Co-funded by the Erasmus+ Programme of the European Union

Building Skills 4.0 through University and Enterprise Collaboration

SHYFTE 4.0

WP2: Implementation of SHYFTE framework for training and learning

D2.4: Pilot in domain 4

Artificial Intelligence

vs:1.0.0

Deliverable Lead and Editor: Sharifah K. Syed Yusof, UTM

Contributing Partners: Universiti Teknologi Malaysia, All

Date: 2022-09

Dissemination: Confidential

Status: <~~Draft~~ ¦ Consortium Approved ¦ ~~EU Approved~~>

The objectives of this deliverable are to describe:
- the learning materials
- the Training of trainers (ToT)
- the evaluation of the quality of the learning material and training
- the Training of students (ToS)
- the mitigation actions due to Covid 19.

Project Ref: 598649-EPP-1-2018-1-FR-EPPKA2-CBHE-JP
Grant Agreement:
2018 - 3316 / 001 - 001

Co-funded by the Erasmus+ Programme of the European Union

Document Status

Deliverable Lead	Sharifah Kamilah SYED YUSOF, UTM
Internal Reviewer 1	Zhang Haiqing, CUIT
Internal Reviewer 2	Aicha Sekhari, ULL
Type	Deliverable
Work Package	WP2: Implementation of SHYFTE framework for training and learning
ID	D2.4: Pilot in domain 4 Artificial Intelligence
Due Date	2022-09
Delivery Date	2022-09
Status	<~~Draft ¦~~ Consortium Approved ~~¦ EU Approved>~~

Status

This deliverable is subject to final acceptance by the EACEA.

Further Information

http://www.shyfte.eu/

Disclaimer

Project Partners:

Table of Contents

Contents

1. Executive Summary

This document describes the implementation of the SHYFTE Framework for Training and Learning pilot project in UTM Malaysia. The aims of the is pilot to significantly improve the quality of “Artificial Intelligence” courses through the use of the new skills required by the companies for the industry of the future. Based on the skills 4.0 framework and the teaching and learning materials defined in the WP1, the objectives of this deliverable are to describe:

- the learning materials
- the training of trainers (ToT)
- the evaluation of the quality of the learning material and training
- the training of students (ToS)
- the mitigation actions due to Covid 19
- the summary achievement (See Table of Achievement WP2 UTM as attached)

All the modules in the AI domain are newly developed. There are 13 new modules in the domain framework. The learning materials for 12 are formed and developed except for the Reinforcement Learning module where the trainer is to be identified. Each module has been reviewed by one (1) Internal coming from local Institution of Higher Learning (IHL) and one (1) external from local industry.

The purpose of the ToT session is to guide the potential trainers of the particular module regarding the module learning outcomes, teaching and learning activities and assessment methods. For the ToTs, the trainers have been identified based on their expertise, experience, and research area. The trainers have conducted the ToTs to 53 potential trainers. The selection of potential trainers is based on their interests on the respective domain and module specifically. During the ToT, 4 researchers from UPM, 3 researchers from CMU and 1 researcher from KU attended the sessions. The partners from China could not participate due to the COVID situation in their country. In ToT 79% of attendees responded to the questionnaires. From the feedback received from the attendees, they strongly agreed that the trainers provided suitable learning materials and used learning methods that stimulate interest

in the specific topics. Majority of the respondents also agreed that they are comfortable to be one of the trainers upon attending the sessions.

For ToS, there are 50 students and 2 from industry attended the sessions. 73% of them responded to the training survey. At least 83% participants strongly agree that every performance measure was achieved. Nevertheless, some continuous quality improvement plans include appropriate training scheduling plan, more hands-on activities and increase training duration. Upon completion of the ToTs and ToS, attendees were provided with Certificates of Appreciation.

The summary of the proposed key performance indicators (KPI) as compared to the achieved KPI for Domain 4 is shown in the Table 1.1.

Table 1.1: Summary of achievement for domain AI

NO.	PROPOSED KPI	ACHIEVED KPI	
1	At least 6 modules	12 modules developed	
2	Modules reviewed by internal and external reviewer	Yes	
3	Trained 5 -10 trainers per country	19 (ToT1) 34 (ToT2)	
4	1 staff trained per partner	UTM – 42 UPM – 4	KU – 1 CMU – 3
5	5 questionnaires per ToT	31 overall responses for ToT	
6	1 improvement plan from the questionnaires	1 overall plan	
7	100 -120 students trained per country	50 students trained (UTM)	
8	5 – 10 trained from companies	5 trained from companies (3 from ToT, 2 from ToS)	
9	70% of trainer (TOT) responded the questionnaires	79% (42 out of 53 trainers responded)	
10	70% of students (TOS) responded to the questionnaires	73% (38 out of 52 students responded)	

Although the ToTs and ToS were scheduled to be in July 2020, the sessions were delayed due to the COVID situation. The equipment could not arrive on time especially the GPU equipment because of global shortage in supplies. Furthermore, Financial Department of our institutions were closed and the needs for hardcopy documentation for procurements exacerbated the situation. During the pandemic, all teaching and learning activities especially lectures and laboratory sessions were put on hold. Hence, the ToTs were conducted online instead and divided into two (2) sessions. The first session is theoretical in nature, whilst the second session involves more hands-on, and the use of equipment purchased from SHYFTE equipment cost.

2. Domain 4: Artificial Intelligence (AI)

The Malaysia 4IR Policy, aligned with the National Policy on Science, Technology, and Innovation (DSTIN) 2021-2030, aims to develop Malaysia as a high-tech nation by 2030. Adopting 4IR in Malaysia has certainly implicated the learning, training, and development roles. These roles are becoming more significant and challenging in the effort to yield knowledgeable and highly skilled human resources. Erasmus+ SHYFTE4.0 definitely meets the goals mentioned. Under deliverable D1.2-D1.3, 4IR knowledge assessment was conducted.

The main purpose of the survey is to evaluate the 4IR skills in the current job employer and future HEI graduates, hence, addressing the needs for Industry 4.0 revolution in the future undertakings. There are a total of 29 questions constructed by the SHYFTE team. 95 Malaysia national and multinational companies participated in the UTM assessment survey.

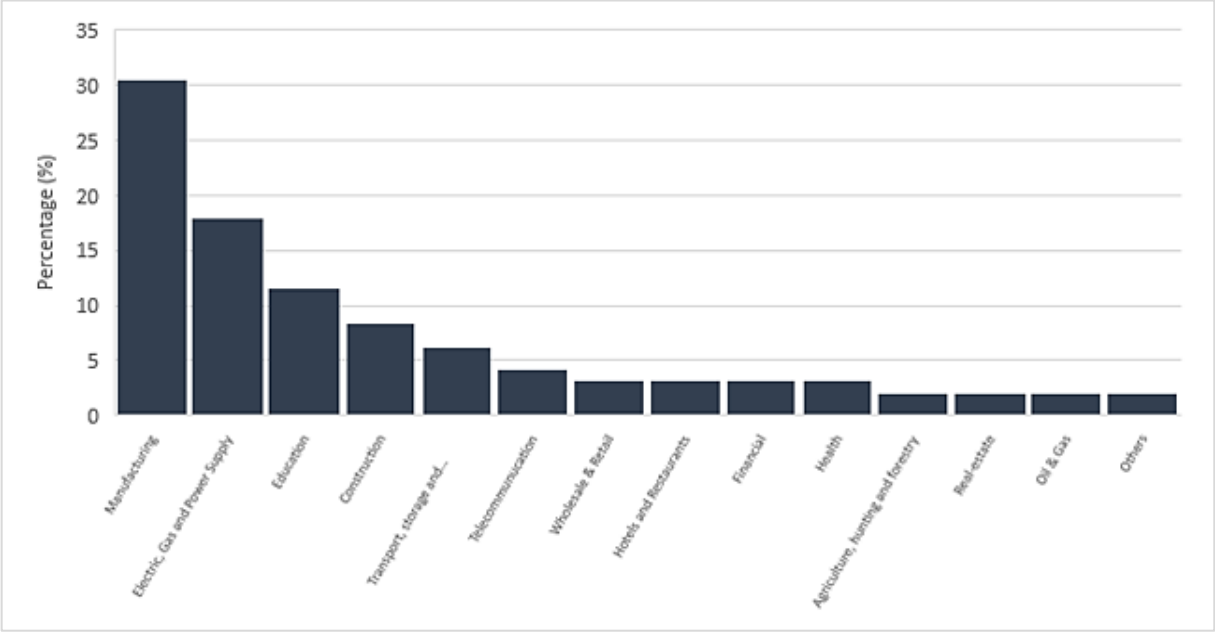


Figure 2.1: Categories of companies involved in assessment survey

It was found that 18.9 % of the companies have not heard of the term Industry 4.0 and about 12% have no to low vision for digital transformation. In relation to the AI domain, the adoption of AI to the industry is low. Over 46.5% respondents do not use AI algorithms or

foresee no use for it. Industries agree that IR4.0 can be implemented hence allowing the SME to be more competitive and agile. Therefore, from the gap analysis carried out, proper actions must be taken in addressing the needs of the 4IR through its academic programme, curricular transformation, and training needs. In alignment to SHYFTE4.0, UTM has taken initiatives and moving forward in establishing SHYFTE objective. (www.utm.my/shyfte/)

2.1 Domain 4: Skill Sets

From the IR4.0 knowledge assessment survey gap analysis, the fundamental needs of AI knowledge and skills in the future Malaysia workforce is essential. Through discussions with industries, three important skill sets (SkS) have been identified as follows:

SkS-D4-1: Machine Learning

SkS-D4-2: Optimization

SkS-D4-3: AI Application

In collaboration with UTM Associate Partner, Centre for Artificial Intelligence and Robotics (CAIRO), thirteen new suitable and related modules are proposed for the skill sets. In ensuring constructive knowledge and skills development in the domain, three competency levels are formed: Beginner, Intermediate and Expert level. From the skills set and competency level, the overall AI domain training framework is shown in Figure 2.2.

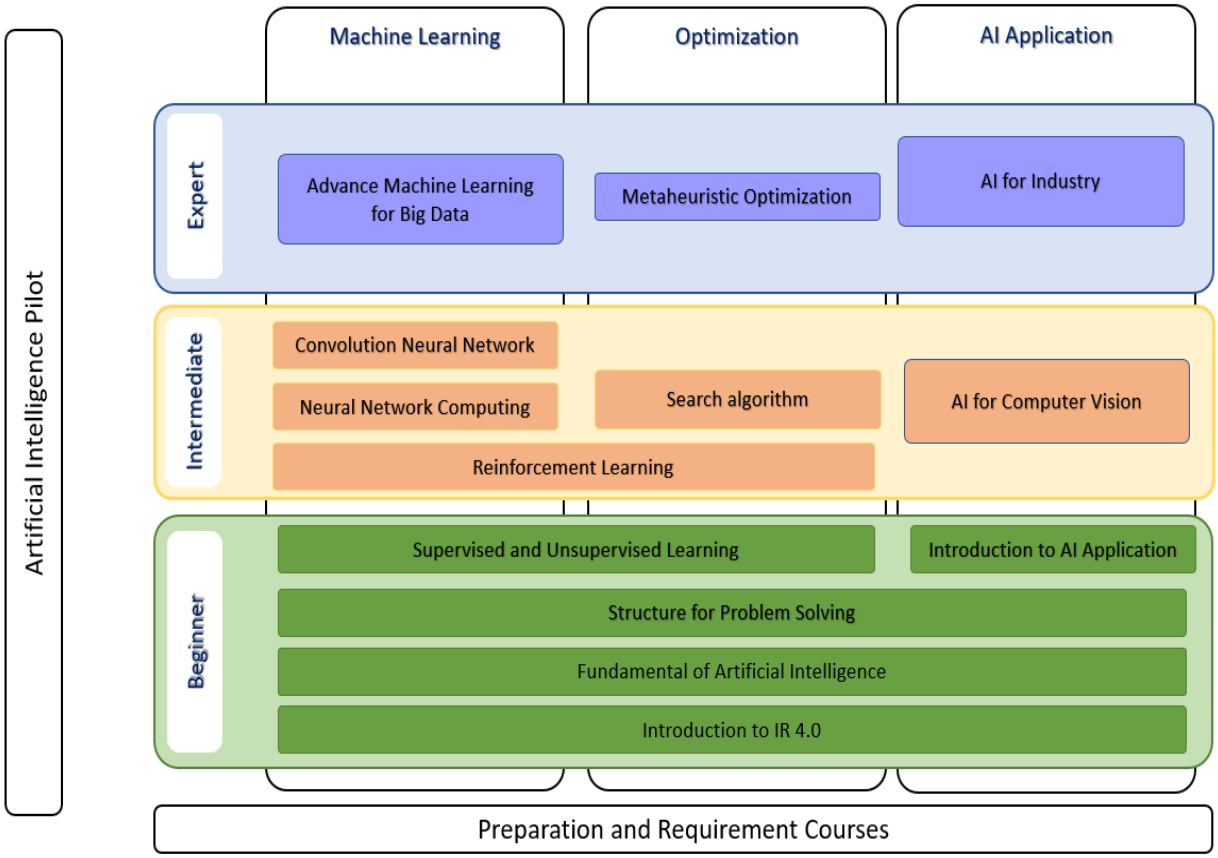


Figure 2.2: Artificial Intelligence Domain Learning Framework

The module developers for SHYFTE Artificial Intelligence domain are as follows:

Table 2.1: Module developers for Artificial Intelligence domain

Level	Module Title	Module Developer	School
Beginner	Introduction to IR4.0	Dr. Norjulia Mohamad Nordin	Electrical Engineering
	Fundamental of AI	Dr. Norjulia Mohamad Nordin	Electrical Engineering
	Structure for Problem Solving	Dr. Aida Ali	Computing
	Supervised and Unsupervised Learning	Dr. Aida Ali	Computing

	Introduction to AI Application	Assoc. Prof. Ir. Dr. Hazlina Selamat	CAIRO
Intermediate	Reinforcement Learning	TBI	TBI
	Neural Network Computing	Dr. Uswah Khairuddin	CAIRO
	Search Algorithm	Assoc. Prof Ir. Ts. Dr. Nurul Muazzah Abdul Latiff	Electrical Engineering
	AI for Computer Vision	Dr. Usman Ullah Sheikh	Electrical Engineering
	Convolution Neural Network	Assoc. Prof. Ir. Dr. Kumeresan a/l A. Danapalasingam	Electrical Engineering
Expert	Advance Machine Learning for Big Data	Dr. Shafatunnur Hassan	Computing
	Metaheuristic Optimization	Assoc. Prof. Ir. Ts. Dr Nurul Muazzah Abdul Latiff	Electrical Engineering
	AI for Industry	Assoc. Prof. Dr. Yeong Chee Fai	CAIRO

2.2 Domain 4: Learning Materials

In SHYFTE, all the modules in the AI domain are newly developed. There are 13 new modules in the framework. The modules learning materials for 12 have been formed and developed except for the Reinforcement Learning module where the trainer is to be identified.

3. Learning Materials Description

This section provides detailed information about the learning materials developed including the topics, teaching plans (delivery method and soft skills), prerequisites and learning outcomes.

3.1 Beginner Level

3.1.1 Introduction to Industrial Revolution 4.0

MODULE TITLE	**:**	**Introduction to Industrial Revolution 4.0**		
TOTAL LEARNING HOURS	**:**	5 hours		
PREREQUISITE	**:**	-		
SKILL LEVEL	**:**	Beginners		
SKILL SET	**:**	Machine Learning Optimization Artificial Intelligence Application		
LEARNING OUTCOMES	**:**	Participants should be able to: 1. Describe the various stages of industrial revolutions. 2. Identify the drivers and enablers of Industry 4.0. 3. Analyse the opportunities, challenges brought about by Industry 4.0.		
SYNOPSIS	**:**	Comprehensive coverage on stages of industrial revolutions, drivers, and enablers of IR 4.0 as well as various opportunities, challenges brought by IR 4.0, and how to prepare to reap the benefits in organizations and individual perspective.		
LECTURE	**:**	**MODULE CONTENTS**		**Learning Hours**
		1.	Evolvement of industrial revolutions	1
		2.	Drivers, enablers, compelling forces and challenges for IR 4.0	1
		3.	Related disciplines, system and technologies for enabling IR 4.0	1

	4.	Road to Industrial Revolution 4.0	1
	5.	Business issues in IR 4.0	1
		Total	5
DELIVERY METHOD :	Lecture Case study Group work (active learning method)		
SOFT SKILLS :	Problem solving Analytical thinking Teamwork Decision making		

3.1.2 Fundamental of Artificial Intelligence

MODULE TITLE :	**Fundamental of Artificial Intelligence**	
TOTAL LEARNING HOURS :	5 hours	
PRE-REQUISITE :	-	
SKILL LEVEL :	Beginners	
SKILL SET :	Machine Learning Optimization Artificial Intelligence Application	
LEARNING OUTCOMES :	Participants should be able to: 1. Explain the basic definition and concept of Artificial Intelligence. 2. Identify types of Artificial Intelligence. 3. Demonstrate understanding of the benefits, challenges, and risks of Artificial Intelligence.	
SYNOPSIS :	Introduction to basic definition and concept of artificial intelligence (AI). Comprehensive coverage on the related standardization of AI (ethical and trustworthiness), the types of artificial intelligence (narrow, general, or super AI) and the benefits, challenges, risk as well as the future of AI.	
	MODULE CONTENTS	**Learning Hours**

LECTURE	:	1.	Artificial and Human Intelligence: An Introduction, history and current trends	1
		2.	What is artificial intelligence (AI)? Narrow AI, General AI or Super AI.	1
		3.	Artificial Intelligence: Benefits, Challenges and Risks	1
		4.	Standardization of AI (ethical and trustworthiness).	1
		5.	The Future of Artificial Intelligence – Human and Machine Together.	1
			Total	5
DELIVERY METHOD	:	Lecture Case study Group work (active learning method)		
SOFT SKILLS	:	Problem solving Analytical thinking Teamwork Decision making		

3.1.3 Structured Problem Solving

MODULE TITLE	:	**Structure Problem Solving**
TOTAL LEARNING HOURS	:	7 hours
PRE-REQUISITE	:	-
SKILL LEVEL	:	Beginners
SKILL SET	:	Machine Learning Optimization Artificial Intelligence Application
LEARNING OUTCOMES	:	Participants should be able to: 1. Explain the structure of problem solving, knowledge representation and artificial intelligence agent. 2. Develop appropriate structure for artificial intelligence solution.

SYNOPSIS	**:**	Overview on the importance of structuring the problem solving through understanding problem definition and solution design from AI perspective.	
LECTURE	**:**	**MODULE CONTENTS**	**Learning Hours**
		1. Importance of structure of problem solving in AI	1
		2. Understanding of knowledge representation and AI agent.	1
		3. Defining graph theory and search strategies	2
		4. Designing and proposing structure of state space for AI solution	3
		Total	7
DELIVERY METHOD	**:**	Lecture Case study Group work (active learning method)	
SOFT SKILLS	**:**	Problem solving Analytical thinking Teamwork Decision making	

3.1.4 Supervised and Unsupervised Learning

MODULE TITLE	**:**	**Supervised and Unsupervised Learning**
TOTAL LEARNING HOURS	**:**	7 hours
PRE-REQUISITE	**:**	-
SKILL LEVEL	**:**	Beginners
SKILL SET	**:**	Machine Learning Optimization

LEARNING OUTCOMES	:	Participants should be able to: 1. Explain the structure and process of machine learning. 2. Develop appropriate machine learning method for artificial intelligence solution.		
SYNOPSIS	:	Transforming data into important features by understanding from machine learning views through machine learning process, learning types and machine learning techniques. Evaluation metrics to measure performance of machine learning methods on datasets helps students to gain insight AI approach to solve real world problems.		
LECTURE	:	**MODULE CONTENTS**		**Learning Hours**
		1.	Defining types and methods how machine learns	1
		2.	Understanding of machine learning process	1
		3.	Understanding supervised learning and unsupervised learning and evaluation metrics	2
		4.	Designing and proposing machine learning method for problem solving	3
			Total	7
DELIVERY METHOD	:	Lecture Case study Group work (active learning method)		
SOFT SKILLS	:	Problem solving Analytical thinking Teamwork Communication		

3.1.5 Introduction to Artificial Intelligence Application

MODULE TITLE	:	**Introduction to Artificial Intelligence Application**
TOTAL LEARNING HOURS	:	7 hours
PRE-REQUISITE	:	-

SKILL LEVEL	**:**	Beginners	
SKILL SET	**:**	Artificial Intelligence Application	
LEARNING OUTCOMES	**:**	Participants should be able to: 1. Explain basic definition of artificial intelligence and its capabilities 2. Describe the workflow in building an AI project/application 3. Describe different AI applications built based on video, image and text data	
SYNOPSIS	**:**	This module provides comprehensive coverage on Artificial Intelligence capabilities and limitations as well as workflow in building AI application or project (engineering and non-engineering based)	
LECTURE	**:**	**MODULE CONTENTS**	**Learning Hours**
		1. Introduction to Artificial Intelligence (AI)	1
		2. Building AI Projects/Applications: Computer Vision Application: Self-Driving Car Speech Recognition Application: Smart Speaker Natural Language Processing: Sentiment Analysis SLAM: Robot Motion Planning	4.5
		3. Realistic View of Artificial Intelligence	1.5
		Total	7
DELIVERY METHOD	**:**	Lecture Case study Group work (active learning method)	
SOFT SKILLS	**:**	Problem solving Analytical thinking Teamwork Decision making	

3.2 Intermediate Level

3.2.1 Neural Network Computing

MODULE TITLE	**:**	**Neural Network Computing**		
TOTAL LEARNING HOURS	**:**	7 hours		
PRE-REQUISITE	**:**	Fundamental of Artificial Intelligence Structure Problem Solving Supervised and Unsupervised Learning		
SKILL LEVEL	**:**	Intermediate		
SKILL SET	**:**	Machine Learning		
LEARNING OUTCOMES	**:**	Participants should be able to: 1. Explain the basic concept of Neural Network and Artificial Neural Network 2. Apply Neural Network and Artificial Neural Network to solve real problem		
SYNOPSIS	**:**	Introduction to Neural Networks and Artificial Neural Networks fundamentals as well as intermediate level implementation. Comprehensive coverage on knowledge and skills to develop, design and analyse industrial problem using Neural Network (NN) and Artificial Neural Network (ANN) through real case study and a hands-on programming session.		
LECTURE	**:**	**MODULE CONTENTS**		**Learning Hours**
		1.	Introduction to fundamentals of artificial intelligence, neural network, and vision process.	1
		2.	Supervised and unsupervised Neural Network.	1
		3.	Simulation on data analysis using Neural Networks (supervised and unsupervised)	5
			Total	7

DELIVERY METHOD	:	Lecture Case study Group work (active learning method) Real data simulation and hands-on
SOFT SKILLS	:	Problem solving Analytical thinking Teamwork Decision making Infographic communication

3.2.2 Convolution Neural Network

MODULE TITLE	:	**Convolution Neural Network**	
TOTAL LEARNING HOURS	:	7 hours	
PRE-REQUISITE	:	1. Supervised and Unsupervised Learning 2. Neural Network Computing	
SKILL LEVEL	:	Intermediate	
SKILL SET	:	Machine Learning	
LEARNING OUTCOMES	:	Participants should be able to: 1. Explain the basic concept of Convolution Neural Network. 2. Apply Convolution Neural technique to solve real problem	
SYNOPSIS	:	Introduction to Convolution Neural Networks (CNN) techniques as well as intermediate level of CNN implementation. Comprehensive coverage on knowledge and skills to develop, design and analyse industrial problem using Convolution Neural Network (CNN) technique through real case study and a hands-on programming session. Specifically, Python programming language will be used in this module.	
		MODULE CONTENTS	**Learning Hours**

LECTURE :	1.	Introduction to Machine Learning and the Importance of data in manufacturing system.	1
	2.	Introduction to Phyton programming language for data collecting in production process.	1
	3.	Neural Networks vs Convolution Neural Networks in designing the data collecting system.	2.5
	4.	Simulation on data analysis using Convolution neural networks.	2.5
		Total	**7**
DELIVERY METHOD :	Lecture Case study Group work (active learning method) Real data simulation and hands-on		
SOFT SKILLS :	Problem solving Analytical thinking Teamwork Decision making Infographic communication		

3.2.3 Search Algorithm

MODULE TITLE :	**Search Algorithm**
TOTAL LEARNING HOURS :	7 hours
PRE-REQUISITE :	1. Supervised and Unsupervised Learning 2. Structure Problem Solving
SKILL LEVEL :	Intermediate
SKILL SET :	Optimization

LEARNING OUTCOMES :	Participants should be able to: 1. Understand the roles of Search Algorithm. 2. Formulate appropriate search strategy for complex problems. 3. Apply search techniques for complex problems.		
SYNOPSIS :	This module offers emphasizes on theoretical and practical aspects of search strategies, and various search algorithms from exhaustive search to heuristic search algorithms. The module features practical implementations through case studies and simulation, undertaken both individually and in groups.		
	MODULE CONTENTS		**Learning Hours**
LECTURE :	1.	Search strategies	2
	2.	Exhaustive search and heuristic search	1
	3.	Breadth-first search	1
	4.	Depth-first search	1
	5.	Heuristic evaluation and best first search	2
		Total	7
DELIVERY METHOD :	Lecture Case study Group work (active learning method) Real data simulation and hands-on		
SOFT SKILLS :	Problem solving Analytical thinking Teamwork Decision making Infographic communication		

3.2.4 Artificial Intelligence for Computer Vision

MODULE TITLE	**:**	**Artificial Intelligence for Computer Vision**	
TOTAL LEARNING HOURS	**:**	7 hours	
PRE-REQUISITE	**:**	1. Introduction to Industry 4.0 2. Fundamental of Artificial Intelligence 3. Introduction to Artificial Intelligence Application 4. Supervised and Unsupervised Learning 5. Convolution Neural Network	
SKILL LEVEL	**:**	Intermediate	
SKILL SET	**:**	Artificial Intelligence Application	
LEARNING OUTCOMES	**:**	Participants should be able to: 1. Explain the fundamentals of computer visions and identify the related applications. 2. Develop real-time AI applications for edge AI using programming and software tools. 3. Demonstrate understanding on the methodology of implementing real-time AI systems for real-world applications.	
SYNOPSIS	**:**	Introduction to the fundamentals of computer vision and exposure to various applications of computer visions in industry. Comprehensive coverage on embedded implementation of AI algorithm for computer vision and the edge AI application using jetson nano board.	
LECTURE	**:**	**MODULE CONTENTS**	**Learning Hours**
		1. Introduction to the fundamentals of computer vision and various applications of computer visions in industry.	1
		2. Introduction to embedded systems and edge AI application using Jetson board (Procedure, structure and related operating system and programming language)	3
		3. Computer vision application demo and hands-on: image processing (OpenCV and CUDA on the Jetson,	3

		Working with GPIO, and acquiring camera input, deep learning method on jetson board)	
		Total	7
DELIVERY METHOD	:	Lecture Case study Group work (active learning method) Real data simulation and hands-on	
SOFT SKILLS	:	Problem solving Analytical thinking Teamwork Decision making Programming Skill	

3.3 Expert Level

3.3.1 Advance Machine Learning for Big Data

MODULE TITLE	**:**	**Advance Machine Learning for Big Data**		
TOTAL LEARNING HOURS	**:**	7 hours		
PRE-REQUISITE	**:**	1. Fundamental of Artificial Intelligence 2. Supervised and Unsupervised Learning 3. Neural Network Computing 4. Convolution Neural Network		
SKILL LEVEL	**:**	Expert		
SKILL SET	**:**	Machine Learning		
LEARNING OUTCOMES	**:**	Participants should be able to: 1. Explain the basic concept and application of advance machine learning. 2. perform a wide variety of end-to-end data science tasks using multiple massive datasets.		
SYNOPSIS	**:**	Introduction to basic concept and application of advance machine learning. Comprehensive coverage on manipulating massive datasets on Graphic Processing Unit (GPU), performing data analysis at massive scale and performing multiple analysis task on several massive datasets.		
LECTURE	**:**	**MODULE CONTENTS**		**Learning Hours**
		1.	Introduction to advance machine learning and related application of advance machine learning to big data.	1
		2.	Ingest and manipulate massive datasets directly on GPU.	2
		3.	Perform data analysis at massive scale utilizing a wide variety of GPU-accelerated machine learning algorithm.	2
		4.	Performing multiple analysis tasks on several massive datasets.	2
			Total	7

DELIVERY METHOD	:	Lecture Case study Group work (active learning method) Real data simulation and hands-on
SOFT SKILLS	:	Problem solving Analytical thinking Teamwork Decision making

3.3.2 Metaheuristic Optimization

MODULE TITLE	:	**Metaheuristic Optimization**		
TOTAL LEARNING HOURS	:	7 hours		
PRE-REQUISITE	:	1. Fundamental of Artificial Intelligence 2. Supervised and Unsupervised Learning 3. Search Algorithm		
SKILL LEVEL	:	Expert		
SKILL SET	:	Optimization		
LEARNING OUTCOMES	:	Participants should be able to: 1. Identify the metaheuristic search strategy for different problems. 2. Formulate appropriate solutions for complex problems. 3. Design intelligent-based systems for complex problems based on metaheuristic algorithm.		
SYNOPSIS	:	This module describes the basic concept of metaheuristic optimization and identifies the types of metaheuristic search strategy in solving domain's problem. Trainees will be taught on how to formulate appropriate solutions and design intelligent computer-based systems to solve complex problem in different domains.		
LECTURE	:	**MODULE CONTENTS**		**Learning Hours**
		1.	Optimization model	1

	2.	Metaheuristic concept – representation, objective function, constraint handling, parameter tuning, performance analysis	2
	3.	Introduction to optimization and Evolutionary Algorithm	1
	4.	Simulated annealing	1
	5.	Genetic Algorithm	1
	6.	Particle Swam Optimization	1
		Total	7
DELIVERY METHOD :	Lecture Case study Group work (active learning method) Real data simulation and hands-on		
SOFT SKILLS :	Problem solving Analytical thinking Teamwork Decision making		

3.3.3 Artificial Intelligence for Industry

MODULE TITLE :	**Artificial Intelligence for Industry**
TOTAL LEARNING HOURS :	7 hours
PRE-REQUISITE :	1. Introduction to Industry 4.0 2. Fundamental of Artificial Intelligence 3. Structure Problem Solving 4. Introduction to Artificial Intelligence Application
SKILL LEVEL :	Expert
SKILL SET :	Artificial Intelligence Application

<table>
<tr><td>LEARNING OUTCOMES :</td><td colspan="3">Participants should be able to:
1. Explain the basic definition and concept of Artificial Intelligence and Artificial intelligence for industry.
2. Identify categories of Artificial Intelligence for industry.
3. Describe the different Artificial Intelligence applications for industry.</td></tr>
<tr><td>SYNOPSIS :</td><td colspan="3">Introduction to basic definition and concept of artificial intelligence (AI) for industry as well as exposure to the AI-based industrial improvement (categories and types of applications).</td></tr>
<tr><td rowspan="7">LECTURE :</td><td colspan="2">MODULE CONTENTS</td><td>Learning Hours</td></tr>
<tr><td>1.</td><td>Introduction to Artificial Intelligence for industry</td><td>1</td></tr>
<tr><td>2.</td><td>Artificial Intelligence for Industry: product applications for user value creation.</td><td>1</td></tr>
<tr><td>3.</td><td>Artificial Intelligence for Industry: Process Applications for productivity improvement</td><td>1</td></tr>
<tr><td>4.</td><td>Artificial Intelligence for Industry: Insight Applications for Knowledge Discovery</td><td>2</td></tr>
<tr><td>5.</td><td>Artificial Intelligence-based industrial improvement (case study).</td><td>2</td></tr>
<tr><td colspan="2">Total</td><td>7</td></tr>
<tr><td>DELIVERY METHOD :</td><td colspan="3">Lecture
Case study
Group work (active learning method)
Real data simulation and hands-on</td></tr>
<tr><td>SOFT SKILLS :</td><td colspan="3">Problem solving
Analytical thinking
Teamwork
Decision making</td></tr>
</table>

4. Use of SHYFTE Equipment

This section explains on the usage of the equipment in SHYFTE which covers training, research and teaching development, administrative and training management system as elaborated in the next subsection. The list and details of SHYFTE equipment for domain AI is as follows:

Table 7.1: List of SHYFTE equipment for domain AI

No.	Equipment	Total
1.	Deep learning workstation	1
2.	High-performance desktop	1
3.	Jetson nano developer kit set	7
4.	Mobile workstation (HP Zbook studio)	4

4.1 SHYFTE Equipment Application

a) Deep learning workstation and high-performance desktop

The deep learning workstation and high-performance desktop are equipped with a high-performance Central Processing Unit (CPU) and Graphics Processing Unit (GPU). The hardware is suitable for real-time processing as well as large neural network training. Figure 4.1 and Figure 4.2 depict the deep learning workstation and high-performance desktop, respectively.

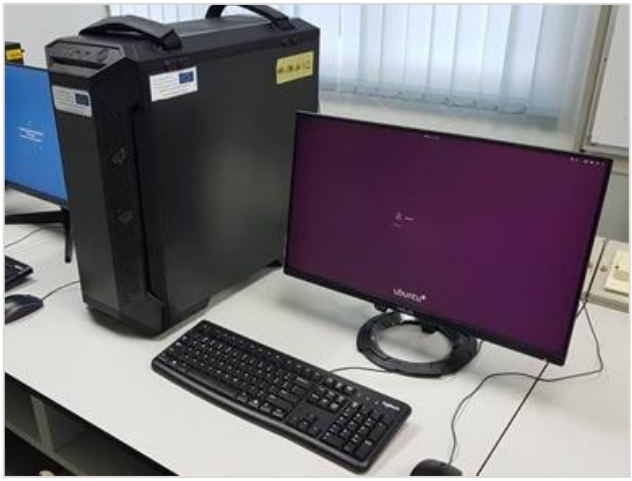


Figure 4.1: Deep learning workstation

Figure 4.2: High-performance desktop

Machine learning research and development requires a huge dataset to be processed with complex algorithms for long periods of time. The current hardware is used as follows.

i. Training platform

The Deep learning workstation is configured as a server in the computer laboratory at UTM. The workstation can be used for training in the area of AI, machine learning, computer vision and Python programming remotely. As of now, students attending the lab can connect to the Workstation remotely in the lab through other computers to execute/run/learn complex machine learning without the need to have powerful personal computers.

The Workstation can serve 40 students concurrently with good performance. The modules served in the UTM SHYFTE modules can be run/executed on the server. As continuous future training is in the pipeline, the workstation will be used for future classes on the modules in UTM SHYFTE.

ii. Research and development

During off training hours, the deep learning workstation is used for research and development in the field of AI and machine learning. The workstation is equipped with open-source Python libraries, and commercial MATLAB (UTM License) software for the purpose of research. At the moment the workstation is used by

4 students through remote connection. The Workstation will continuously be used as an AI training platform for research students at UTM (PhD and MPhil).

iii. General training management and administration

The high-performance desktop is used for general training management and administration. Besides that, the desktop is also used as a deep learning workstation during off hours. The desktop computer has a high-performance CPU and GPU and is capable of machine learning as well. The desktop will be used for general training management, and to supplement machine learning research together with the deep learning workstation.

b) Jetson Nano and mobile workstation

Through the SHYFTE program, UTM acquired X Nvidia Jetson Nano Boards and Y mobile workstations. The mobile workstation is used to program and setup the Nvidia Jetson Nano embedded platform. The Jetson Nano will be used in the following ways:

i. Training of AI, machine learning computer vision

The modules developed in the SHYFTE program for AI will continuously use the Nvidia Jetson Nano board as a platform for teaching and learning. Hands-on Worksheet on AI in Computer Vision is developed for learning and training purposes. (See Annex 1)

ii. Final Year Projects for Undergraduate students at UTM

The Nvidia Jetson Nano is an excellent platform for real-time embedded systems. The platform is planned to be used as a target platform for undergraduate final year students in their projects. The training material that has been developed will be used to assist the students in using the platform.

iii. Embedded Systems Research Projects for Postgraduate

UTM has several research groups/research labs that focus on machine learning, AI, computer vision and embedded systems. The boards will be available for use by these entities to further their research and development in the above-mentioned areas.

Figure 4.3 shows the Jetson Nano developer kit while Figure 4.4 illustrates the mobile workstation. All SHYFTE equipment are attached with SHYFTE stickers to show that the equipment are co-funded by the Erasmus+ programme.

Figure 4.3: Jetson nano developer kit

Figure 4.4: Mobile workstation

4.2 Use Case of SHYFTE Equipment

Some of the SHYFTE equipment is used for Training of Students (ToS) session. Below is the list of details of use case of SHYFTE equipment.

Date	5 July 2022
Module Title	Artificial Intelligence for Computer Vision (with hands-on session)
Level	Intermediate
Skill Set	Artificial Intelligence Application
Equipment	Jetson nano developer kit High performance workstation
Implementation	Using the Nvidia Jetson Nano embedded platform, several image processing and computer vision applications were explored during the

	ToS session. Students were trained to initialize and booting up the Jetson, setting up the development environment, and running the tutorials: • Tutorial 1: Testing OpenCV Library & Python • Tutorial 2: Opening File and Displaying It • Tutorial 3: Playing Video • Tutorial 4: Webcam • Tutorial 5: Basic Image Processing • Tutorial 6: Image Filtering • Tutorial 7: Edge Detection, Morphological Operations • Tutorial 8: Scaling, Cropping • Tutorial 9: Graphics • Tutorial 10: Face Detection • Tutorial 11: Deep Learning on Jetson • Setting up the Deep Learning Server

Figure 7.5 shows the usage of SHYFTE equipment during the AI for Computer Vision module ToS session.

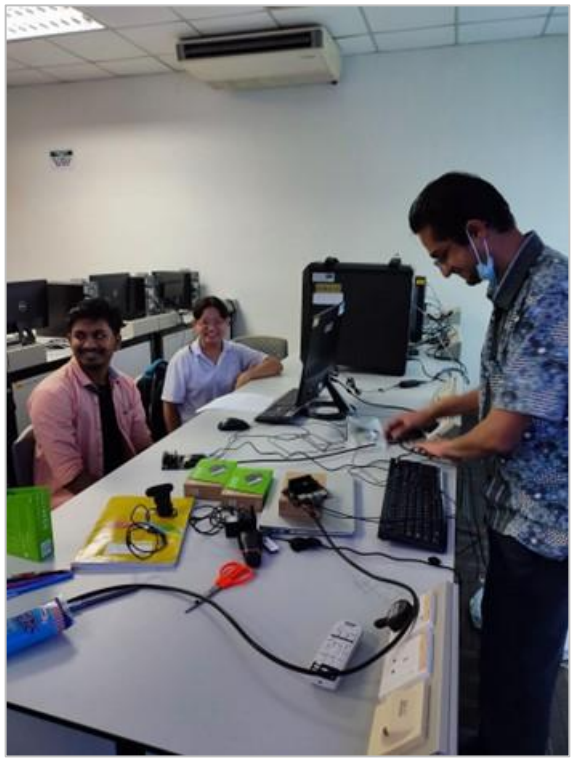


Figure 7.5: Usage of SHYFTE equipment during ToS session

5. Learning Materials Review

The review process is evaluated by internal and external assessors. The selection of the assessors is based on the expert area and experience on the subject matter. We engaged with two external reviewers from industry to review the training modules and internal reviewers from academic institution. The learning materials review for AI domain are listed in the following table.

Table 5.1: Reviewers for Artificial Intelligence domain

No.	Name	Reviewer Role	Modules Reviewed
1	Dr. Shafaatunnur Hassan School of Computing, Universiti Teknologi Malaysia	Internal	1. Search Algorithm 2. AI for Computer Vision 3. Convolution Neural Network 4. Advanced Machine Learning for Big Data 5. Metaheuristic Optimization 6. AI for Industry
2	Assoc. Prof. Dr. Mohamad Hafis Izran Ishak School of Electrical Engineering, Universiti Teknologi Malaysia		1. Introduction to IR4.0 2. Fundamental of AI 3. Structure for Problem Solving 4. Supervised and Unsupervised Learning 5. Introduction to AI Application 6. Reinforcement Learning 7. Neural Network Computing
3	Ms. Norzieyuswati Md. Zenal, Senior Engineer, Intel Malaysia	External	1. Search Algorithm 2. AI for Computer Vision 3. Convolution Neural Network 4. Advanced Machine Learning for Big Data 5. Metaheuristic Optimization 6. AI for Industry
4	Ir. Dr. Abdul Aziz Abdul Rahman, Head of the Data Science Unit, Telekom Malaysia Research & Development (TMRND)	External	1. Introduction to IR4.0 2. Fundamental of AI 3. Structure for Problem Solving 4. Supervised and Unsupervised Learning 5. Introduction to AI Application 6. Reinforcement Learning Neural Network Computing

The review is conducted based on the assessment of module content and its relevance in meeting the modules outcomes as well as according to the professions related to the domain. Additionally, the exposure of software/hardware equipment is also assessed accordingly.

Detailed criteria reviewed on each module are as follows.

A. Module content

B. Relevance of the module content in meeting the module learning outcomes

C. Relevance of the module content to professions related to AI

D. Exposure on equipment (hardware and software)

The Likert scale is listed as below:

4 – Excellent: Fully aligned to the AI domain

3 – Good: Mostly aligned to the AI domain

2 – Satisfactory: Somewhat aligned to the AI domain

1 – Need improvement: Alignment to the AI domain is not clear

5.1 Overall Improvement Actions

The summary of the material review findings is tabulated in the Table 5.2. From the table, most of the training modules score almost perfect rating scores on average and on individual rating criteria. Despite a few modules achieved lower scores, nevertheless the rating averages are all close to 3 which tell that the modules contents are mostly aligned to the AI domain. Most importantly, there are rooms of improvement to further enhance the learning materials. Amendments to the lower score criteria have been affected by the module developers before the actual training is carried out.

Table 5.2: Review rating level for all training modules

		Criteria A				Criteria B				Criteria C				Criteria D				AVG
	Training Modules	IR 1	IR 2	ER 1	ER 2	IR 1	IR 2	ER 1	ER 2	IR 1	IR 2	ER 1	ER 2	IR 1	IR 2	ER 1	ER 2	
1	Introduction to IR 4.0		3		4		4		4		4		4		4		4	3.9
2	Fundamental of AI		4		4		4		4		4		4		4		4	4.0
3	Structure for Problem Solving		4		4		4		4		4		4		3		4	3.9
4	Supervised and Unsupervised Learning		4		4		4		4		4		4		4		4	4.0
5	Introduction to AI Applications		4		4		4		4		4		4		3		4	3.9
6	Reinforcement Learning		4	4			4	4			4	4			4	4		4.0
7	Neural Network Computing		4	3			4	3			4	3			4	4		3.6
8	Search Algorithm	2		4		1		4		2		3		2		4		2.8
9	AI for Computer Vision	3		4		3		4		3		4		3		4		3.5
10	Convolution Neural Network	1		4		1		4		2		4		2		4		2.8
11	Advance Machine Learning for Big Data	3		3		2		2		3		2		3		4		2.8
12	Metaheuristic Optimization	2		4		1		4		2		4		2		4		2.9
13	AI for Industry	3			4	3			4	3			4	3			4	3.5

Nevertheless, the learning materials relevancy to the professional needs to be improved by engaging with the Industry or SME continuously during the training management review process. Improvement in software/hardware exposure is essential for effective training. This comes in with proper resource management planning in the future.

6. Training of the Trainers (ToT) Sessions

Upon the completion of learning materials development and revision, Training of the Trainers (ToT) sessions are conducted. The main purpose of ToT is to prepare instructors to present module information effectively, respond to trainee questions, and lead training activities that reinforce learning.

We have disseminated the calling for ToT to potential trainers in the respective domains and those involved in IR4.0 related areas. The dissemination is made through emails, social media platforms and website to attract groups from SHYFTE partners, Institute of Electrical and Electronics Engineers (IEEE) and Faculty of Engineering. These are attached in the Annex 2.

The Training of Trainers was conducted in 2 sessions in virtual mode as follows:

Table 6.1: Training of Trainers sessions

Part	Date	No.	Modules	Skill Level	Skill Set
I	25 July 2021 - 27 July 2021	1	Introduction to Artificial Intelligence Application	Beginner	AI Application
		2	Artificial Intelligence for Computer Vision (Part I)	Intermediate	AI Application
		3	Artificial Intelligence for Industry	Expert	AI Application
II	8 February 2022 - 28 February 2022	1	Artificial Intelligence for Computer Vision (Part II)	Intermediate	AI Application
		2	Supervised and Unsupervised Learning	Beginner	Machine Learning Optimization
		3	Convolutional Neural Network	Intermediate	Machine Learning
		4	Advance Machine Learning for Big Data	Expert	Machine Learning

The selection of the trainers is based on the teaching and learning, research competency and experience in the AI domain. The trainers are also responsible to develop the module learning materials which include module outcomes, module content, training module activities, and module assessment methods. Our associate partner, CAIRO contributes to the ToT sessions.

Overall, there are 161 participants who have attended both ToT sessions. Due to the travel restrictions in Malaysia, all sessions were held virtually via Webex applications. The participants are from UTM, partner universities such as UPM, CMU and KU, other universities such as Chiang Rai Rajabhat University, Rambhai Barni Rajabhat University and industry such as Health Utility Innovate Sdn Bhd. Table 6.2 shows the summary of participants and their organizations who have attended ToT Part I and Part II.

Table 6.2: Summary of participants and organizations for ToT Part I and Part II

PART	NO.	ORGANIZATIONS	TOTAL TRAINERS	TOTAL OTHER PARTICIPANTS
I	1	Universiti Teknologi Malaysia	7	28
	2	Universiti Putra Malaysia	4	-
	3	Chiang Mai University	3	-
	4	Chiang Rai Rajabhat University	1	-
	5	Health Utility Innovate Sdn. Bhd.	-	1
	6	Kasetsart University	1	-
	7	Suan Sunandha Rajabhat University	1	-
	8	Rambhai Barni Rajabhat University	1	-
	9	Tippayawong	1	-
	Total number of participants		**19**	**29**
II	1	Universiti Teknologi Malaysia	26	23
	2	Universiti Putra Malaysia	5	10

	3	Northern Technical University Mousl, Iraq	2	2
	4	Politeknik Sultan Salahuddin Abdul Aziz Shah	-	1
	5	Universiti Selangor	1	-
	6	Innates PLT	-	1
	Total number of participants		**34**	**37**

6.1 Part I

The first part of the ToT session was held from 25 July 2021 until 27 July 2021 via Google Meet Application. The session began with the introductory talk by Dr. Norjulia Mohamad Nordin entitled 'Introduction to Domain 4 Training Framework'. Table 6.3 lists down the modules involved for ToT Part I and the details of the trainers and Figure 6.1 shows the poster that has been disseminated for the ToT Session Part I.

Table 6.3: Modules for ToT sessions Part I and details of the trainers

Module	Name	Affiliation
Introduction to Artificial Intelligence Application	Assoc. Prof. Ir. Dr. Hazlina Selamat	Centre for AI & Robotics (CAIRO), Universiti Teknologi Malaysia
Artificial Intelligence for Computer Vision (Part I)	Dr. Usman Ullah Sheikh	School of Electrical Engineering Universiti Teknologi Malaysia
Artificial Intelligence for Industry	Assoc. Prof. Dr. Yeong Che Fai	Centre for AI & Robotics (CAIRO), Universiti Teknologi Malaysia

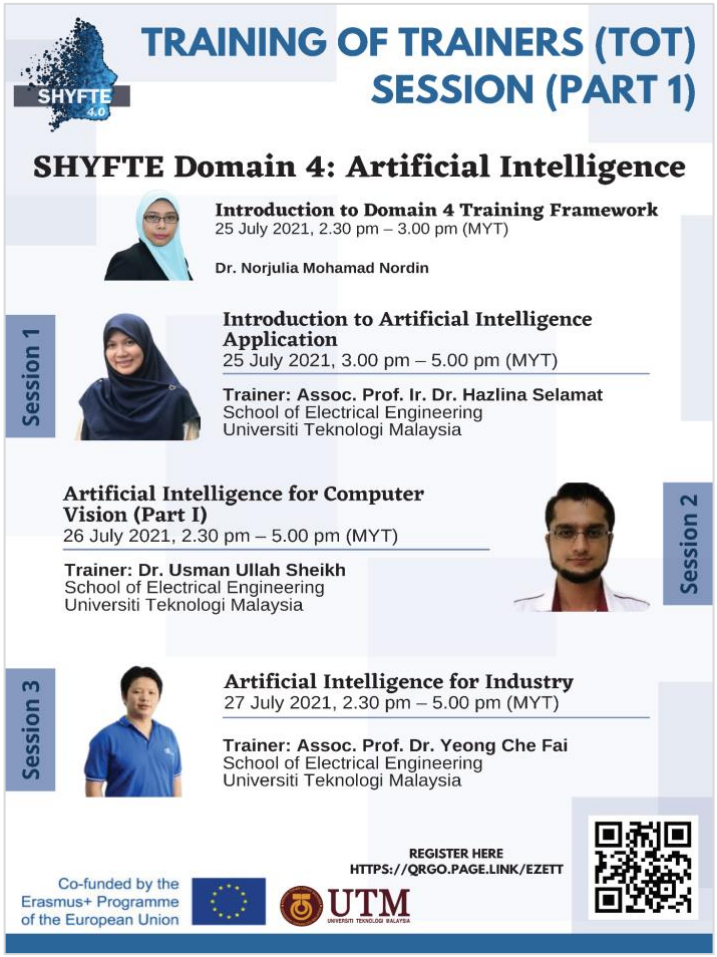


Figure 6.1: Poster disseminated for ToT sessions Part I

6.1.1 Part I Description

The ToT sessions for Domain 4, Part I was attended by around 82 participants. The details of participants are listed in Annex 3. Figure 6.2 shows the number of participants for each module.

	Module Title	No. of Participants	Percentage of Participants
	Introduction to Artificial Intelligence Application	22	26.8%
	Artificial Intelligence for Computer Vision (Part I)	23	28.1 %
	Artificial Intelligence for Industry	37	45.1%

Figure 6.2: The number of participants for each module

Figure 6.3(a) – Figure 6.3(f) are from the ToT sessions Part I.

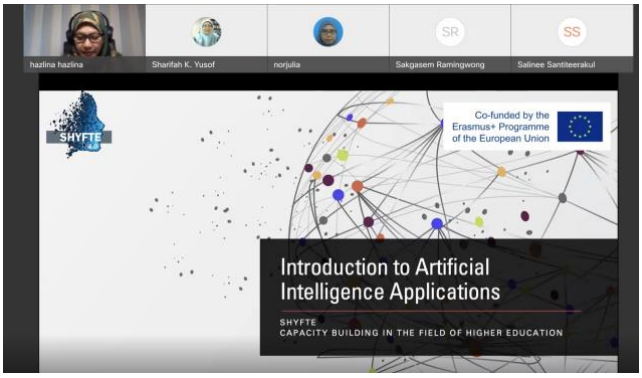


Figure 6.3(a): ToT session on 25 July 2021

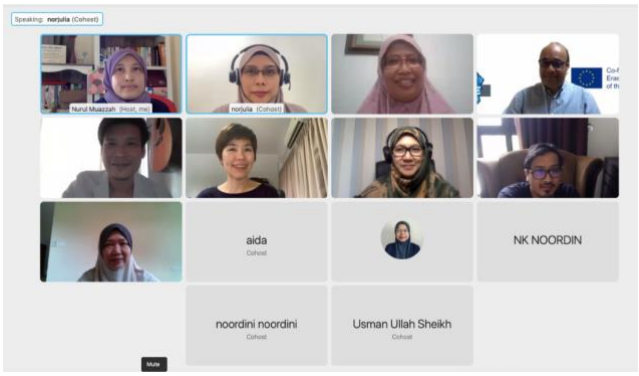


Figure 6.3(b): Attendees and trainers for ToT session on 25 July 2021

Figure 6.3(c): ToT session on 26 July 2021

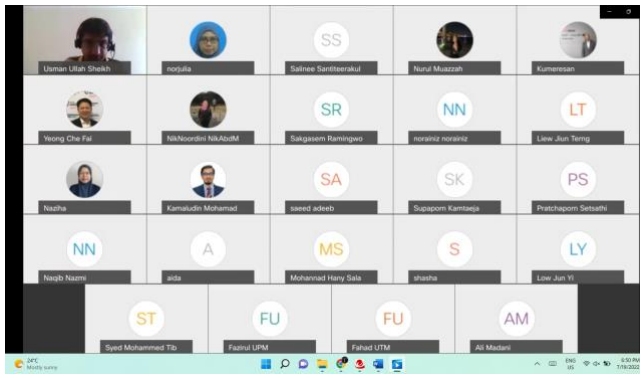


Figure 6.3(d): Attendees and trainers for ToT session on 26 July 2021

Figure 6.3(e): ToT session on 27 July 2021

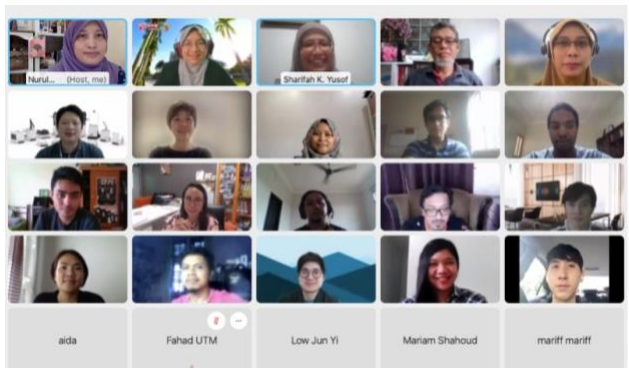


Figure 6.3(f): Attendees and trainers for ToT session on 27 July 2021

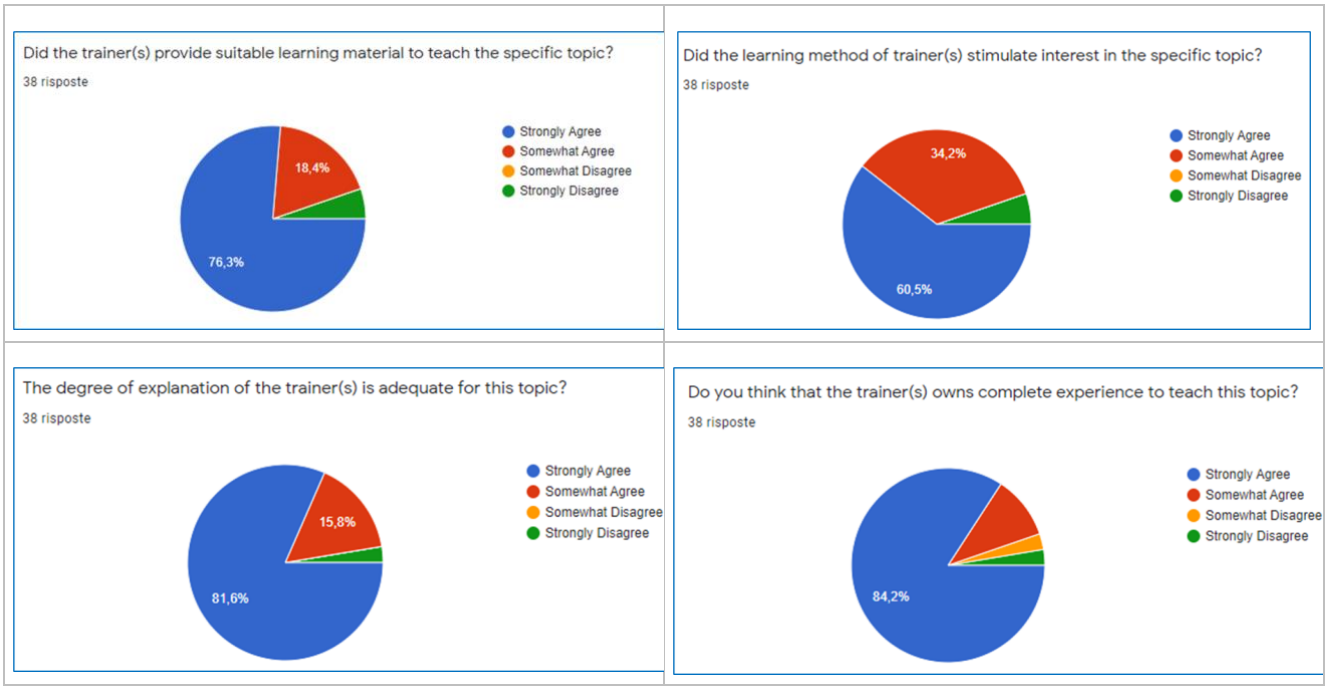
6.1.2 Part I Feedback

We have disseminated the satisfaction questionnaire to all participants of ToT at the end of each session. Table 6.4 below shows the number of answers for each module in Domain 4. Even though not many have participated in the questionnaire, overall, it can be concluded that most of them are satisfied with the ToT sessions.

Table 6.4: The number of respondents for satisfaction questionnaire in ToT Part I

Module Title	No. of Respondents
Introduction to Artificial Intelligence Application	11
Artificial Intelligence for Computer Vision (Part I)	1
Artificial Intelligence for Industry	1

The results of the questionnaire for the whole ToT sessions are depicted in Figure 6.4. More than half of the respondents answered 'Strongly agree' to the questions in the questionnaire. Generally, they strongly agreed that the trainers provided suitable learning materials and used learning methods that stimulate interest in the specific topics. More than 80 percent of the respondents strongly agree that the degree of explanation of the trainers is adequate for this topic and the trainers are experienced enough to teach this topic. Majority of the respondents also agreed that they are comfortable to be one of the trainers upon attending the sessions.



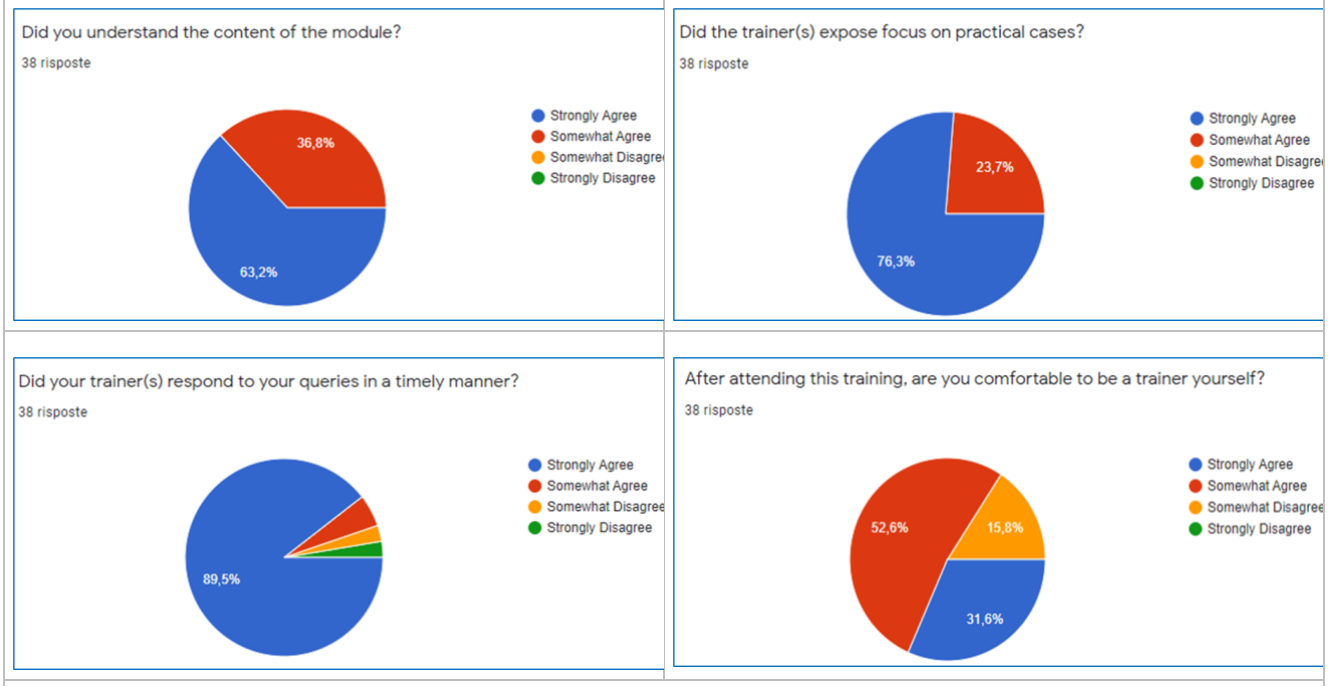


Figure 6.4: Analysis from satisfaction questionnaire for ToT Sessions Domain 4 Part I

6.2 Part II

We organized the ToT session Part II from 8 February 2022 until 28 February 2022 and this time, Webex Application with recorded facility is used. Figure 6.5 illustrates the poster that has been disseminated for the ToT session Part II. The modules offered for Part II and the details of the trainers are listed in Table 6.5.

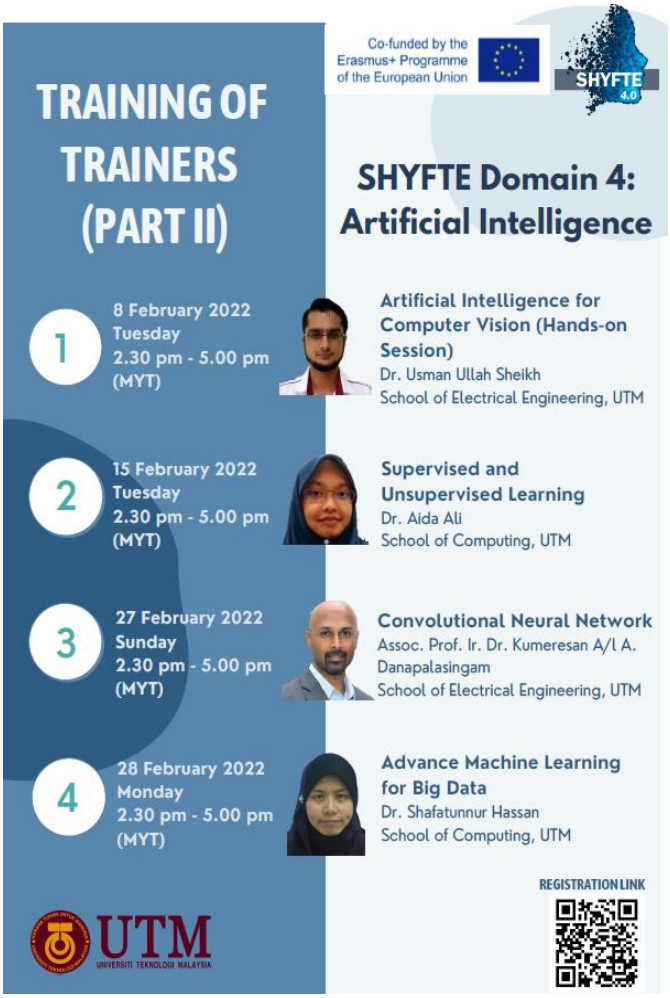


Figure 6.5: Poster disseminated for ToT session Part II

Table 6.5: Details of modules and trainers involved in the ToT session Part II

Module	Name	Affiliation
Artificial Intelligence for Computer Vision (Hands-on)	Dr. Usman Ullah Sheikh	Centre for AI & Robotics (CAIRO), Universiti Teknologi Malaysia
Supervised and Unsupervised Learning	Dr. Aida Ali	School of Computing, Universiti Teknologi Malaysia
Convolutional Neural Network	Assoc. Prof. Dr. Ir Kumeresan a/l Danapalasingam	School of Electrical Engineering, Universiti Teknologi Malaysia
Advance Machine Learning for Big Data	Dr. Shafatunnur Hassan	School of Computing, Universiti Teknologi Malaysia

6.2.1 Part II Description

The ToT session for Domain 4, Part II was attended by around 78 participants. The details of participants are listed in Annex 4. Figure 6.6 shows the percentage of participants for each module. The participants for Part II ToT session are from different organizations such as UPM, University of Selangor, Politeknik Sultan Salehuddin Abdul Aziz Shah, and industry such as Innates Sdn. Bhd. Photos from ToT Session Part II are shown in Figure 6.7.

Figure 6.6: The percentage of participants for each module

Figure 6.7(a): ToT session on 8 February 2022

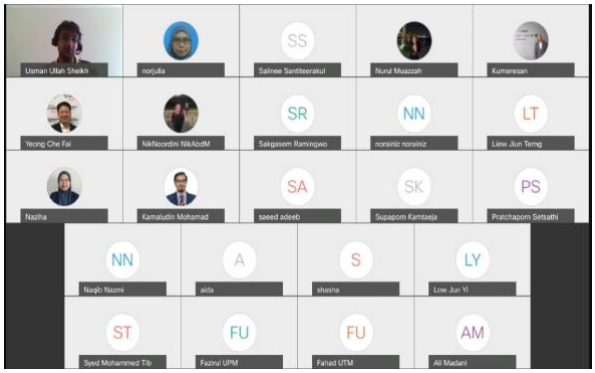


Figure 6.7(b): Attendees and trainers for ToT session on 8 February 2022

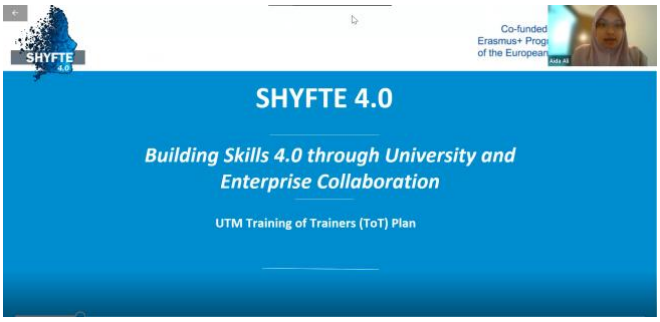


Figure 6.7(c): ToT session on 15 February 2022

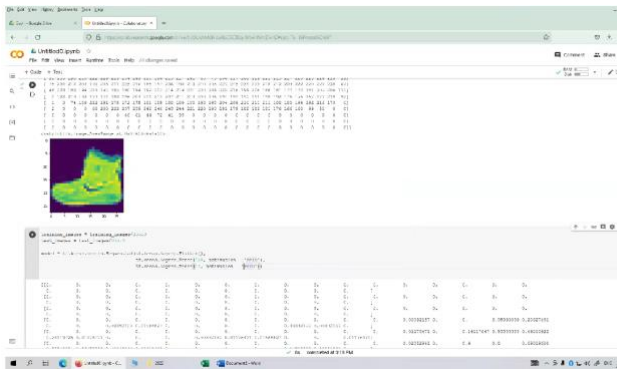


Figure 6.7(d): ToT session on 27 February 2022

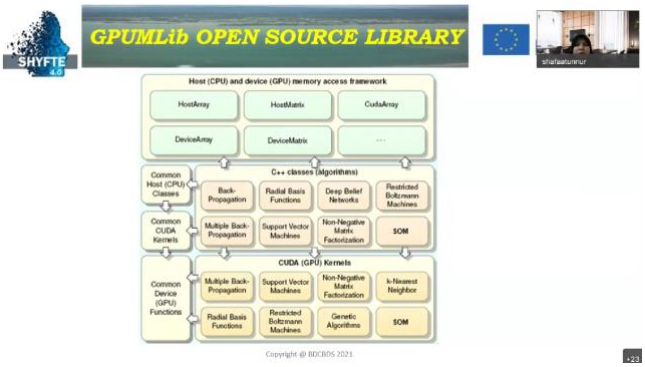


Figure 6.7(e): ToT session on 28 February 2022

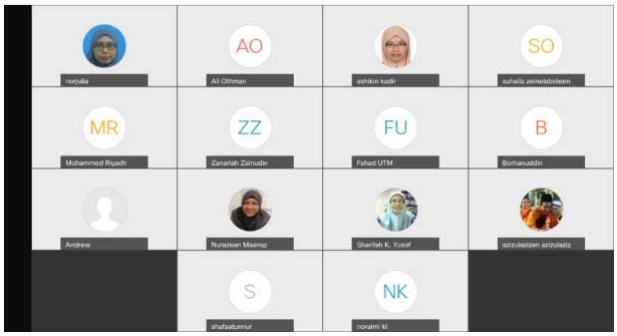


Figure 6.7(f): Attendees and trainers for ToT session on 28 February 2022

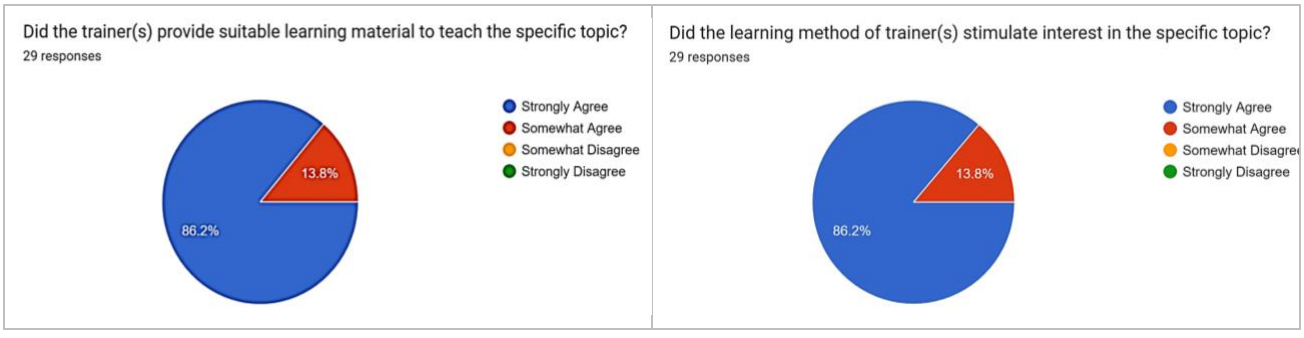
6.2.2 Part II Feedback

Following the practice in ToT session Part I, we have distributed the satisfaction survey to all participants in ToT Part II at the end of each session. In total, there are 29 respondents to the survey and the number of answers for each module offered in ToT Part II are listed in Table 6.6.

Table 6.6: Number of responses for satisfaction survey ToT Part II

Module Title	No. of Respondents
Artificial Intelligence for Computer Vision (Hands-on)	7
Supervised and Unsupervised Learning	7
Convolution Neural Network	8
Advance Machine Learning for Big Data	7

Figure 6.8 shows the results of the questionnaire for the ToT sessions Part II. Majority of the respondents strongly agree that the trainers have provided suitable learning materials and used learning methods that stimulate interest in the specific topics. Most of them also strongly agree that the trainers are experienced in the particular topics and that their degree of explanation is adequate. Around 69% of the respondents strongly agree that they have understood the contents of the module and the remaining are somewhat agree about this. Meanwhile, the majority of the respondents have agreed that the trainers have exposed focus on the practical cases while around 3.5% of the respondents somewhat disagree about this. Even though most of the respondents feel comfortable to be one of the trainers upon completion of these sessions, around 5.9% of the respondents do not feel comfortable about this. However, all the respondents agreed that the trainers have responded to their queries in a timely manner.



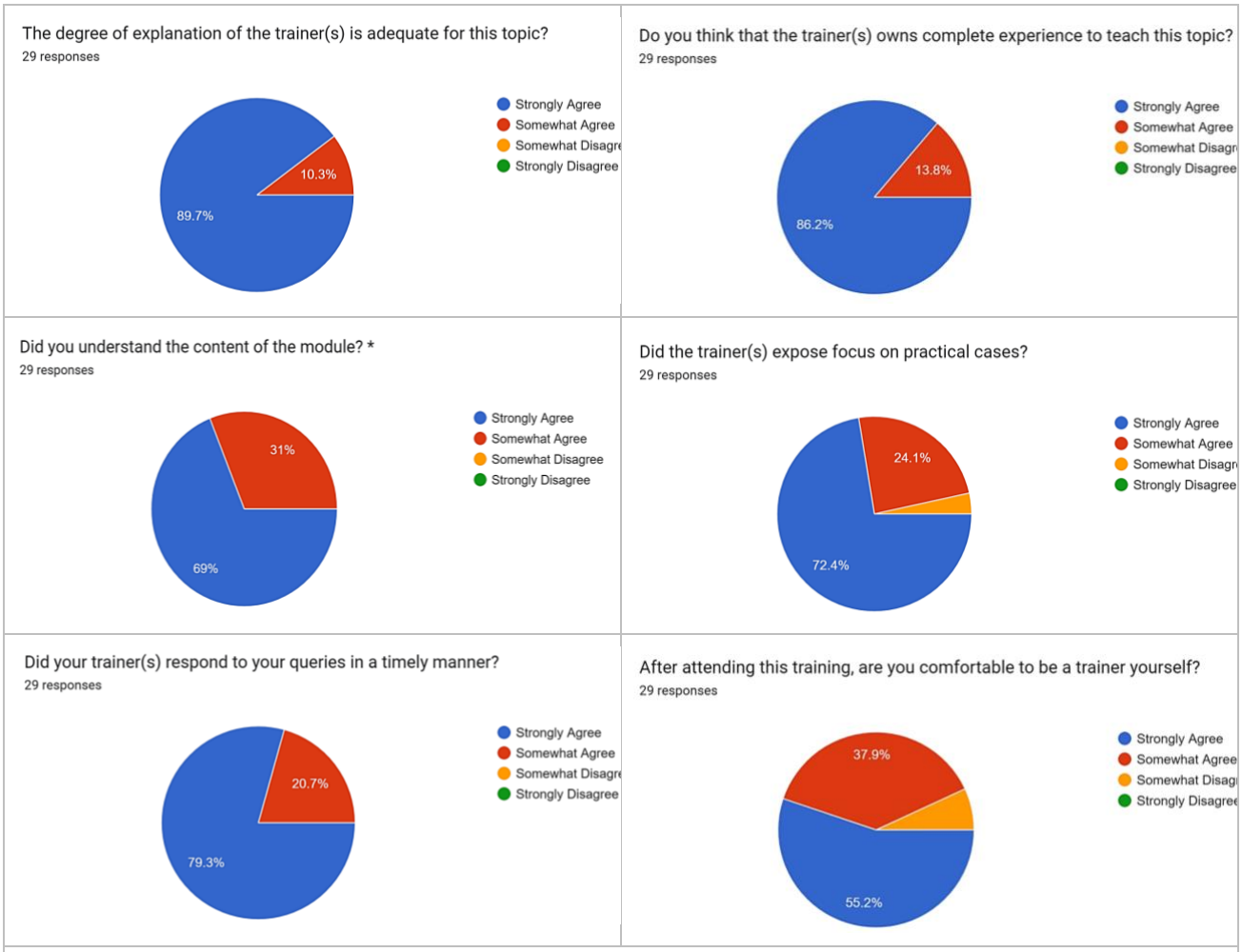


Figure 6.8: Analysis from satisfaction questionnaire for ToT session Part II Domain 4

7. Training of the Students (ToS) Sessions

After the completion of the Training of the Trainers (ToT) sessions, the Training of Students (ToS) sessions are carried out. The calling to the ToS was disseminated and promoted to the students through various mediums such as emails, e-poster, UTM Career Centre (UTMCC) and social media platforms to invite participants. The SHYFTE 4.0 training model is based on the Learning Framework developed by SHYFTE team for deliverable task D2.5. The training is applicable to Academic or Non-Academic programme. The procedure of the ToS are as follows.

1. The interested participants need to define the Programme/Training module
   a) An applicant needs to register and apply to the SHYFTE Learning Centre Management. Registration was done using Google form.
2. Student Selection
   a) For the first pilot training of Students, priority is given to UTM students with different background
   b) The successful applicants were informed through email
3. Students attended the ToS and trainer(s) conducted the module training
   a) Students did the training assessment
   b) Trainers obtained feedback on the training

Table 7.1 summarized the training modules description for the ToS. The ToS was conducted via face-to-face class and online platform Webex. This information was disseminated to all participants through Google form and email. Training modules of various range of competency skills and participant levels were carried out to acquire overall observation and reviews from our targeted stakeholders.

Table 7.1: Mapping of competency skills and training level for each training module

Level	Competency Skill	Training Module	Trainer
Beginner	• Machine Learning • Optimization • AI Application	Fundamental of AI	Dr. Norjulia Mohamad Nordin
	• Machine Learning • Optimization	Supervised and Unsupervised Learning	Dr. Aida Ali
Intermediate	AI Application	AI for Computer Vision with hands-on session	Dr. Usman Ullah Sheikh
Expert	• AI Application • Optimization	AI for Industry	Assoc. Prof. Dr Yeong Che Fai
		Metaheuristic Optimization	Assoc. Prof. Ir. Ts. Dr Nurul Mu'azzah Abdul Latif

Meanwhile, Figure 7.1 depicts the ToS poster disseminated to attract participants through social media platforms. Figure 7.2 on the other hand is the bunting that has been printed for promotion purposes. The bunting was initially placed near the entrance of the faculty and was relocated to the entrance of the lecture room where the ToS was being held.

A Google form was created for participants registration and collecting detailed information on the participants such as:

- Full name
- Mobile number
- Matrix number (for UTM students only)
- School/Faculty (for UTM students only)
- Institution / Organization
- Academic background
- Academic programme enrolled
- Working experience

- Organization
- Years of experience

- Training module selected to register
- Reasons for enrolling

Figure 7.1: ToS poster disseminated to potential participants

Figure 7.2: Bunting for promotion purposes

The list of registered participants is listed in Annex 5. The statistical information is presented in Figure 7.3. Figure 7.4 shows the academic information in terms of academic level

and academic programmes of the register participants. Meanwhile Figure 7.5(a) – Figure 7.5(c) depict the statistical information on the previous participants working experience.

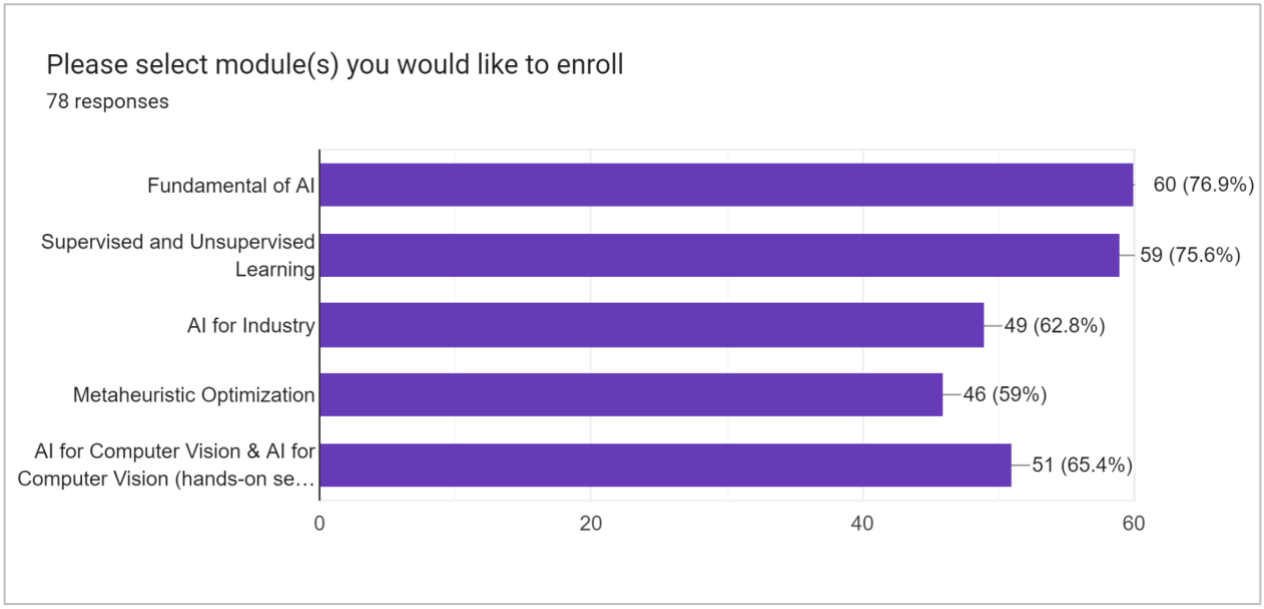


Figure 7.3: Percentage of students registered according to the modules

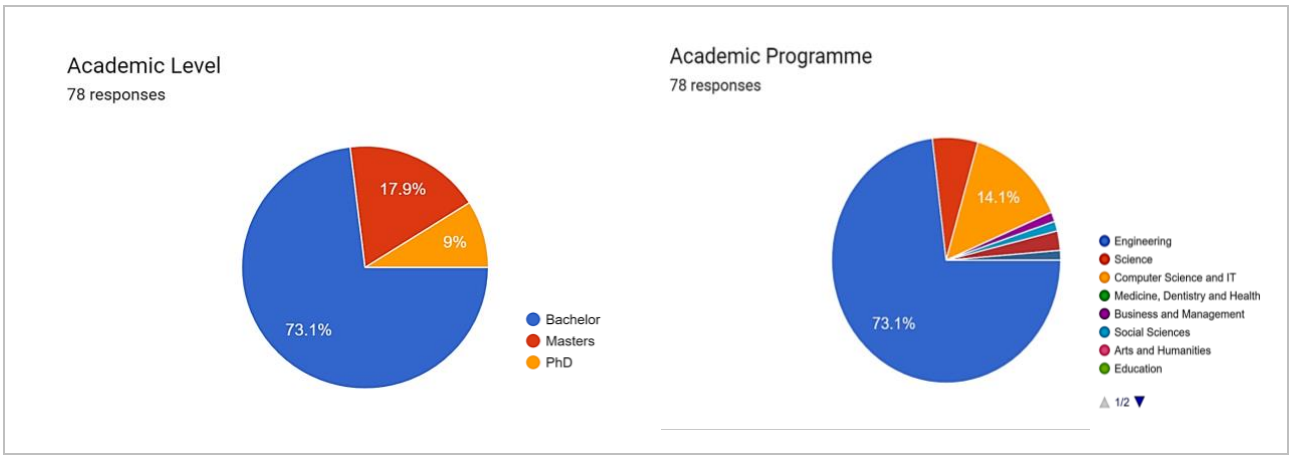


Figure 7.4: Academic information of the registered participants

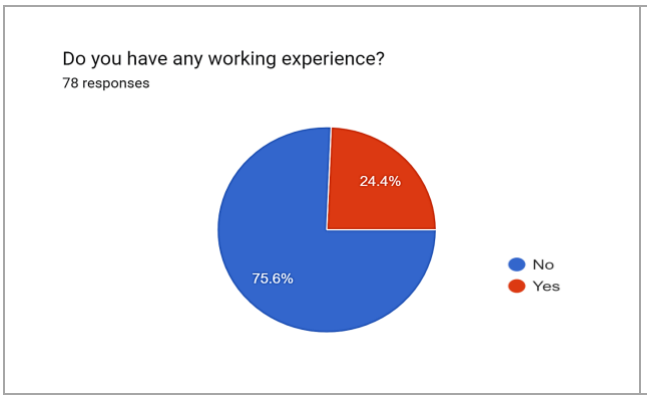


Figure 7.5(a): Working experience information of the registered participants

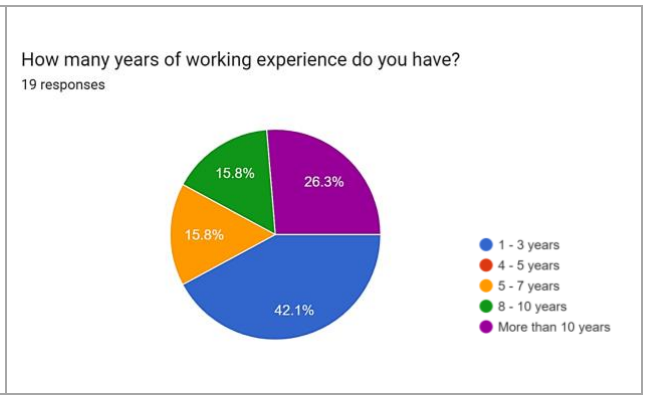


Figure 7.5(b): Number of years of experience for participants

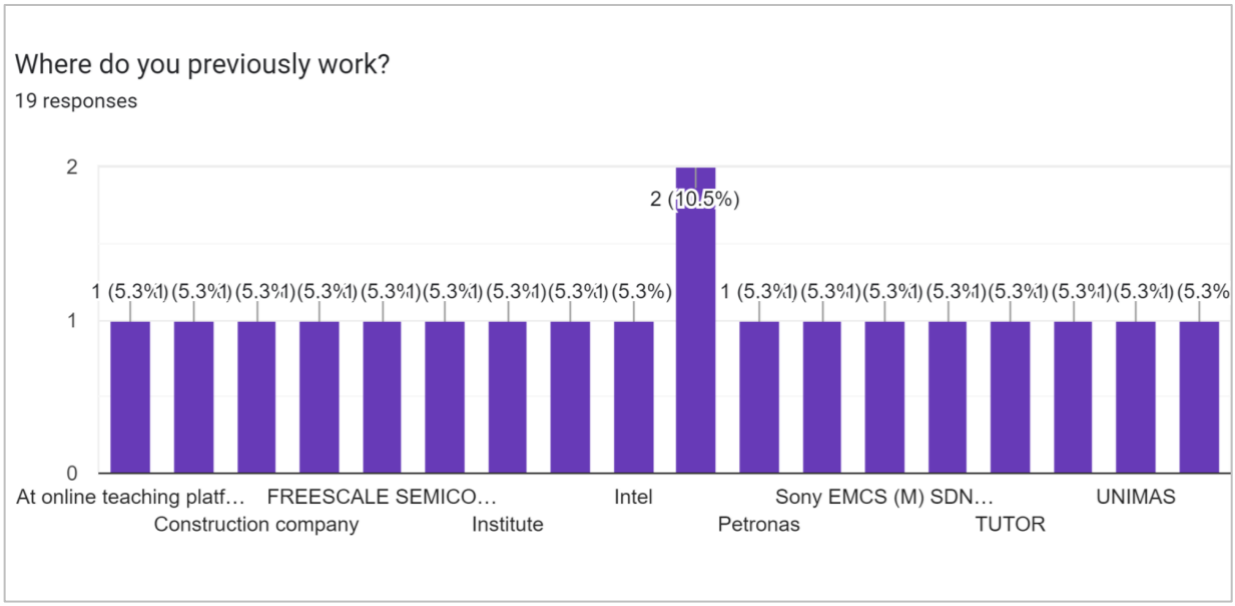


Figure 7.5(c): Previous working experience background of the registered participants

Figure 7.6 shows the statistic for enrolment reasons of the registered participants. More than half of the participants intended to enrol in the training modules to enhance their skills and knowledge and that they are interested in the fields that they chose. Less than half participated in the training modules due to demand from industries and for networking purposes.

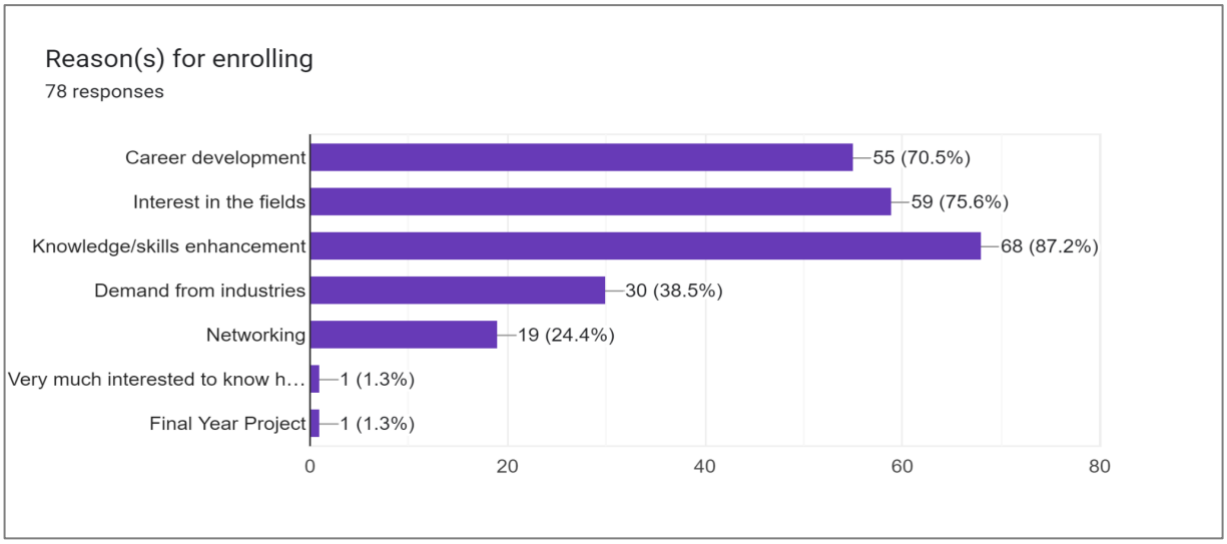


Figure 7.6: Enrolment reasons of the registered participants

7.1 Description of ToS Session

The ToS comprised five training modules as listed in the Table 7.1. The five training modules cover the beginner, intermediate and advanced levels in the AI domain framework. The module developers conducted the ToS themselves in 5 hours minimum.

All training modules were conducted in face-to-face communication in a classroom setting except for the AI for Industry module which were done as a webinar to accommodate participants from industries who are unable to come to UTM physically. Each training module was supplemented with PowerPoint presentations and multiple class activities using various teaching and learning tools to further enhance student engagement and facilitate learning and promote better understanding among students. Digital education tools applied in the classroom setting are as listed below:

- Padlet
- Mentimeter
- Teachable Machine (a web-based tool to create machine learning models by Google)

Figure 7.7 – 7.12 depict the activities that were held during the ToS sessions. All training modules involved various class activities whether individual or group. For example, Figure 7.7 illustrates how the Mentimeter was used as one of T&L tools as an ice-breaking session and for reflection activity for the Supervised and Unsupervised Machine Learning module, respectively. As shown in Figure 7.8, during the Fundamental of AI training session, the trainer had the students discuss and present in groups about real-world AI applications to help students get better understanding on the topic in class. Hands-on activities were also conducted using Nvidia Jetson Nano during the AI for Computer Vision module as shown in Figure 7.11. The Nvidia Jetson Nano is a powerful computer for embedded AI applications.

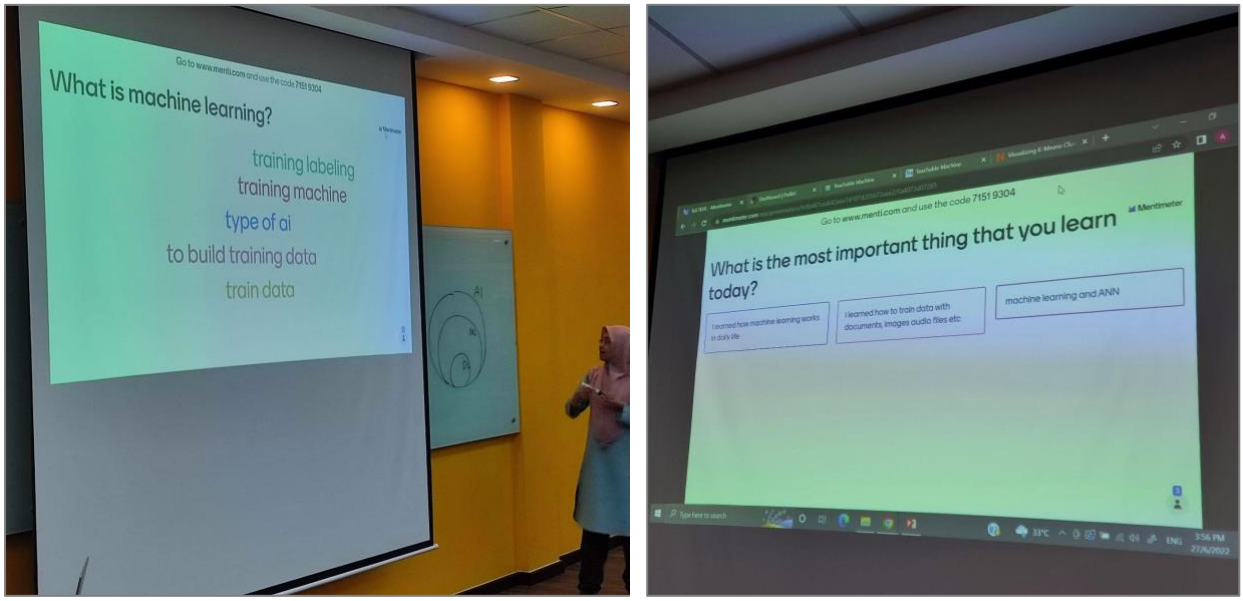


Figure 7.7: Mentimeter is used as T&L tool during Supervised and Unsupervised Machine Learning module ToS session

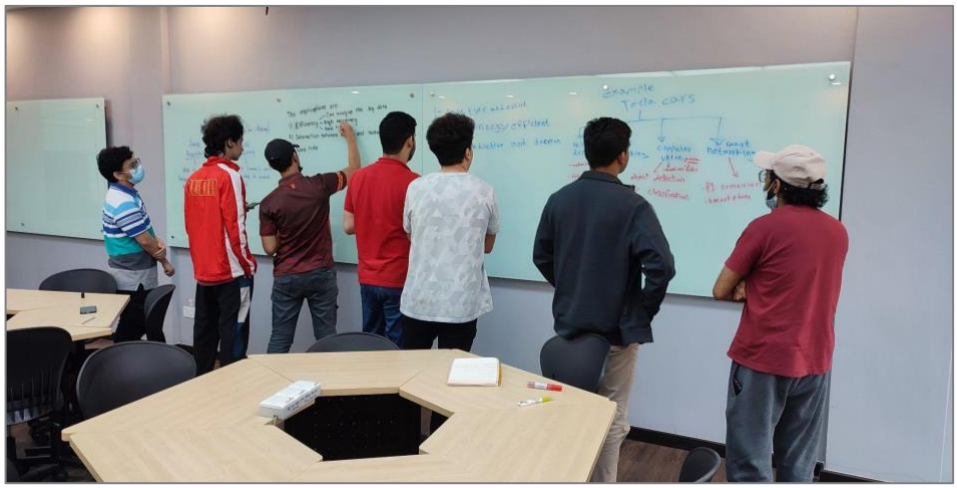


Figure 7.8: Brainstorming activity in groups during Fundamental of AI training of students.

Figure 7.9: Participants of AI for Computer Vision module (hands-on session) in the laboratory where the training was held

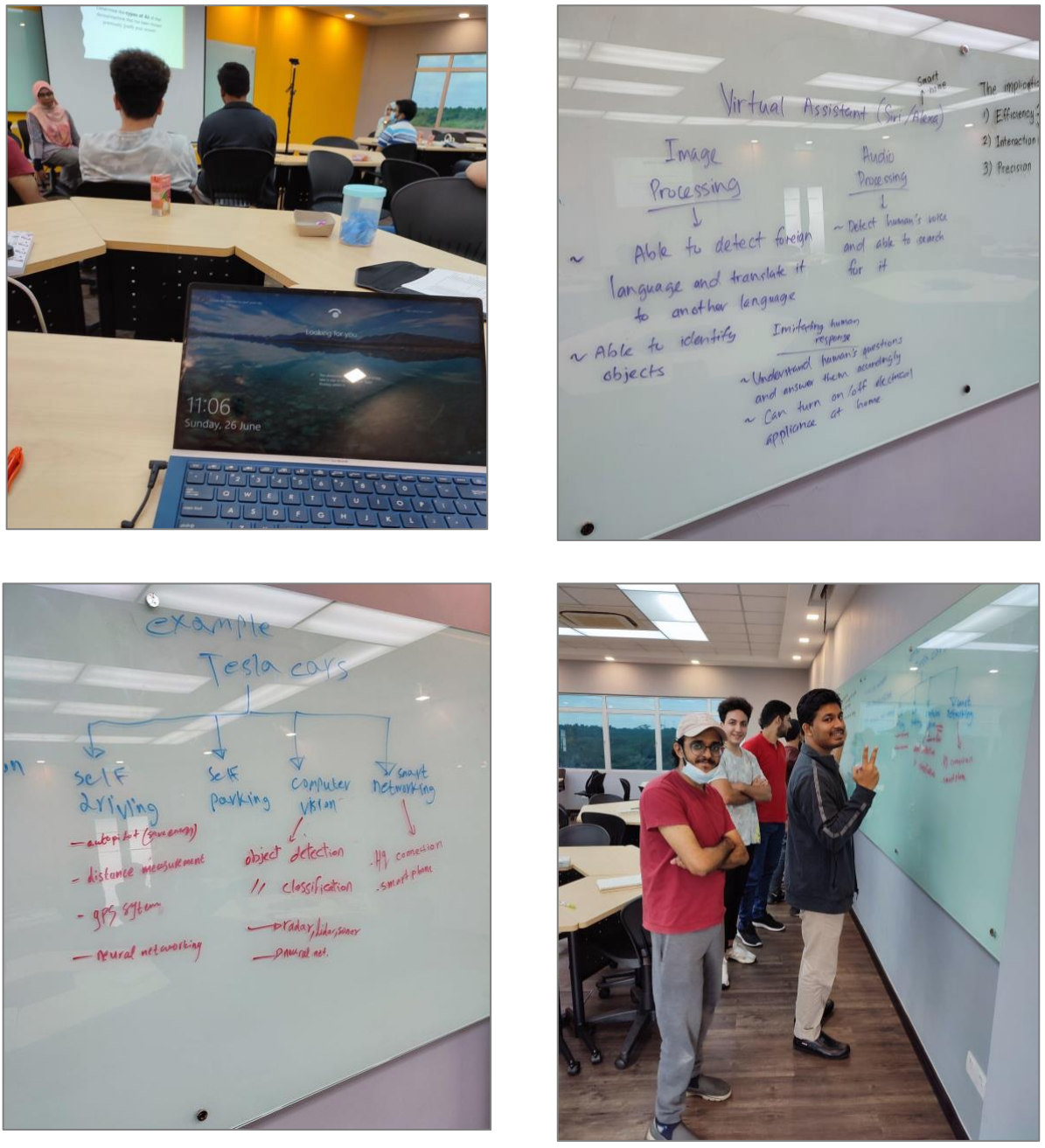


Figure 7.10: Trainer engaged with students in a discussion to guide students for group activities during the ToS of Fundamental of AI. Students wrote findings of activities on whiteboard as shown above.

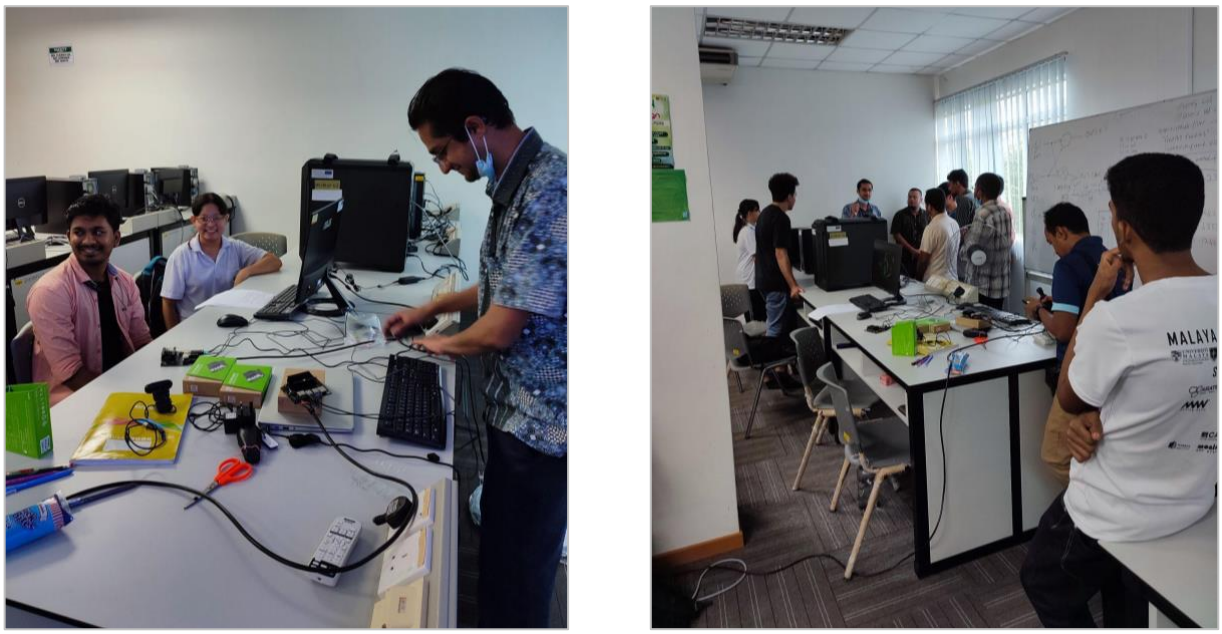


Figure 7.11: Trainer is demonstrating to students on how to implement Jetson Nano during a hands-on session for ToS of AI for Computer Vision.

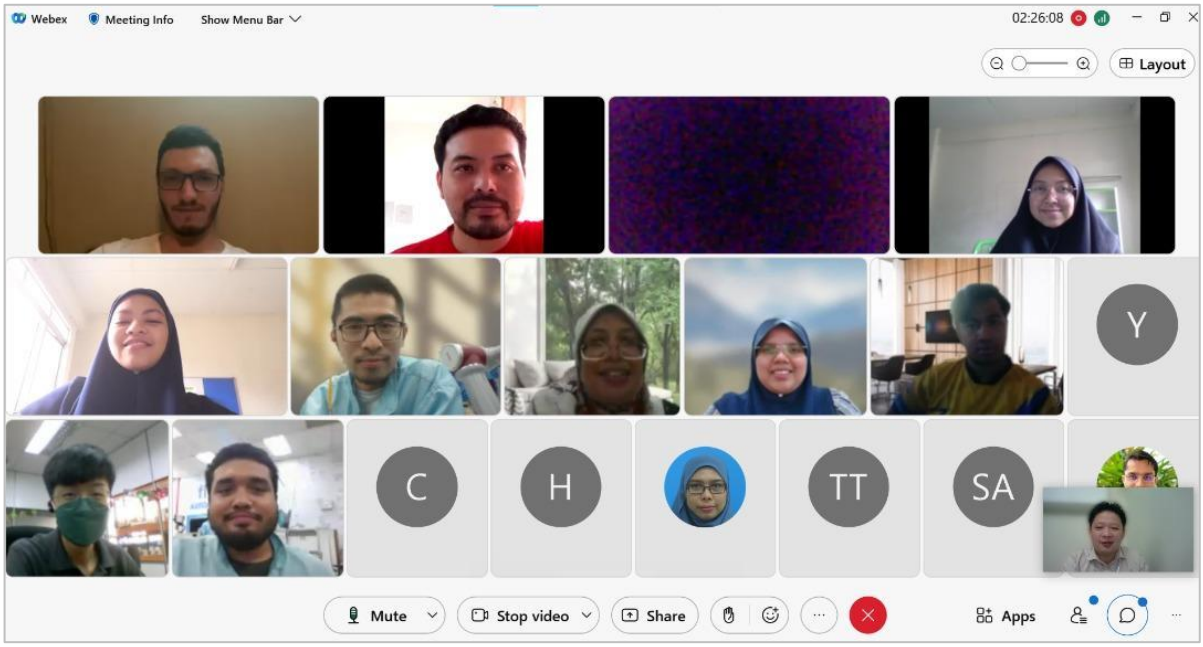


Figure 7.12: The ToS of AI for Industry training module was conducted as a webinar on Webex

Figure 7.13 shows the padlet as T&L tool for students to collaborate and share findings of group activities during ToS of Supervised and Unsupervised Machine Learning module. Students shared the pictures and videos and reflections from their group activities.

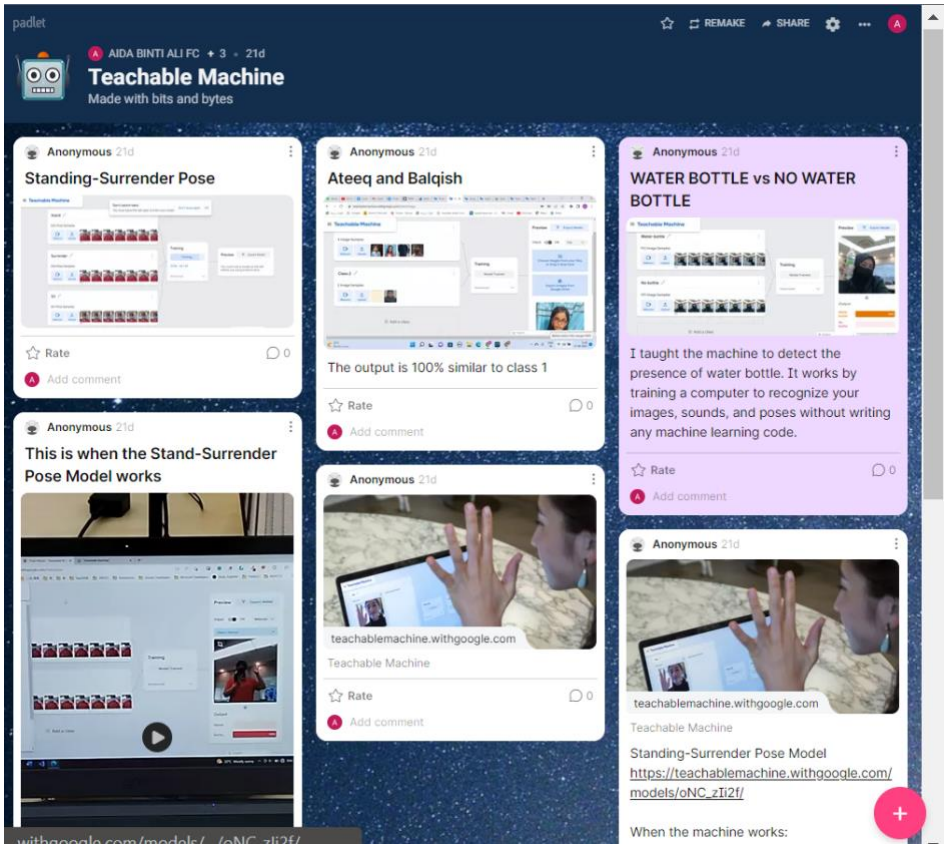


Figure 7.13: Example of activities using Padlet

7.2 Feedback from ToS Session

After the training class has completed, a ToS satisfaction survey was carried out by disseminating a questionnaire on Google form to all participants. There was feedback from 37 participants altogether as illustrated in the Figure 7.14 below. Figure 7.14 also shows the demographic of participants for ToS session in terms of their affiliation, academic background, and academic programme. Meanwhile Figure 7.15 shows the statistic from the answers of questionnaire surveys that were given to the students at the end of the ToS sessions.

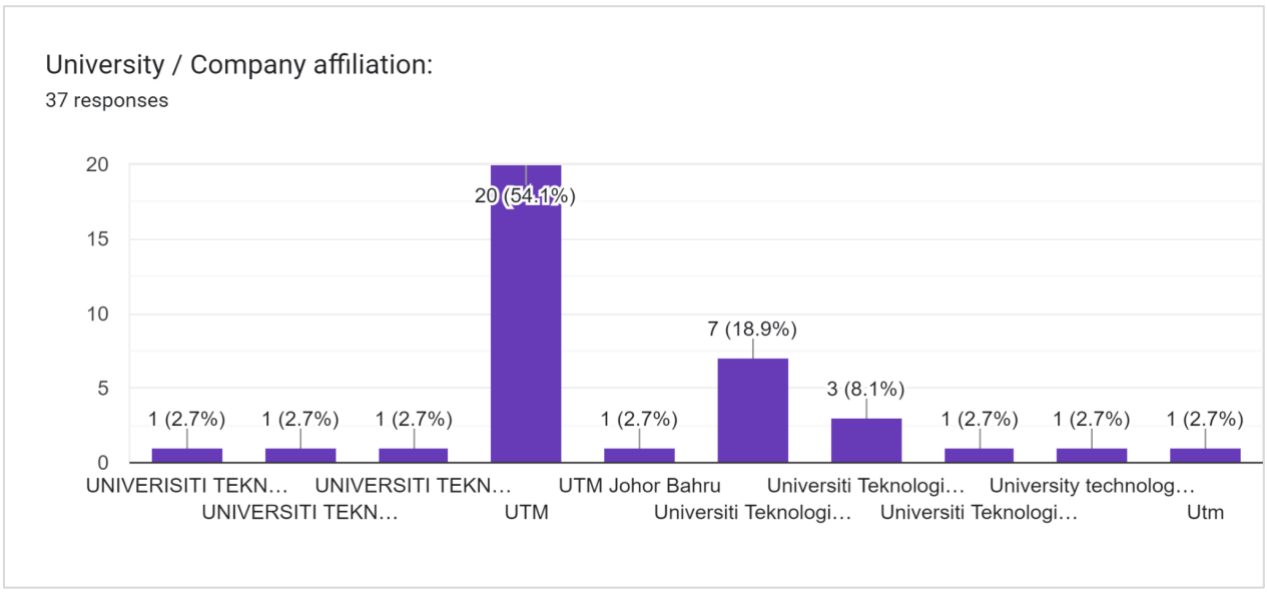


Figure 7.14(a): Affiliation for all participants of the ToS

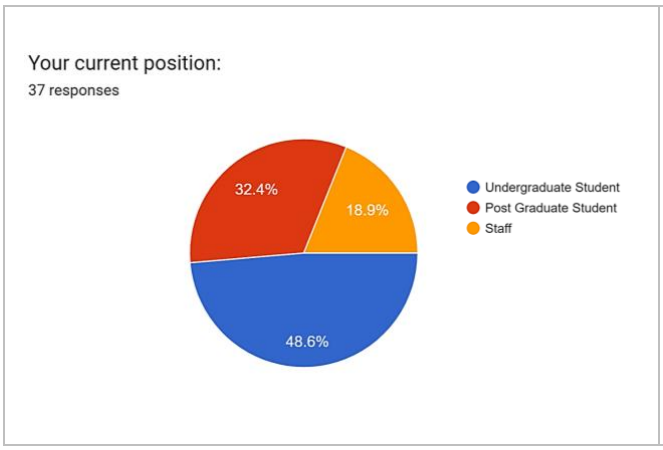


Figure 7.14(b): Academic background

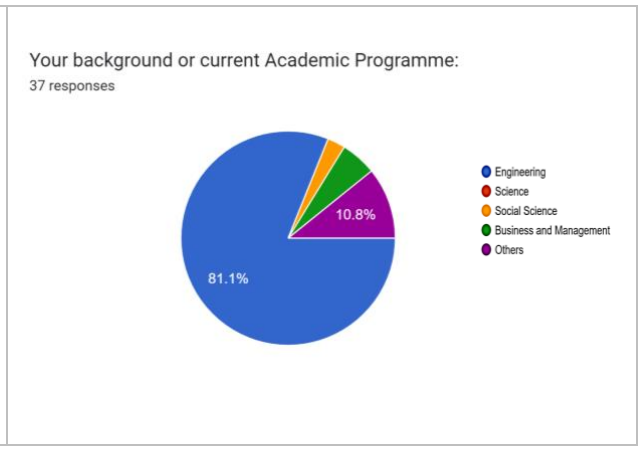
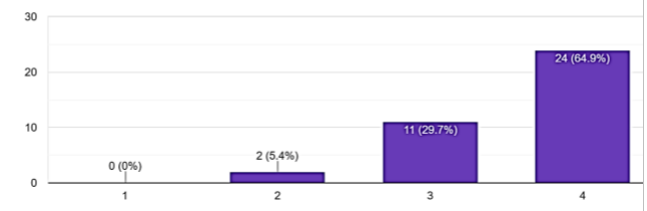


Figure 7.14(c): Academic programme

Figure 7.14: Demographic of participants of the ToS

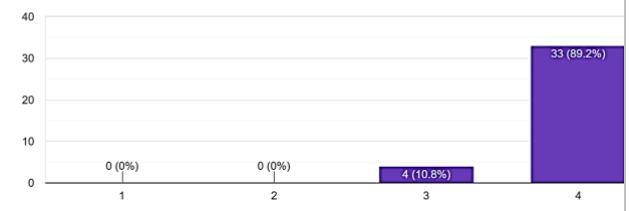
Was your own preliminary knowledge sufficient to understand the topics?

37 responses



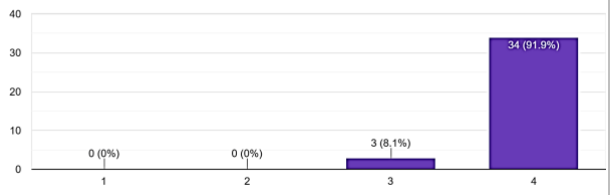
Is the training workload proportional to the work assigned?

37 responses



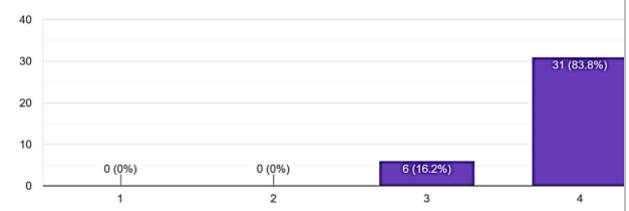
Is the training material (indicated and available) suitable for the study of the topic?

37 responses



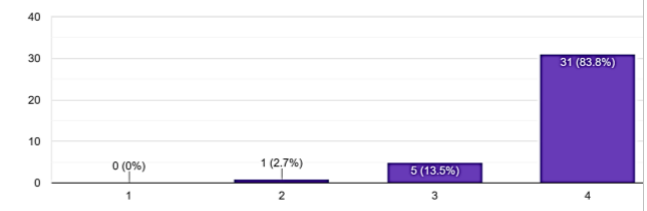
Have the evaluation methods been clearly defined?

37 responses



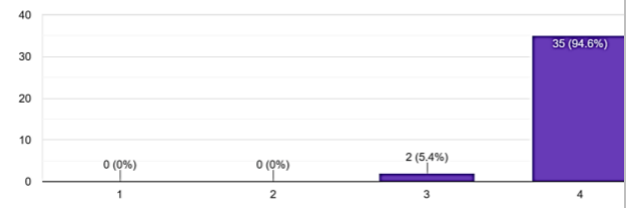
Are the lessons, exercises and other training activities carried out in accordance with the timetable?

37 responses



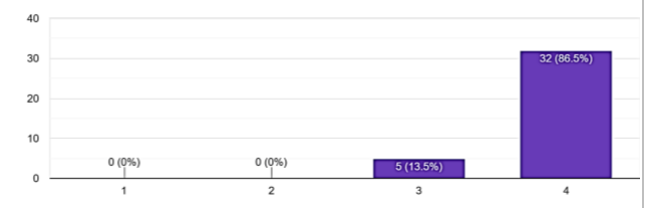
Does the Instructor stimulate/motivate interest in the topic?

37 responses



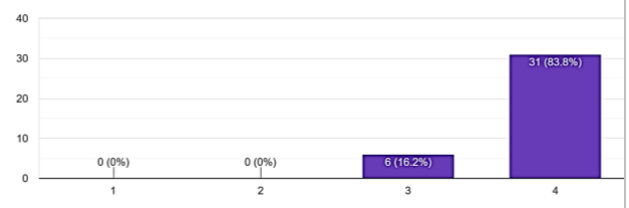
Does the Instructor explain the topics clearly?

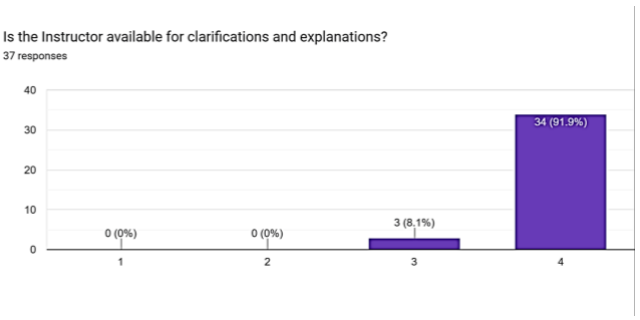
37 responses

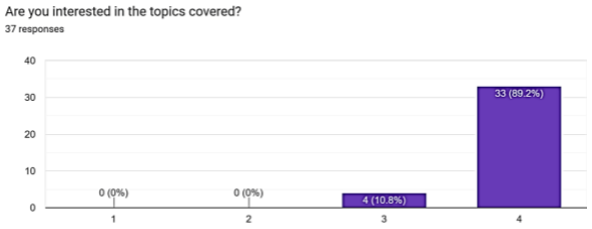


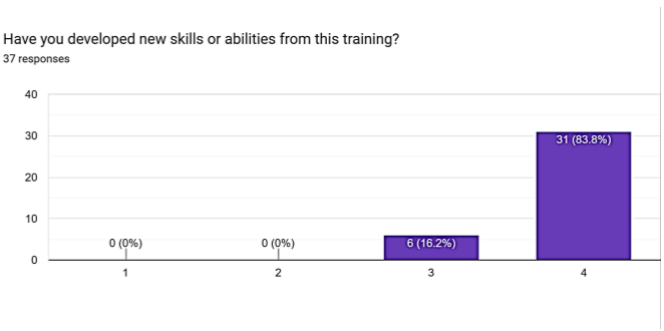
Are the training activities (exercises, games, simulation, etc.) useful for learning the topic?

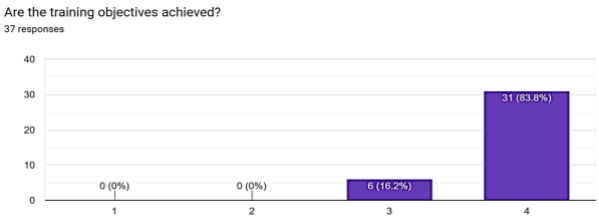
37 responses

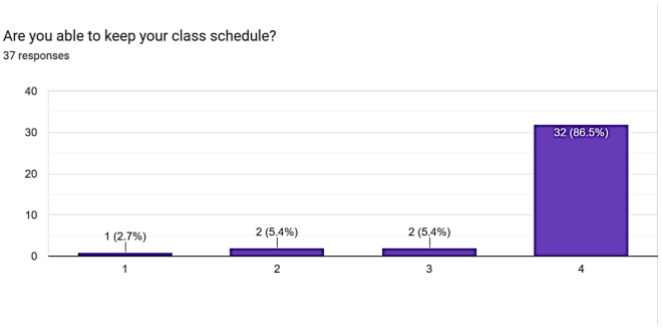


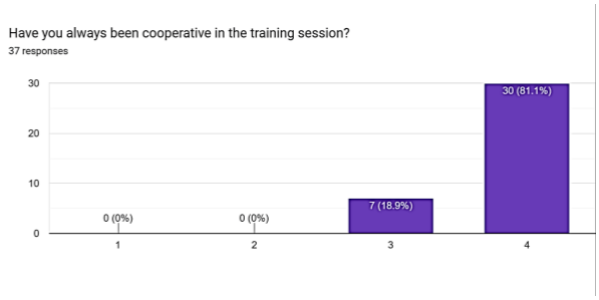

Is the Instructor available for clarifications and explanations?
37 responses
40
30
20
10
0
0 (0%)
0 (0%)
3 (8.1%)
34 (91.9%)
1
2
3
4

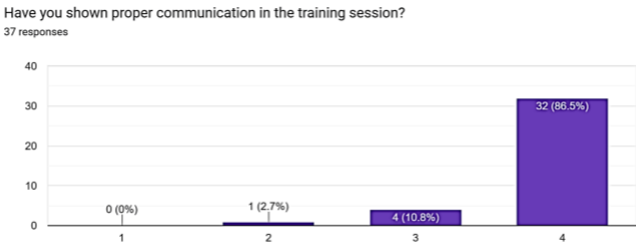

Are you interested in the topics covered?
37 responses
40
30
20
10
0
0 (0%)
0 (0%)
4 (10.8%)
33 (89.2%)
1
2
3
4

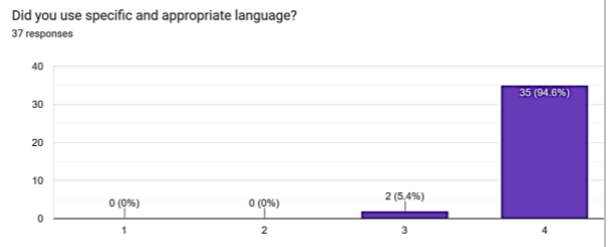

Have you developed new skills or abilities from this training?
37 responses
40
30
20
10
0
0 (0%)
0 (0%)
6 (16.2%)
31 (83.8%)
1
2
3
4


Are the training objectives achieved?
37 responses
40
30
20
10
0
0 (0%)
0 (0%)
6 (16.2%)
31 (83.8%)
1
2
3
4


Are you able to keep your class schedule?
37 responses
40
30
20
10
0
1 (2.7%)
2 (5.4%)
2 (5.4%)
32 (86.5%)
1
2
3
4


Have you always been cooperative in the training session?
37 responses
30
20
10
0
0 (0%)
0 (0%)
7 (18.9%)
30 (81.1%)
1
2
3
4


Have you shown proper communication in the training session?
37 responses
40
30
20
10
0
0 (0%)
1 (2.7%)
4 (10.8%)
32 (86.5%)
1
2
3
4


Did you use specific and appropriate language?
37 responses
40
30
20
10
0
0 (0%)
0 (0%)
2 (5.4%)
35 (94.6%)
1
2
3
4

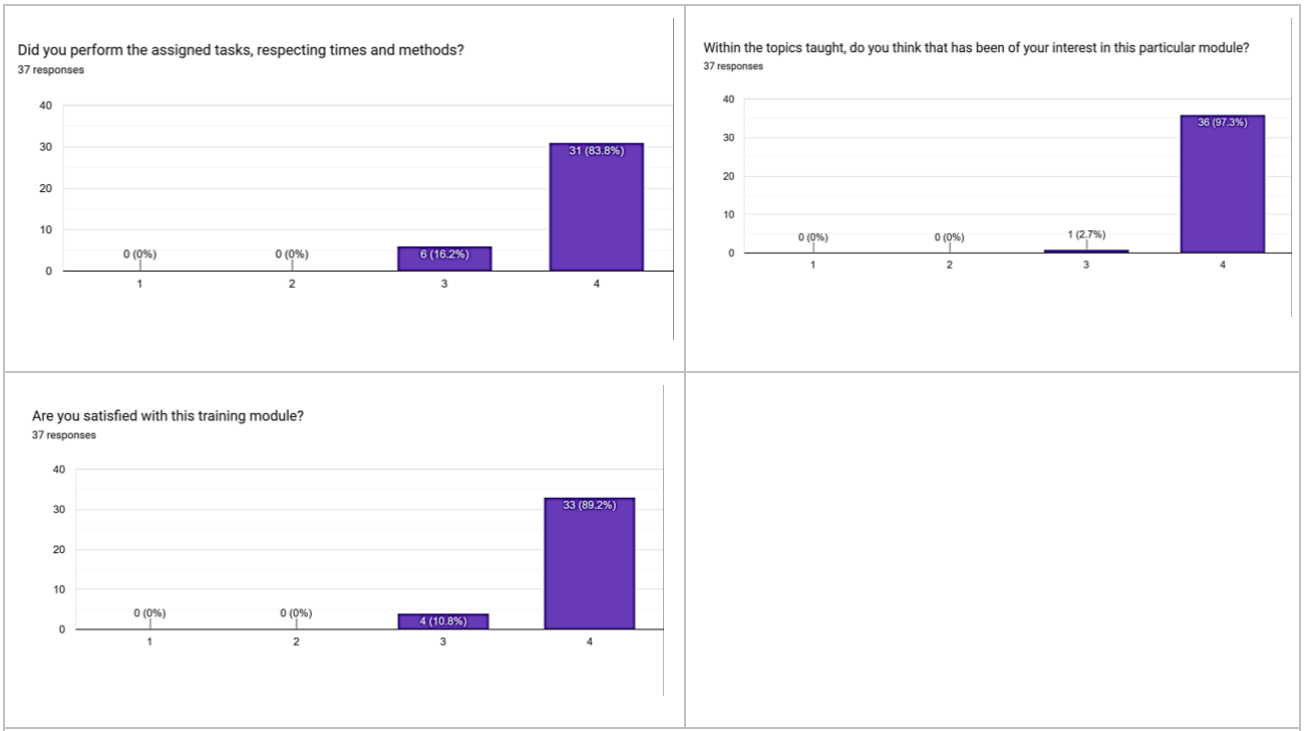


Figure 7.15: Survey responses from ToS participants

From the ToS survey done, it can be concluded that almost all participants gave positive comments. The bar graphs in Figure 7.15 depict that at least 83% participants strongly agree that every performance measure was achieved.

Figure 7.16 shows the excerpts of comments from participants on ToS. Almost all participants give positive comments on the training session. However, a few participants felt that the ToS was conducted at an inconvenient time since week 15 was when the final exam has started. Also, some respondents expressed interest to participate via online for the ToS but were unable to come because many training sessions were carried out physically in UTM JB campus.

- *Great training! Love it. Hope to have more training like this in the future. I will definitely join if there's more and even for topics that are more advanced.*
- *Can make it into more than 1 day because it was very interesting and makes me understand more about machine learning*
- *A good exposure on personal level and given me an idea of an AI and anticipation for the industry I'm working in.*
- *Please provide us more training or scholarship in the field of computer vision with a great lecturer like Dr Osman. He has the ability to pass the knowledge to us clearly in a professional way.*
- *We need to continue in this field so we can provide valuable projects that can assist people in their lives.*
- *Thanks in advance for what you have done for us so far.*
- *The Trainer's Industry entrepreneurial experience is valuable*

Figure 7.16: Comments from participants

Table 7.2 also reflects similar findings because the mean for all survey questions is very close to 4 with standard deviation scores nearing to 0 suggesting that there is very small variation in participants' answers to the survey done. This means participants agree in unison that the ToS achieved all the intended objectives. Hyperlink to video footage of participant interviews and individual reflection on ToS can be found in the Resources in Section 8.

Table 7.2: Statistical analysis on survey responses from ToS participants

No.	Survey Question	Mean	Standard Deviation
1.	Was your own preliminary knowledge sufficient to understand the topics?	3.595	0.591
2.	Is the training workload proportional to the work assigned?	3.892	0.311
3.	Is the training material (indicated and available) suitable for the study of the topic?	3.919	0.273
4.	Have the evaluation methods been clearly defined?	3.838	0.369
5.	Are the lessons, exercises and other training activities carried out in accordance with the timetable?	3.811	0.455
6.	Does the Instructor stimulate/motivate interest in the topic?	3.946	0.226
7.	Does the Instructor explain the topics clearly?	3.865	0.342
8.	Are the training activities (exercises, games, simulation, etc.) useful for learning the topic?	3.838	0.369
9.	Is the Instructor available for clarifications and explanations?	3.919	0.273
10.	Are you interested in the topics covered?	3.892	0.311
11.	Have you developed new skills or abilities from this training?	3.838	0.369
12.	Are the training objectives achieved?	3.838	0.369
13.	Are you able to keep your class schedule?	3.757	0.674
14.	Have you always been cooperative in the training session?	3.811	0.392
15.	Have you shown proper communication in the training session?	3.838	0.436
16.	Did you use specific and appropriate language?	3.946	0.226
17.	Did you perform the assigned tasks, respecting times and methods?	3.838	0.369
18.	Within the topics taught, do you think that has been of your interest in this particular module?	3.973	0.162
19.	Are you satisfied with this training module?	3.892	0.311

8. Resource for Learning Materials

8.1 Public Materials

A website dedicated to Artificial Intelligence domain is developed by UTM team in order to update the news and events on SHYFTE activities. The address of the website is https://www.utm.my/shyfte/ and it can be accessed by public. In addition, a playlist on Youtube is created to showcase SHYFTE activities and can be accessed via the following address:

https://youtube.com/playlist?list=PLSB8f39y-65nRKDbcGGTNHwBAqYwlkUmA

There are two specific videos created for SHYFTE AI domain as listed below:

1. Video on Introduction of UTM SHYFTE: https://youtu.be/nJ0EDJoyIh0
2. Video on Training of Students: https://youtu.be/GZvtYwIle8M

Table 8.1 shows the resources link for each training modules involve in the ToT and ToS sessions. The resources were used for the development of the modules, as well as for the training sessions and they can be accessed publicly.

Training Module	Resource Link
Fundamental of Artificial Intelligence	[1] https://youtu.be/kWmX3pd1f10 [2] Kok, J. N., Boers, E. J., Kosters, W. A., Van der Putten, P., & Poel, M. (2009). Artificial intelligence: definition, trends, techniques, and cases. *Artificial intelligence*, *1*, 270-299. [3] Kaul, Vivek, Sarah Enslin, and Seth A. Gross. "The history of artificial intelligence in medicine." *Gastrointestinal endoscopy* (2020). [4] https://www.mygreatlearning.com/blog/what-is-artificial-intelligence/. [5] https://www.luxtag.io/blog/artificial-intelligence-challenges-benefits-and-risks/. [6] https://www.upgrad.com/blog/top-challenges-in-artificial-intelligence/. [7] https://ec.europa.eu/digital-single-market/en/news/ethics-guidelines-trustworthy-ai.

Introduction to Artificial Intelligence Application	[1] https://www.theguardian.com/technology/2018/oct/10/amazon-hiring-ai-gender-bias-recruiting-engine [2] Explaining and Harnessing Adversarial Examples, Goodfellow et al, ICLR 2015 [3] https://towardsdatascience.com/compas-case-study-fairness-of-a-machine-learning-model-f0f804108751
Supervised and Unsupervised learning	[1] https://youtu.be/cfj6yaYE86U [2] https://teachablemachine.withgoogle.com/
Artificial Intelligence for Computer Vision	[1] https://youtu.be/Uvu6NNOvhg4 [2] https://developer.nvidia.com/embedded/jetson-nano-developer-kit [3] https://youtu.be/NYM0l1JZIVA [4] https://youtu.be/QXIwdsyK7Rw [5] https://youtu.be/OcycT1Jwsns
Convolution Neural Network	[1] https://youtu.be/QzY57FaENXg [2] https://viso.ai/deep-learning/vgg-very-deep-convolutional-networks/
Artificial Intelligence for Industry	[1] https://www.techopedia.com/definition/190/artificial-intelligence-ai [2] https://robots.ieee.org/robots/?t=sort [3] https://kambria.io/blog/three-types-of-ai/ [4] https://hbr.org/2018/01/artificial-intelligence-for-the-real-world
Advance Machine Learning for Big Data	[1] Shafaatunnur Hasan, Siti Mariyam Shamsuddin and Noel Lopes. Machine Learning Big Data Framework and Analytics for Big Data Problems.International Journal of Advances in Soft Computing and its Application, 6, 2(2014), 1-14. [2] Shafaatunnur Hasan, Siti Mariyam Shamsuddin and Noel Lopes. Soft Computing Methods for Big Data Problems. GPU Computing and Applications (2015), 235-247. [3] http://gpumlib.sourceforge.net
Metaheuristic Optimization	[1] Thomas Weise, Metaheuristic Optimization, Hefei University, Institute of Applied Optimization, Shushan District, Hefei, Anhui, China. http://iao.hfuu.edu.cn/images/teaching/lectures/metaheuristic_optimization/01_introduction.pdf [2] S. Russel, P. Norvig, Artificial Intelligence, A Modern Approach, Pearson. [3] “Traveling Salesman Problem (TSP) with Miller-Tucker-Zemlin (MTZ) in CPLEX/OPL. https://co-enzyme.fr/blog/traveling-salesman-problem-tsp-in-cplex-opl-with-miller-tucker-zemlin-mtz-formulation/ [4] https://csvisualized.eschirtz.com/#/demos/ep01

	[5] Simulated Annealing - The Travelling Salesman Problem, John Walker, June, 2018 https://www.fourmilab.ch/documents/travelling/anneal/ [6] T. Munkata, "Fundamentals of the New Artificial Intelligence, Neural, Evolutionary, Fuzzy and More:, Second Edition, Springer, 2008. [7] Martins, J., & Ning, A. (2021). *Engineering Design Optimization*. Cambridge: Cambridge University Press. doi:10.1017/9781108980647. [8] https://tools-unite.com/tools/random-picker-wheel [9] http://www.edc.ncl.ac.uk/highlight/rhjanuary2007g02.php

8.2 Confidential Materials

All confidential materials were uploaded in OwnCloud and will also be uploaded in the learning centre's website. Table 8.2 lists down all the links that stores the resources in terms of notes and recorded training sessions.

Training Module	Resource Link
Fundamental of Artificial Intelligence	Notes: https://disp-ds.univ-lyon2.fr/owncloud/f/1382956
Introduction to Artificial Intelligence Application	Notes: https://disp-ds.univ-lyon2.fr/owncloud/f/1382957 Recorded lecture for Training of Trainers: Link: https://utm.webex.com/utm/ldr.php?RCID=605a4150ce1d1f9096a2c5dd3ebdac2e Password: NhHFpxP5
Supervised and Unsupervised learning	Notes: https://disp-ds.univ-lyon2.fr/owncloud/f/1382959 Recorded lecture for Training of Trainers: https://disp-ds.univ-lyon2.fr/owncloud/f/1417116

Artificial Intelligence for Computer Vision	Notes: https://disp-ds.univ-lyon2.fr/owncloud/f/1382963 Recorded lecture for Training of Trainers: Part 1 link: https://utm.webex.com/utm/ldr.php?RCID=6c9c5c2a66ff27603ae5e3d9fc304733 Password: XapWdKH5 Part 2 link: https://utm.webex.com/utm/ldr.php?RCID=d5d271395c8d168b3d5304ffaee25da8 Password: uPJDeX7V
Convolution Neural Network	Notes: https://disp-ds.univ-lyon2.fr/owncloud/f/1382964 Recorded lecture for Training of Trainers: Link: https://utm.webex.com/utm/ldr.php?RCID=28214af05d22425e206c8e743c48bc69 Password: yVyExhF5
Artificial Intelligence for Industry	Notes: https://disp-ds.univ-lyon2.fr/owncloud/f/1382961 Recorded lecture for Training of Trainers: Link: https://utm.webex.com/utm/ldr.php?RCID=687e32373fb010fc9f4971ba37f849b2 Password: QpABagE3 Recorded lecture for Training of Students: Link: https://utm.webex.com/utm/ldr.php?RCID=5127b883c795d0b8ad98104e94119524 Password: RjmDMjR7

Advance Machine Learning for Big Data	Notes: https://disp-ds.univ-lyon2.fr/owncloud/f/1382960 Recorded lecture for Training of Trainers: Link: https://utm.webex.com/utm/ldr.php?RCID=fe95f9a3f95e6eedfce8a0c5d238f36f Password: Jgu56PMM
Metaheuristic Optimization	Notes: https://disp-ds.univ-lyon2.fr/owncloud/f/1382962

9. Deviations or Mitigations Actions

Deviation and some mitigations have taken place during the implementation and completion of the project. This is due to COVID -19 such that many activities were not implemented according to plan. A delay in procurement affected the conduct of training. It is further worsened by the movement control order (MCO) which do not allow anyone to work on campus.

The project mitigated to conduct the ToT training online instead of face to face due to pandemic and lock down. The training managed to get participations from some SHYFTE partners and also from industry. 80% of the ToS sessions were carried out in face-to-face settings. Two employees from industry, Flextronics Berhad participated in the online ToS training. Based on the attendance list, some of the registered selected students were unable to attend due to circumstances. Overall, we managed to achieve the planned target for ToS attendance and feedback. From our observations and findings, the students prefer and favour the implementation of training in face-to-face mode. UTM will continue to improve the modules for future training based on the feedbacks received from the training survey.

UTM also has to conduct ToS without the assistance of EU partners who were supposed to assist for the 20 days training. However, the comments received from internal and external reviewers, as well as feedback from ToT, helped UTM to improve the conduct of training for ToS.

10. Future Direction and Sustainability of Learning Centre

To ensure the sustainability of the Learning Centre for the AI domain, a few measures are suggested as follows:

i. A continuous curriculum review on the existing and new academic programme is possible to include the SHYFTE domain and modules that are relevant to Skill4.0.
ii. Learning is a lifelong journey. Acquiring new skills throughout life not only enhances wellbeing, but also employment prospects. Therefore, with regards to the Learning Centre, lifelong learning courses offering is essential.
iii. To develop micro-credential (MC) courses for the AI domain modules. Each of the module will consist of several MC courses. The courses can be offered to the public at cost which can be used to support the running of the learning centre. Upon successful completion of the courses the participants will be awarded with the MC badges. Depending on the module level, the MC badges can be collected as evidence for up-skilling or re-skilling by employees. In addition, the collected MC badges can also be used to obtain credit transfers for relevant academic programs.
iv. To encourage credit transfer with European partners through European Credit Transfer and Accumulation System (ECTS).
v. Develop Massive Open Online Courses (MOOC) based on the AI domain modules to be offered in relevant academic programs whether at postgraduate or undergraduate level. Students all over the world would be able to enrol in the MOOC offered and upon completion, the courses can be considered for acceptance in other relevant academic programs. Industry plays a critical role in specifying the skills needed today and into the future. Strengthening industry engagement is a key measure in SHYFTE is important in order to provide relevant training to employer needs and skills change hence boosting trainees' outcomes through better qualifications.

11. Conclusion

SHYFTE project has completed after a 10-month extension. We have successfully completed the project by developing 12 new modules that would enhance the skillset of participants in the area of Artificial Intelligence (AI). During the course of the project, a few deviations and mitigations due to pandemic have taken place to ensure the completion of the project. We have conducted two training of trainers (ToT) sessions through online mode to potential trainers to ensure sustainability of the training implementation. We have also conducted training of students (ToS) which were mostly conducted through face-to-face mode. Many students have shown interest to further enhance their skill in the domain. Participation from the industry met the project KPI needs. Both trainings utilized the equipment purchased under the SHYFTE project and will be used for future trainings. Feedbacks from the training were taken into considerations for continuous improvement actions. The sustainability of the project is enhanced with the development of a Learning Centre which provides a platform for potential participants to enrol into this customizable training.

http://www.shyfte.eu/