implementation at the Universiti Malaysia Pahang Al-Sultan Abdullah in Malaysia. Furthermore, this study is concerned with the factors that could influence the motivation level among undergraduate students at UMPSA to take a TVET subject using a learning factory facility.

Table 2: Descriptive statistics of the variable involved

Construct	Size N	Min	Max	Mean	Mean Average	Standard deviation	Excess kurtosis	Skewness
PEH1	60	3	5	4.40		0.718	-0.774	-0.657
PEH2	60	2	5	4.35		0.777	-0.933	0.074
PEH3	60	2	5	4.28		0.715	-0.768	0.443
PEH4	60	2	5	4.27	4.331	0.800	-0.731	-0.391
PEH5	60	2	5	4.32		0.770	-0.850	0.011
PEH6	60	1	5	4.32		0.854	-1.346	2.321
PEH7	60	3	5	4.38		0.691	-0.679	-0.653
SDL1	60	3	5	4.27		0.756	-0.492	-1.079
SDL2	60	1	5	4.40		0.764	-1.777	5.321
SDL3	60	2	5	4.07		0.880	-0.287	-1.293
SDL4	60	3	5	4.18	4.269	0.770	-0.331	-1.227
SDL5	60	2	5	4.32		0.748	-0.849	0.215
SDL6	60	2	5	4.23		0.767	-0.663	-0.213
SDL7	60	3	5	4.42		0.696	-0.784	-0.558
SSD1	60	2	5	4.38		0.804	-1.020	-0.001
SSD2	60	3	5	4.32		0.725	-0.569	-0.887
SSD3	60	3	5	4.38		0.691	-0.679	-0.653
SSD4	60	2	5	4.28	4.321	0.804	-0.769	-0.377
SSD5	60	3	5	4.37		0.758	-0.735	-0.869
SSD6	60	3	5	4.32		0.725	-0.569	-0.887
SSD7	60	1	5	4.20		0.819	-1.156	2.397
LM1	60	2	5	4.23		0.745	-0.665	-0.003
LM2	60	3	5	4.38		0.666	-0.622	-0.614
LM3	60	2	5	4.33		0.774	-0.891	0.038
LM4	60	2	5	4.40	4.343	0.669	-1.026	1.448
LM5	60	2	5	4.35		0.732	-0.928	0.490
LM6	60	3	5	4.40		0.694	-0.731	-0.610
LM7	60	2	5	4.30		0.766	-0.811	-0.008

To interpret and explain the descriptive statistics in Table 2, each column is broken down to discuss the insights they provide for the constructs listed as PEH, SDL, SSD and LM. The second column, size, shows the number of respondents for each item (N=60 for all items). It indicates the sample size used to calculate the descriptive statistics. The third and fourth columns, min and max, indicate the range of responses for each item, showing the lowest (Min) and highest (Max) values. The fifth column relates to the mean, which represents the average score for each item. Higher mean values suggest that respondents, on average, rated the item more favorably. The sixth column, the average mean, represents the average means for each construct. The seventh column, standard deviation (SD), shows the variability or dispersion of responses. Lower SD values indicate that responses are closer to the mean, while higher values suggest more variability. For example, SDL3 has an SD of 0.880, indicating relatively higher variability compared to SDL7 with an SD of 0.696. The eighth column, excess kurtosis, measures the “tailedness” of the distribution. Positive values indicate heavier tails (more outliers), while negative values indicate lighter tails (fewer outliers). For instance, SDL2 has a kurtosis of -1.777, showing a lighter tail distribution, whereas SSD7 has a kurtosis of 2.397, showing a heavier tail distribution. The last column, skewness, measures the asymmetry of the distribution. Positive skewness signifies a distribution with a longer right tail, while negative skewness signifies a longer left tail. For example, PEH6 has a skewness of 2.321, indicating a positive skew, meaning more responses are clustered on the lower end. On the other hand, SDL4 has a skewness of -1.227, indicating a negative skew with more responses clustered on the higher end.

A set of five endpoints Likert scale descriptors was used in this study. The minimum value for Practical Engagement for Hands-on Experience (PEH) is 1, whereas the maximum value is 5. The minimum value for self-directed learning (SDL) is 1, and the maximum value is 5. The minimum value for soft skill development (SSD) is 1, whereas the maximum value is also 5. For the learning motivation, the minimum value is 2 and the maximum value is 5.

The following descriptive results were also derived from this research. PEH items have the following observation. The mean values for PEH items are relatively high (ranging from 4.27 to 4.40), indicating that respondents generally find practical engagement to be favorable. The standard deviations are moderate, showing some variability in responses. Notably, PEH6 has a high skewness (2.321), indicating a significant number of lower ratings compared to the mean. SDL items also have relatively high mean values (ranging from 4.07 to 4.42), suggesting positive responses towards self-directed learning. SDL3 shows the highest standard deviation (0.880), indicating more variability. The skewness values are mostly negative, except for SDL2 (5.321), indicating a substantial number of high ratings for SDL2.

The mean values for SSD items are consistently high (ranging from 4.20 to 4.38), suggesting that respondents perceive their soft skill development positively. The standard deviations are moderate, indicating some variability. SSD7 has a positive skewness (2.397), suggesting more lower-end ratings. Learning Motivation (LM) items have mean values ranging from 4.23 to 4.40, indicating a generally high level of motivation among respondents. The standard deviations are relatively low to moderate, showing less variability in responses. The skewness values are close to zero, indicating a relatively symmetrical distribution of responses.

Conclusion and Recommendations

Motivation continues to be one of the most researched ideas in academia today, with an array of hypotheses and substantial empirical research to support them all. Overall, the descriptive statistics suggest that respondents have a positive perception of their practical engagement, self-directed learning, and soft skill development, which contribute to learning motivation in using a learning factory facility to learn a TVET subject. This is based on the result, which indicates that all three contributing factors display a high mean value towards motivation to learn a TVET subject using a learning factory facility. A mean value between 3.68 to 5.00 is considered high for a 5-Likert scale survey (Darusalam & Hussin, 2018). Thus, the use of the Learning Factories facility possesses the ability to transform the processes of teaching-learning, particularly in motivating students to learn a TVET subject. LF concept offers learners a platform to discover their hidden and inner potential through practical hands-on experience.

However, this study carries some limitations. This study was limited to one small group of students using the learning factory during semester 1, 2022/2023. Future studies should be extended to investigate the relationship between the independent variables (PEH, SSD and SDL) with the dependent variables, which is the learning motivation using a learning factory facility (LM). Such a study can help to "explain" and predict more about an individual's motivations to learn. It is also observed that the use of the learning factory facility can motivate students to take the TVET courses. This is important to help the industry overcome the shortage of skilled and experienced workers in the manufacturing industry. Findings from this study can be used to assist higher education institutions (HEIs) in developing the needed competencies required by the industry. The study evaluated the motivation level of students in using the learning factory facility to teach a TVET subject to undergraduate students by analyzing questionnaire responses. Various factors were identified to contribute to the student's learning motivation. However, there are other measures of learning factory motivating factors which are beyond this study. Furthermore, there are variations in the distributions, with some items showing more variability or skewness than others. Understanding these statistics helps in identifying areas where perceptions are highly favorable and where there might be room for improvement or further investigation. Therefore, it is anticipated that further research will be needed to close those gaps.

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