DUCTING DESIGN STUDIES USING MULTIMEDIA PLATFORM FOR EDUCATIONAL PURPOSE

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in fulfillment of the requirement for the degree of
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DECLARATION

I declare that this project report entitled "Ducting Design Studies Using Multimedia Platform For Educational Purpose" is the result of my own work except as cited in the references

Signature : .....

Name : Ahmad Syazwan bin Mohd Sobri

Date : .....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Thermal - Fluids).

Signature :. .....

Name of Supervisor : Prof. Dr. Md Razali bin Ayob

Date : .....

DEDICATION

I dedicated this Final Year Project to my lovely parent, Mr. Mohd Sobri bin Samsudin, Mdm Saidah binti Ramli and my family because they always keep supporting me and giving me courage in completing this project. Thankful and appreciation I give to Prof. Dr Md. Razali Ayob as my supervisor that always guide me in completing this project. Much appreciation I give to my friends that helps me and guide me in completing this project.

ABSTRACT

Heating, Ventilating and Air Conditioning (HVAC) system is a system that consist of component to treat the air and use it duct network to transmit the treated air to specific location. The duct network of the HVAC system need to be design appropriately in order to reduce loss in the duct, so the treated air can be delivered according to the demand of the place. In order to design a good duct network, ducting design study are crucial to be learn as the behavior of the duct network are explained. For engineering student, the ducting design knowledge are covered in the subject of Air Conditioning System or HVAC course. A ducting design studies involve calculations and theory related to the duct variable, which makes the learning of ducting design topic are complex. For some student, ducting design studies is considered as a challenging subject as it is involving theory, calculation and some consideration. Thus, the project is implemented to propose a multimedia platform in the field of ducting design studies and to create the internet-based learning platform for ducting design studies in order to overcome the problem of learning such as boredom and one-way interaction of learning. By implementing multimedia element in the source of study, the project is proposing an interactive learning by having a multimedia implementation into the learning of engineering topic such as ducting design studies.

ABSTRAK

Sistem Pemanas, Ganti Udara dan Penyaman udara (HVAC) adalah satu sistem yang terdiri daripada komponen untuk merawat udara dan menggunakan rangkaian saluran untuk menghantar udara yang dirawat ke lokasi tertentu. Rangkaian sistem saluran HVAC perlu direka bentuk sewajarnya untuk mengurangkan kerugian udara di dalam salur, supaya udara yang dirawat boleh dihantar secukupnya mengikut permintaan sesuatu tempat. Dalam usaha untuk mereka bentuk rangkaian saluran yang baik, pembelajaran mengenai reka bentuk saluran adalah penting untuk dipelajari supaya seseorang dapat memahami sifat rangkaian saluran HVAC. Bagi pelajar kejuruteraan, pembelajaran mengenai reka bentuk saluran dibincangkan dalam subjek Sistem Penyaman Udara atau kursus HVAC. Pembelajaran mengenai reka bentuk saluran melibatkan pengiraan dan teori yang berkaitan dengan pembolehubah salur, yang menjadikannya sebagai satu subjek yang kompleks. Bagi sesetengah pelajar, pembelajaran mengenai reka bentuk saluran dianggap sebagai mata pelajaran yang mencabar kerana ia adalah melibatkan teori, pengiraan dan beberapa pertimbangan. Oleh itu, projek ini dilaksanakan untuk mencadangkan satu platform multimedia dalam mempelajari reka bentuk saluran HVAC dan mewujudkan platform pembelajaran berasaskan internet untuk mengatasi masalah pembelajaran seperti kebosanan dan interaksi satu arah didalam pembelajaran. Dengan melaksanakan elemen multimedia dalam sumber pembelajaran, projek ini mencadangkan pembelajaran interaktif dengan menyuntik elemen multimedia ke dalam pembelajaran berkaitan topik kejuruteraan seperti pembelajaran mengenai reka bentuk saluran HVAC.

ACKNOWLEDGEMENT

Firstly, I would like to express my grateful for giving me opportunity to complete this report in the time given. I would like to thank to my supervisor of the project, Prof. Dr Md Razali bin Ayob for giving me the knowledge and guidance upon completing the Final Year Project. Without his supervision and guidance in this project, the project might not have completed in time and successful. By his guidance, I could able to gain experiences in managing and preparing a project for the level of bachelor degree.

I would also express my gratitude to my Academic Advisor, Dr Rafidah Hassan for giving me hopes, idea and courage in completing this project. Her encouragement is much helping me in preparing mentally and physically to complete this project. Special appreciations I give to lecturers and my fellow friends because always guiding and helping me in completing all the requirement of the project. Not to forget, a lot of love I express to my family for always have faith in me. Thank you.

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LIST OF ABBREVIATION

CAI	Computer Aided instruction
CBT	Computer-Based Training
HTML	Hypertext Mark-up Language
HVAC	Heating, Ventilating and Air Conditioning
ILM	Interactive Learning Module
MOOC	Massive Open Online Course
URL	Uniform Resource Locator
VAV	Variable Air Volume

LIST OF SYMBOL

Δp_t	Total pressure
$p_{t,1}$	Total pressure at station 1
$p_{t,2}$	Total pressure at station 2
p_s	Static pressure
p_v	Velocity pressure
ρ	Density of air
V	Velocity of the air in the duct
D_e	Equivalent round diameter
A	Cross sectional area of the duct
p	Perimeter of the duct
C	Coefficient of loss
f	Friction coefficient
L	Length of the duct
D	Diameter of the duct

CHAPTER 1

INTRODUCTION

1.1 Background

Heating, Ventilating and Air Conditioning (HVAC) is a term used to describe the control of treated air and delivered to the intended space or system. The basic components of HVAC are compressor, condenser, expansion valve and evaporator. The air conditioning process is the total control of temperature, the air humidity, supplying outside air for ventilation and control the air movement in the occupied space. In HVAC system, there are five basic processes required to condition the air which are heating process, cooling process, humidifying process, dehumidifying process and cleaning process (R. McDowall, 2006).

HVAC ducting system play a main role in transmitting the conditioned air to the specific space. According to C. Aydin and B. Ozerdem (2005), HVAC system is the branching network of round and rectangular tube of sheet metal, fiberglass board or a flexible plastic and wire composite that include a large number of components such as dampers, turning vanes, variable-air-volume (VAV) control units, cooling or heating coils, supply and return registers and the sensors for temperature, humidity, smoke, carbon dioxide concentration, pressure and flow rate.

There are many types of ducting system available nowadays and the design of the ducting system are influencing the utility bills of the building. By studying ducting design

methodology, building clients able to choose most suitable design for their ducting network of the HVAC system. A bad design and installation of ductwork may result in the poor air flow and consuming higher electricity. Therefore, a ducting design consideration is an important element to be highlighted when any ducting network to be installed in HVAC system of a building.

The main idea of a ducting design study is to consider duct right size and suitable duct network for installation. The learning of ducting design involved calculations and theory that make the subject matter becoming a little bit more complicated. Thus many students found that ducting design studies is a challenging subject as it is involving theories, calculations and some design judgement. A multimedia approach is considered as a good platform to represent the ducting design studies as it involves a combination of media to represent the course content, which offer variety of techniques so much so making learning of ducting design more enjoyable.

1.2 Problem Statement

The ducting design studies are crucial as to achieve an efficient and effective environmental control system. When ducting design configurations looked in details, one realized that there are a lot of consideration to be accounted for in producing a good ducting design. For mechanical engineering student, the ducting design knowledge is taught in Heating, Ventilating and Air Conditioning (HVAC) course.

The conventional way to learn and deliver ducting design or any other engineering courses is to use a classroom method and theories are enhanced in an engineering laboratory. The classroom method is using unilateral communication where only one person is conducting the class, namely the educator. According to M.Z.M. Zin, A.A. Sakat, N.A.

Ahmad and A. Bhari (2013), unilateral communication by educators would eventually led students to act as a passive recipient, hence, would raise boredom. This would effect and limit the student's ability to understand the subject, thus student may not capable to apply their knowledge practically later.

In order to present a more enjoyable and creating interest amongst students especially in ducting design studies which full of facts and making judgement, a modern approach which is effective must be found. The best practice in today's education system is to maximize the multimedia applications. The multimedia platform for educational purpose is believe can enhance the student understanding by serving the student with a variety of media applications in order to keep the learning activities meaningful and help the student to enhance understanding during revision session.

1.3 Objective

This project has two objectives. The first is to propose a multimedia platform for engineering educational purpose in the field of ducting design studies. The second objective is to apply an internet-based learning platform for the ducting design studies of HVAC.

1.4 Scope of Project

This project will only focus on the ducting design of HVAC course. Next, the multimedia platform use in this project is OPENLEARNING^{TM}. This platform also used internet as an enabler. The OPENLEARNING^{TM} is the webpage that support Massive Open Online Course (MOOC). The content covered in this ducting design studies dwelled on the design methods which are part of the standard syllabus of HVAC course.

CHAPTER 2

LITERATURE REVIEW

2.1 Ducting Design Fundamental

Ducting design is a part of HVAC system study. Ducting design refers to the design of ductwork (duct network) of HVAC system that enable to transfer the treated air to the desired location of a building. The building and home require a fresh distributed air to pursue a higher indoor air quality at different zone in the building by using a duct system (H. Chen et al, 2016). Cigdem Aydin, Baris Ozerdem (2004) stated that HVAC duct system is a branch network that consist of round or rectangular trunk made from sheet metal, fiberglass board, flexible plastic and also another air conditioning component such as cooling coil and dampers.

Patrick (2010) stated that ductwork is a system that transfer the air from one point to another from the fan efficiently so that the cost of operating the ductwork, noise, heat gain and losses can be minimalized. Another important key in a ducting design is the ability of ductwork to withstand internal pressure and contains of air to distribute to the proper location (PJ Brooks, 2010). The size of ductwork, design construction and installation are also important in the ducting design. Poor design and construction of ductwork may result in discomfort of occupant and increase the electricity power demand due to reduction of overall efficiency of the heating and cooling equipment in building (C. Aydin, 2004). The most basic arrangement for the duct system must have a constant speed of fan and having a constant

volume when the air is flowing in the duct, and serving the separated zone within the ventilated volume (R. Whalley et al, 2010).

2.2 Pressure in the Duct

The root of ducting design is based on fluid dynamic where Bernoulli Equation is the main governing formulae. When the focus of basic of duct design is considered, change in elevation of the system is unimportant. It is also assumed that there is no heat transfer in the system; whether adiabatic or isothermal and air density is assumed as the standard density (Patrick, 2010). When these assumptions are highlighted, the simplified Bernoulli equation for fluid resistance in the ducting design between two stations are

$$\Delta p_t = p_{t,1} - p_{t,2} \tag{1}$$

where p_t is the total pressure,

$p_{t,1}$ is the total pressure at station 1 and

$p_{t,2}$ is the total pressure at station 2.

For the total pressure at each station, it depends on static pressure and velocity pressure at that station. The formula for total pressure in a station is given by

$$p_t = p_s + p_v \tag{2}$$

where p_t is the total pressure,

p_s is the static pressure and

p_v is the velocity pressure.

The static pressure is the pressure that exert in all directions equally in the specific station and the velocity pressure are the pressure that represent the kinetic energy. Velocity pressure is a vector quantity and is calculated using the following formula

$$p_v = \rho\left(\frac{V^2}{2}\right) \tag{3}$$

where ρ is the density of air and V is the velocity of air in the duct.

2.3 Pressure Losses in the Duct

In ductwork, there are two types of losses occurred, which are friction loss and dynamic loss. The friction loss happens in the ductwork because of the viscosity of the fluid and the exchange of momentum between molecules in the ductwork in laminar flow and different velocity in turbulent flow. The equation of friction loss can be determined using Darcy and Colebrook equation. Other method of acquiring friction loss is to use friction chart which is much simpler than the former. See Figure 2.1. In this particular work, it is suggested to use the friction chart rather than the equation of Darcy and Colebrook. However, the friction chart is only applicable for round duct shape. More similar charts should be found if the duct cross-sectional shape is not round. Hence, before the friction loss of the ductwork can be determined, it is crucial to identify the duct shape. If the duct shape is not round, convert the duct configuration to the round duct by using the formula of equivalent round (Patrick 2010).

$$D_e = \frac{1.55A^{0.625}}{p^{0.250}} \tag{4}$$

where D_e is the equivalent round diameter for equal air flow, length and fluid resistance, inch (mm); A is the cross sectional area of the duct, inch^2 (mm^2) and p is the perimeter of the duct, inch (mm).

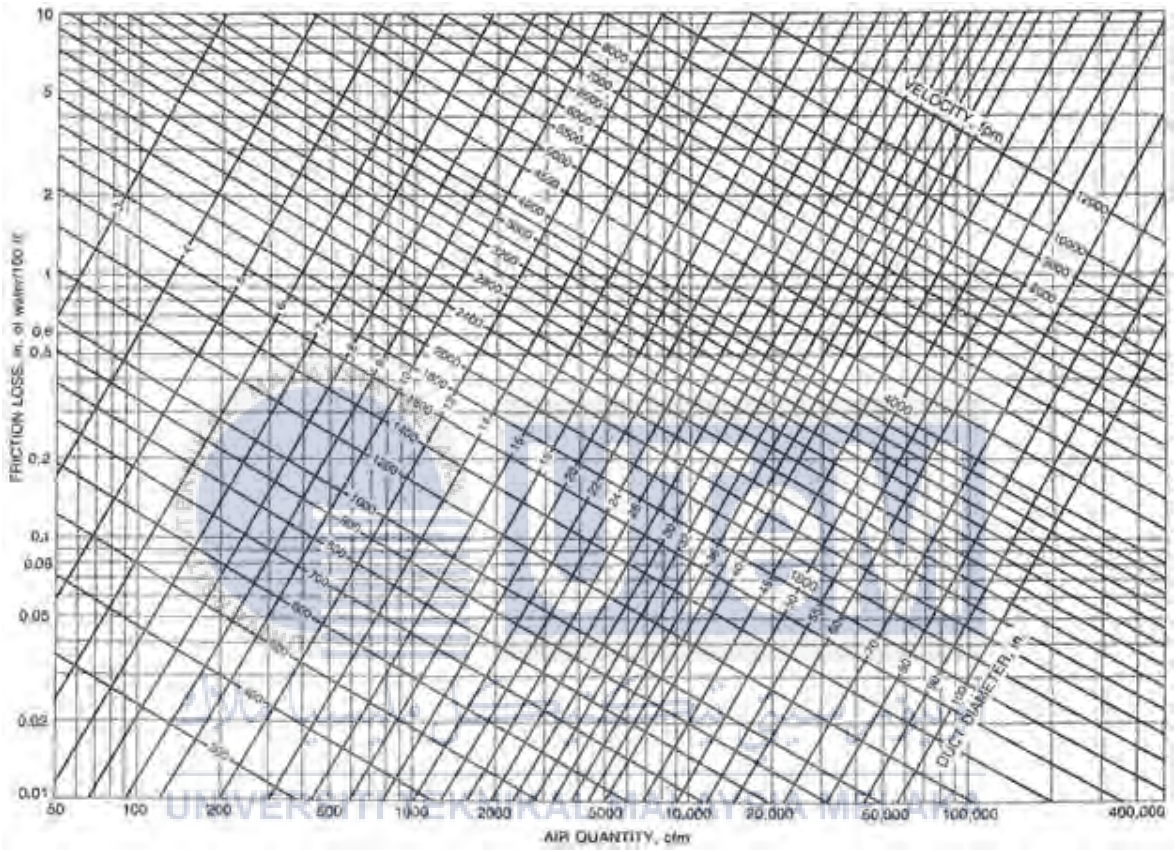

Figure 2.1: Friction chart. (courtesy of www.ashrae.org)

Another loss in the ductwork is the dynamic loss. The dynamic loss can occur from duct fitting that change air flow path direction and also due to flow disturbance. The examples of fitting that caused the dynamic loss are entries, exits, elbows and junctions. To determine the dynamic loss, the formula can be derived from the formula of coefficient of loss, C. The coefficient of loss can be determined by using experimental method where the ductwork is measured between two stations which housed the fitting. The equation of coefficient of loss can be presented by

$$C = \frac{\Delta p_t}{p_v} \tag{5}$$

where C is the coefficient of loss, dimensionless

Δp_t is the total dynamic loss, in. wg (Pa)

p_v is the velocity pressure, in. wg (Pa)

In order to establish the dynamic loss equation, one can rearrange the formula of the coefficient of loss, by moving the velocity pressure from right hand side to left hand side. Thus the formula of dynamic loss can be defined as follow (Patrick, 2010):

$$\Delta p_t = C p_v \tag{6}$$

The total pressure loss consisting of dynamic loss and friction loss. Thus, the general formula to obtain the total pressure loss can be referred as (E.H. Matthews et al, 1999).

$$\Delta P_{loss} = \frac{\rho}{2} V^2 \left(C + \frac{fL}{D} \right) \tag{7}$$

where ρ is the air density;

V is the air velocity inside the duct

C is the total dynamic pressure loss coefficient

f is the friction coefficient

L is the length of the duct

D is the diameter of the duct

2.4 Ducting Design Method

There are three methods commonly use in determining the duct sizing. The methods are constant velocity method, velocity reduction method and equal friction method. The constant velocity method is the method that maintains a minimum carrying velocity where all the duct size is selected. Thus, by using this method, the duct size is not constant as to keep the velocity in the duct work are equal. The second method are velocity reduction method. This method reduces the high velocity of the air at the fan to a lower value at the terminal. The last method is the equal friction method.

The equal friction method is maintaining the constant friction loss by the unit length of the duct. This method can be straightforward by using the friction chart. By making comparisons between these ducts sizing method, the better method to be used when the duct layout is symmetrical and have an equal length is the equal friction method. This is because the equal friction method would give a more balanced system than velocity reduction method and constant velocity method (Patrick, 2010).

Another method of duct sizing is the static regain method. This method is much more complex than the previous three methods. The objective of static regain method is to obtain an equal pressure at the entrance up to the junction and at the point which the upstream of the diffuser (E.H. Matthews et al, 1999). The principle of the static regain method is to increase the static pressure due to regain from the reduction of velocity by sizing the duct run (Patrick, 2010).

There are three major steps occurring in designing a static regain method. The first step is to construct equations of total pressure difference between stations where it must have an equal static pressure and must know the total pressure. The second step is to substitute

the value of total pressure at points for the value to deliver the required air flow. The last step is to make an equal static pressure at the common point at each junction.

2.5 The Conventional Study in Classroom

Conventional classroom is still considered the best way to teach the student because it is cost effective, although it is found that this approach is the least effective method of learning because of the interaction between the teacher and student are less (F.T. Leow et al, 2014). The unilateral communication in the classroom can lead to the boredom of the student during the teaching because this method will lead the student to become a passive recipient. The teacher is playing an important role in overcoming this problem. The educators as a facilitator must control the balance of the classroom by dividing the students into several groups to make a cooperative learning session. The best technique to attract the interest of the student and enhancing the educational system are by implementing and maximizing the use of multimedia application (M.Z.M. Zain et al, 2013).

2.6 Gagne's Model of Instructional Event for Education

In order to know the effectiveness of the implemented methods of teaching, Gagne (1997) identifies that the best way to know whether the student have achieved understanding in the course is by the change of learner capability over the period of time and have a notable changing in performance. Gagne have listed nine instructional events for the educator to have a guideline in their teaching environment (F.T. Leow et al, 2014).

The guidelines that highlighted by Gagne for the educators and teachers when conducting a class are:

1. Gaining attention of the student in class
2. Informing the student on the objective of the subject that need to be obtain after the class
3. Stimulating recall for the class that have been made before so the student can retrieve back their memory in the subject.
4. Presenting the content of the subject.
5. Providing the guidance to the student so the student is more accepting the knowledge.
6. Eliciting performance, by asking question to the student regarding the subject learnt
7. Providing feedback from the student on how the learning environment of the class.
8. Make an assessment for the student to measure the understanding of the student in the subject.
9. Enhancing the retention and transfer, whereby relating the application of the subject to the situation or current case.

By using the technique of Gagne when conducting the class, the quality of student learning are enhanced and it covered all the aspect of teaching and learning.

2.7 Multimedia Application in Education

Although one-on-one tutoring is considered as the best technique of learning, it is logistically and financially impossible for all student in conventional classroom situation, numerous multimedia platform is developed to enhance the quality of learning such as Computer Based Training (CBT) and Computer Assisted Instruction (CAI) (H.D. Surjono, 2015). Multimedia can be defined as the technology that combine the various source of information or media such as texts, graphics, sounds, videos and animations whereby these information is controlled and delivered by a computer system (M.Z.M. Zain et al, 2013).

There is tremendous platform of multimedia to be implemented in education such as television, movies and YouTube which using the video that can be apply in classroom (C.C.C. Lam et al, 2014). In order to overcome the lack in the classroom technique, the educator must implement a multimedia aided stuff in teaching environment as it may give an impact for student especially for a low achievement student in academic. As the multimedia is the combination of media such as graphic, animation, text, picture and video, it could help the teaching environment to boost to a new level and enhance the interest of student to learn the subject (M.Z.M. Zain et al, 2013).

By implementing multimedia aided teaching method, the student will enjoy and participating in class and the learning environment have become an active learning environment. By having an active learning environment, it can enhance the student to emphasize on receiving information and theory in class (J. and B. Wrenn, 2009). The multimedia is also enhancing the student achievement by assisting in the revision of the subject. The multimedia resources are exploited by the student for purpose of revising the subject whereby the revision by using the multimedia rich notes of the subject are believed to help the student to more memorable and retained longer in their memory about the subject, compare to the conventional method of revising whereby only listening and reading are taking place (M.Z.M. Zain et al, 2013).

The use of multimedia element in teaching and revising a subject can help the student to learn more and creating an environment that courage student to enjoy the learning experience. Multimedia element rich note and book are alternatively chosen by student as their source of revision and it added to the variation of choice when learning in a student centered learning environment such as classroom. The multimedia learning element are more flexible in exploring the knowledge. Thus, by using multimedia, it can boost up the learning

interest of the student toward the subject that they take in the classroom and can enhance their knowledge as their learning process become more interesting (F.T. Leow et al, 2014).

2.8 The Result of Implementing Multimedia in Education

The multimedia based application for the education are promoting a meaningful learning to the student whereby the student is able to foster deeper learning in their subject (R.E. Mayer, 2003). Figure 2.2 shows the print-screen of F. T. Leow et. al. in her research using Interactive Learning Module (ILM) to test the effectiveness of multimedia in education at INTI International University whereby for an easy access, ILM are uploaded to the web server to ease the student on using ILM anytime anywhere. The targeted class of the research is the Information Technology (IT) class where the student is familiar with the face to face learning environment. ILM is a software of multimedia enrich learning tool that targeted to help the student in their learning process. After the implementation of ILM from the beginning of semester until the test, a survey is conducted to know the effect of ILM to the student.

Based on the survey, 93.5% of student who are using ILM are agreed that ILM helps them in the individual learning environment and provide the chance of learner-centered learning. They also agreed that ILM helps them in conducting their self-directed learning experience. When implementing ILM, 67.7% of student agreed that they have no difficulty on solving the tutorial question of their course that related to the scope in ILM. 71.1% of the student agreed that ILM helps them in their studies and they have no difficulties when using the ILM software where some student comments are added in the survey state that they can done tutorials to test their understanding of course in ILM repeatedly because ILM provide

a tutorial with random question, which mean the question are different each time they open the tutorial (F.T. Leow et al, 2014).

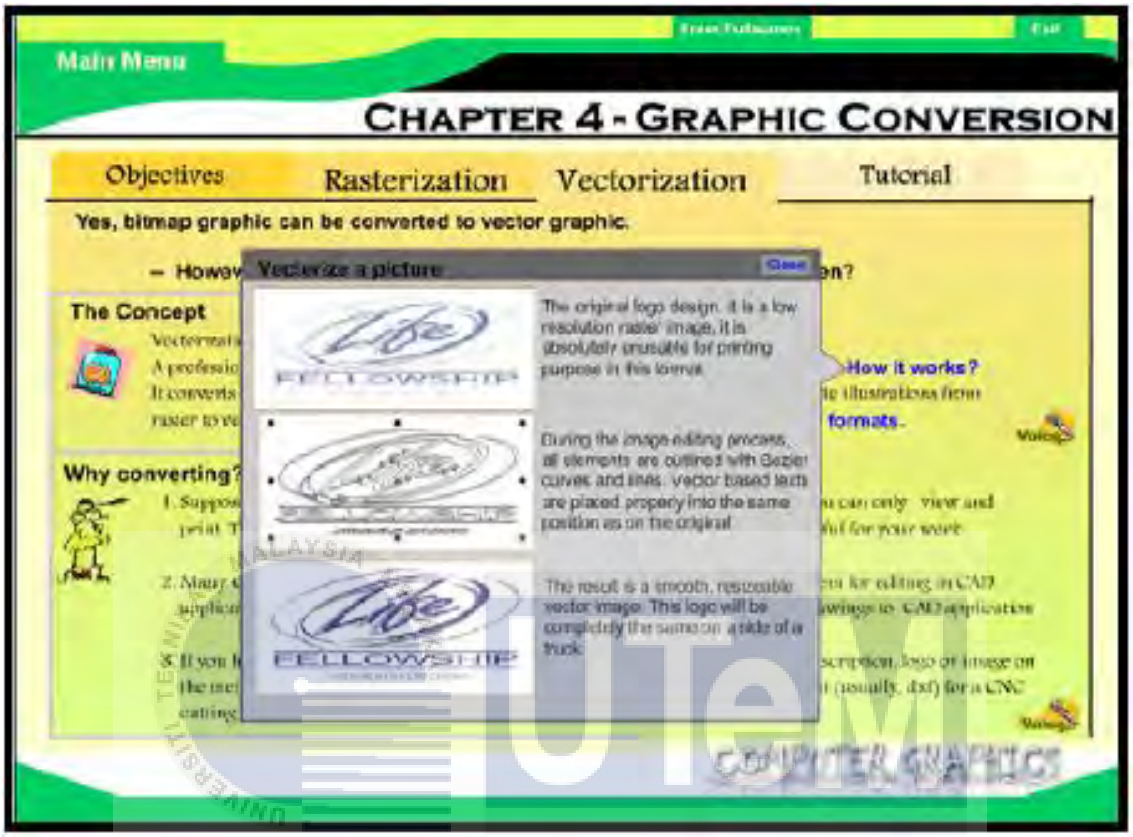

Figure 2.2: The ILM software. (courtesy of F. T. Leow, 2014)

77.4% student is agreed that the use of multimedia in ILM are help in deepen their knowledge and understanding and some student comment that they are no longer need to read the text repeatedly in order to understand the course because of the aid of animation and pictures in ILM. 87.1% student is agreed that they were benefited by implementing ILM in their course. There also 83.9% student find that by using ILM in their course, the way of recalling their knowledge in the course are appropriate and helpful to them in order to enhance their understanding in their course (F.T. Leow et al, 2014).

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will describe the methodology used in this project to propose a multimedia platform of ducting design studies for the educational purpose. This project uses an online platform to present a multimedia based education webpage called OPENLEARNING™. OPENLEARNING™ is one of the Massive Open Online Course (MOOC) which provide a free education based online webpage that give an open access to everyone and have no limit of participants. OPENLEARNING™ is chosen as the medium of presenting a multimedia platform because the OPENLEARNING™ is broadly used in Malaysia as the platform of MOOC.

3.2 Making a Webpage for the Course

This course uses OPENLEARNING™ platform which the domain is https://www.openlearning.com/. In order to create modular for Ducting Design Studies, an account is created as a teacher. There is a variety of choice to sign up in OPENLEARNING™, whereby the choices are logging in using Facebook, using YouTube account, using the account of Gruokr.com or using email. The interface of the start page of OPENLEARNING™ is shown in Figure 3.1.

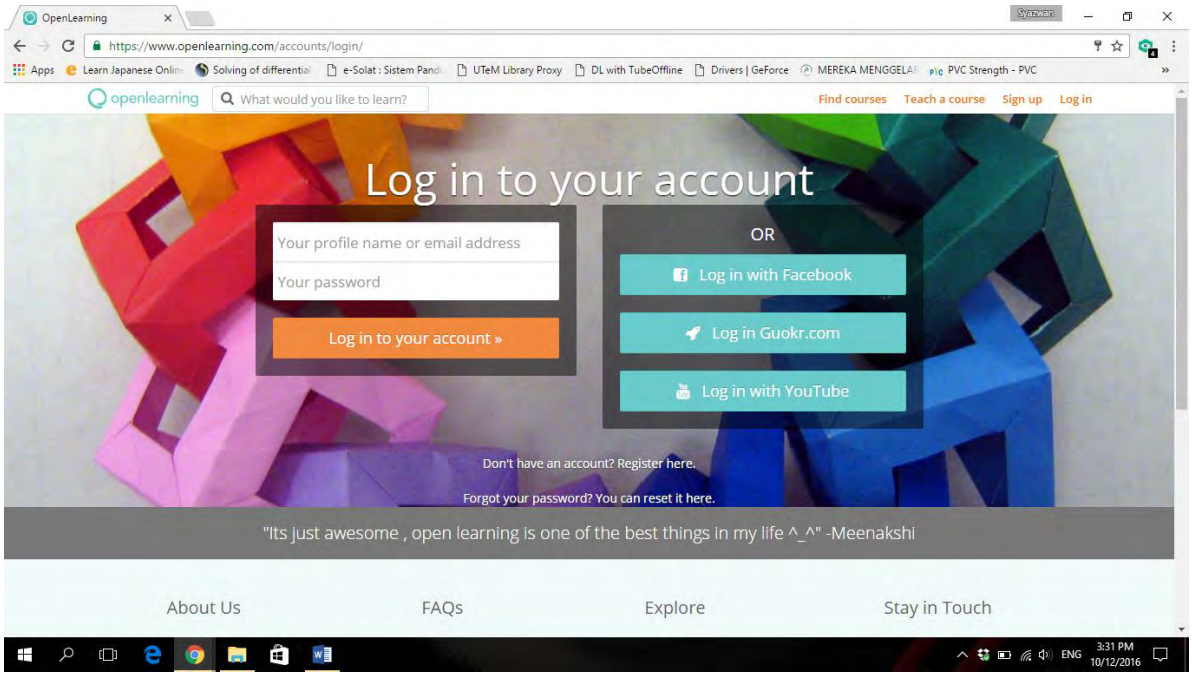

Figure 3.1: The interface of start page of OPENLEARNING™

After clicking the sign up button at OPENLEARNING™, it directed to another page to start registering an account. See Figure 3.2. There are four choices of making an account in OPENLEARNING™. Below is the page of sign up an account of OPENLEARNING™.

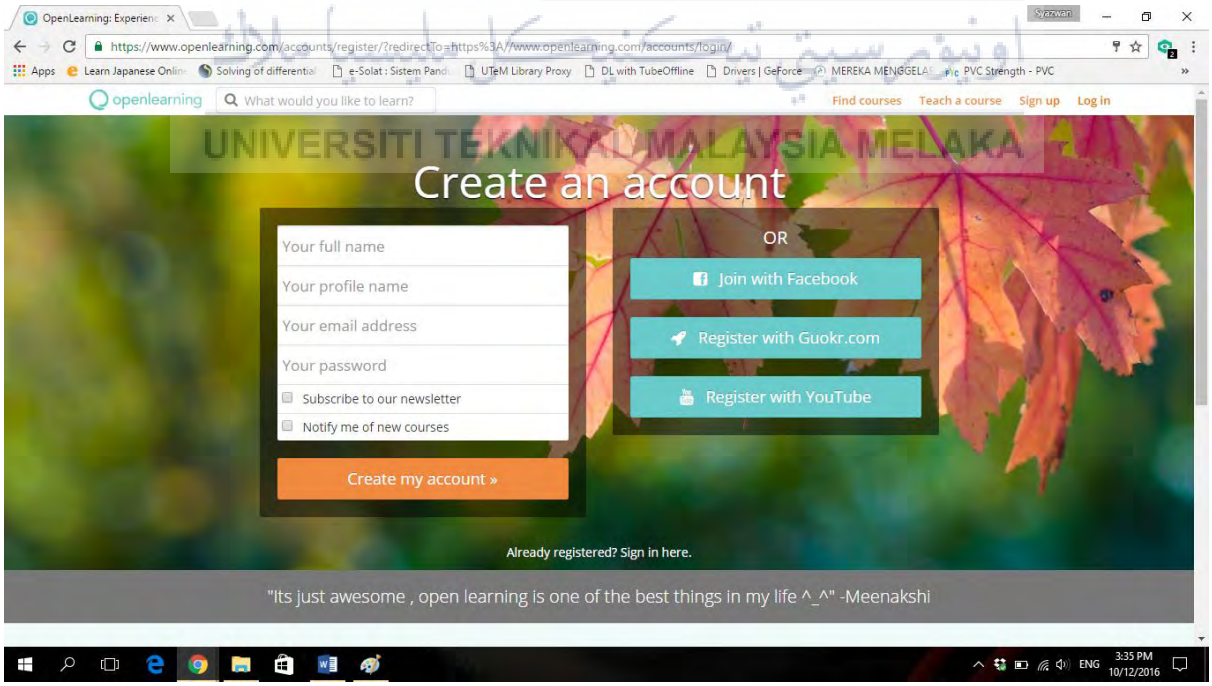

Figure 3.2: sign up page for OPENLEARNING™ account

After signing up with an account, the Ducting Design Studies course is created by clicking the teach button at the below of the page. For a student to enroll in a course in OPENLEARNING™, click the learn button to find the course in OPENLEARNING™. See Figure 3.3.

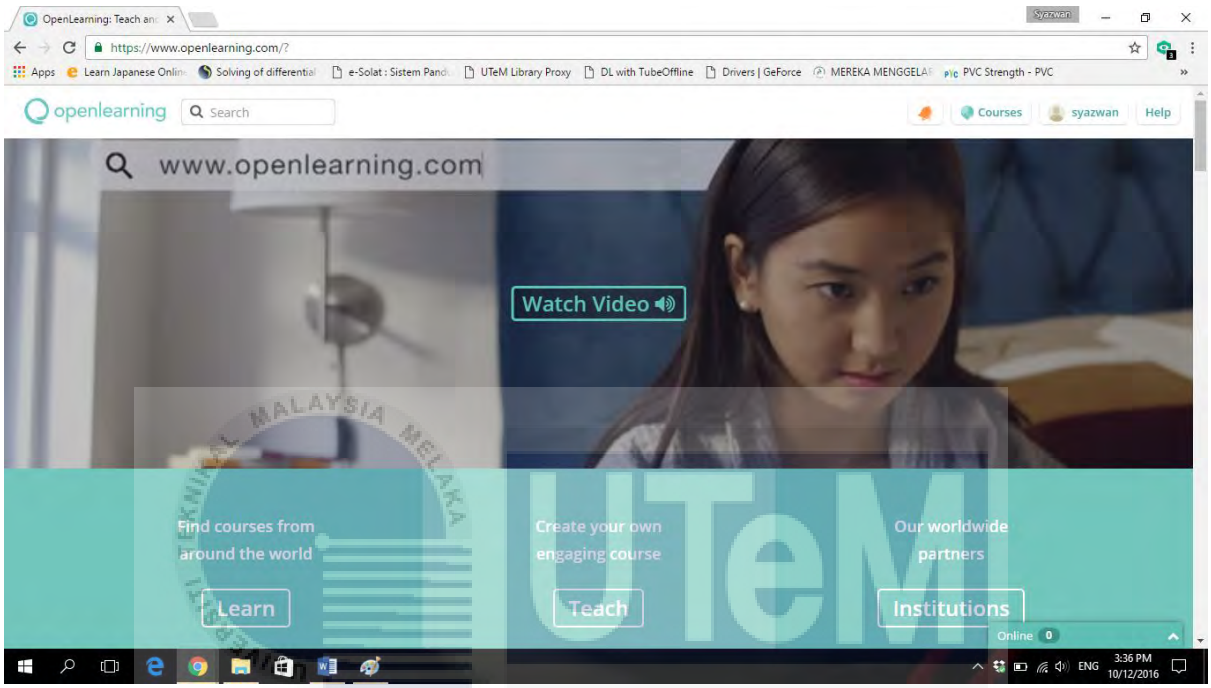

Figure 3.3: Teach button to create a course in OPENLEARNING™

After creating a course, a general setup is made such as name the course, set the course link and define the course briefly to ease the student to find the course. By defining the course, the student is attracted to the course and knowing the course terminology before enrolling the course. This is shown in Figure 3.4.

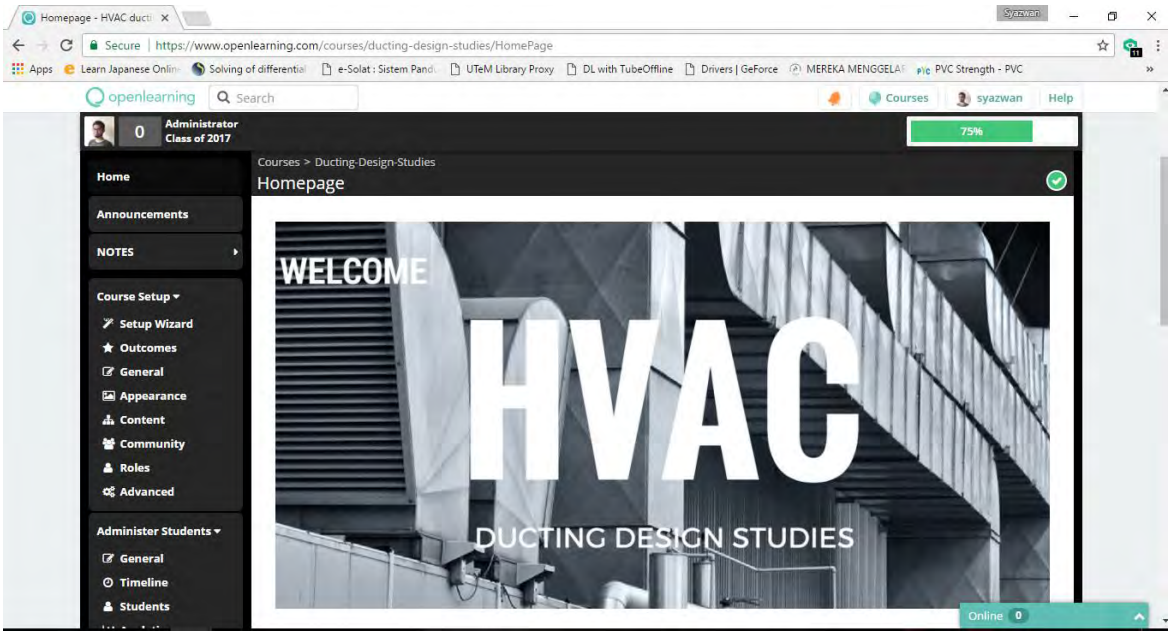

Figure 3.4: The webpage for the course

3.3 Adding Module in a Course

After establishing HVAC Ducting Design Studies course in OPENLEARNING™, the module is created to add the content into the course. The module is used to store the notes of ducting design studies and also viewing the video related to ducting design studies. There are four modules provided in this course, which are Module 1 (Introduction), Module 2 (Variable in Ducting Design), Module 3 (Ducting Calculation and Estimation) and Module 4 (Duct Sizing Methods). With the separation of module, the content in the course can be varied according to chapters or tasks. By separating the syllabus according to chapters or tasks, it is easier for students to find notes or videos that related to their homework or revision. The module is created by go to the course setup, then select content. At content, it will list all modules that have been created. In order to make a new module, enter a new module name at the bottom page that write 'add a new module'. Upon entering the name of the module, it is created automatically. The module can be in the form of videos and notes.

3.4 Content of the Module

There are two types of content that added in the module as the learning source for HVAC ducting studies, which are the slide notes and videos. To cover the syllabus of ducting design studies, there are four slide notes that inserted into the modules. The slide notes are entitled ‘Lesson 1: Introduction’, ‘Lesson 2: Variable in Ducting Design’, ‘Lesson 3: Ducting Calculation and Estimation’ and ‘Lesson 4: Duct Sizing Methods’. All the slide notes are using the format of Microsoft PowerPoint Slide and consisting of ten pages as to ease the student in understanding the slide notes that are provided in this course.

In the first slide note which entitled ‘Lesson 1: Introduction’, the basic knowledge of ducting design is covered. The first slide is discussing about the meaning of ducting design. The third slide note is discussing about the basic knowledge of ducting design such as the material used for ductwork and the types of ductwork configuration are discussed in these notes. Ducting network is a large network that consists of a lot of components such as elbow and trunk. In order to further the understanding of duct basic knowledge, the component of ductwork, the duct material and the configuration of duct system are also included in the first slide notes.

The second slide note that provided in the module are ‘Lesson 2: Variable in Ducting Design’. There are a lot of variables to be considered in designing a ductwork. There are three types of pressure in the duct that are discussed in the note, which are static pressure, velocity pressure and the total pressure in the duct. The total pressure in the duct are the sum of static pressure and velocity pressure. The other variable that included in this note are the losses in duct network. There are two types of losses in the duct network, which are friction loss and the dynamic loss. The losses in the duct are also important variables to consider in

designing a duct network as to ensure good air flow in the duct. The formulae regarding the pressure and losses in the duct are included and discussed in the note.

The third slide note is entitled ‘Lesson 3: Ducting Calculation and Estimation’ whereby the slide note is discussing about the estimation of the duct design and the calculation of the duct variable. There are a lot of calculation involve in designing the duct network. As all the variables have discussed in the second slide note which is ‘Variable in Ducting Design’, the application of the formula in the second slide note is discussed in this note. The calculation that involves in determining the duct sizing are friction rate, friction pressure drop, duct length, duct area, velocity pressure, static pressure and dynamic and frictional losses in the duct. The problem based calculation are also included in this note as to enhance the understanding of the fundamental in ducting design. An example of calculation is given as a guideline to use all the calculation and making estimation for ducting design consideration.

The fourth slide in the module of ducting design studies entitled ‘Lesson 4: Duct Sizing Methods’ is discussing on duct sizing methods that are available in determining a duct network. There are three major duct sizing methods which are equal friction method, static regain method and the velocity reduction method. The main objective in designing the HVAC duct system is to use the lowest cost of duct sizes that can be used. All the three types of duct sizing methods will give the same output, which is the best sizing for the duct network.

After completing of the slide notes in the module, videos are provided for each slide notes in order to increase the understanding of the content in the slide notes. There are four videos to support the slide notes, whereas each slide notes have a video on discussing the content of the slide notes. The video duration are less than 5 minutes each, explaining each

content of the slide notes. The upload of video in module must be done with YouTube page and the module for video are using the platform of YouTube to be viewed in OPENLEARNING™.

After the completion of slide notes and videos in the modules, there are four sets of assessment are provided in the modules. The assessment is aimed to test the understanding of the student who are following the module of HVAC ducting design studies. The assessment is known as quizzes, and there are 4 quizzes provided in this course, under each module. The assessment is built using Google Forms and the link for quizzes are located in each module. By implementing the assessment in the module, the knowledge of the student can be tested. The assessment each are consist of ten questions, which the question provided are related with the content of slide notes and videos in the modules.

The types of question to be assess are in the various forms, such as objective question, multiple choice question and also subjective question. For the assessment of first, second and fourth slide notes, the question consist of six objective question, three multiple-choice question and one subjective question. For the assessment of the third slide note which entitled 'Ducting Calculation and Estimation', the student need to answer a problem based question, whereby the type of question is an objective question.

As to give a new experience of calculating the result from the calculation of duct sizing, an Excel document is attached in the module. The attached Excel document is based on the calculation that stated in the third slide note. See Figure 3.5. The calculation that involves in Excel document are friction rate, friction pressure drop, duct length, duct area, pressure velocity, static pressure and dynamic and frictional losses in the duct. By using this Excel document to calculate the result of various variable in the duct, the student can compare the result of manual calculation and the result from Excel calculation. From the

comparison of the result, the student can see the difference between a manual calculation and a computer based calculation software. The student also can use the answer from Excel calculation as their validation of answer in manual calculation.

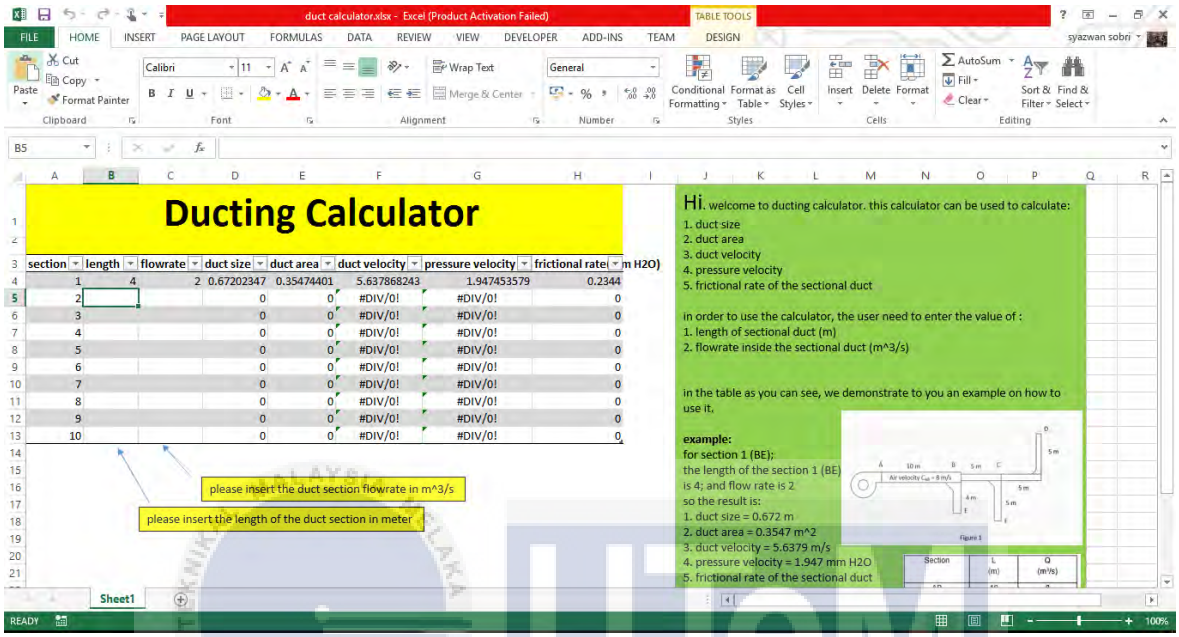

Figure 3.5: Excel duct calculator

The ducting calculator is created by using Microsoft Excel. A table is set up in Excel worksheet which have eight columns and ten rows. The column in ducting calculator are duct section, length, flow rate, duct size, duct area, duct velocity, pressure velocity and frictional rate. The row in the table is representing the section in duct configuration. In order to establish the duct calculator, the formula is inserted into 4th, 5th, 6th, 7th and 8th column. For the fourth column which is column for duct size, the formula that being key-in in the column is

$$f = 0.52 * (C4)\text{^}0.37 \qquad (8)$$

where f refers to formula in the column which is duct size, C4 refer to column C, row number 4, which the value for C4 is representing flow rate value filled by the user. In the fifth

column, the column are representing duct area, which the formula that are key-in in the column is

$$f = (3.142 * (D4\text{^}2))/4 \quad (9)$$

where *f* refers to formula in the column (duct area), D4 refer to column D and 4 refer to row number 4, which representing the value of duct size. In the sixth column, the formula that inserted in the column is

$$f = C4/E4 \quad (10)$$

where *f* refers to the formula in the column (duct velocity), C4 refer to the value of flow rate and E4 refer to the value of duct area. For the seventh column, the value is referred to pressure velocity, the formula that are taken place in the column are

$$f = (F4/4.04)\text{^}2 \quad (11)$$

where *f* refers to the formula in the column (pressure velocity), *F*4 refer to column *F*, row number 4 which representing the value of duct velocity. For the eighth column, the formula that are key into the column are

$$f = 0.0586 * B4 \quad (12)$$

where *f* representing value in the column (frictional rate) and B4 representing the value in column B, row number 4 which represent the value of duct section length.

To use the duct calculator, the user only needs to key in the length of the duct section and the flow rate of the section into the duct calculator. The duct calculator will generate the value of duct size, duct area, duct velocity, pressure velocity and frictional rate of the section.

In addition to Excel duct calculator, a duct calculator using the platform of C++ is also created in order to give the student a variable in using the multimedia platform of duct

calculator. Unlike Excel duct calculator, C++ duct calculator is requesting the user on the value to be inserted. The C++ duct calculator is using While loop, so the calculator will keep asking the same instruction according to how many sections that the user-define.

In order to use the C++ platform to make duct calculator, the series of coding must be implemented. The coding of C++ for duct calculator is shown below.

```
#include <iostream>

using namespace std;

int main()
{
	float C, Q, D, B, f1,l1, DS, A, c, pv, pf, exit;
	int x, n, m ;


		cout << "                                        WELCOME TO DUCTING DESIGN
DUCT SIZING APPLICATION\n\n\n";
		cout << "please enter the total flow rate of the duct (in m3/s)\n";
		cin >> Q;
		cout << "please enter duct velocity (in m/s)\n";
		cin >> C;

		D = sqrt((4 * Q) / (3.142*C));
		cout << "the main duct size is=";
		cout << D;
		cout << "m";
		cout << "\nplease enter number of branch in duct configuration\n";
		cin >> x;

			cout << "this calculator will calculate the section part of
ducting""\n"" therefore please enter the ducting section number\n";
			cin >> n;

			while (n < x+1) {
				cout << "please enter the " << n << " duct flowrate\n";
				cin >> f1;
				cout << "please enter the length of section\n";
				cin >> l1;
				DS = 0.52*(pow(f1, 0.37));
				A = (3.142*pow(DS, 2)) / 4;
				c = f1 / A;
				pv = pow((c / 4.04), 2);
				pf = 0.0586*l1;
		cout << "the duct size for section " << n << " is: " << DS << " m\n";
		cout << "the duct area for section " << n << " is: " << A << " m^2\n";
		cout << "the duct velocity for section " << n << " is: " << c << "
m/s\n";
		cout << "the pressure velocity for section " << n << " is: " << pv <<
" mm H2O\n";
		cout << "the frictional rate for section " << n << " is: " << pf << "
mm H2O\n";
			}

		cout << "thank you for using duct calculator \n Press any key to
exit";
			cin >> exit;


			}

		return 0;
	}
```

Figure 3.6 shows the sample calculation done by using the C++ duct calculator.

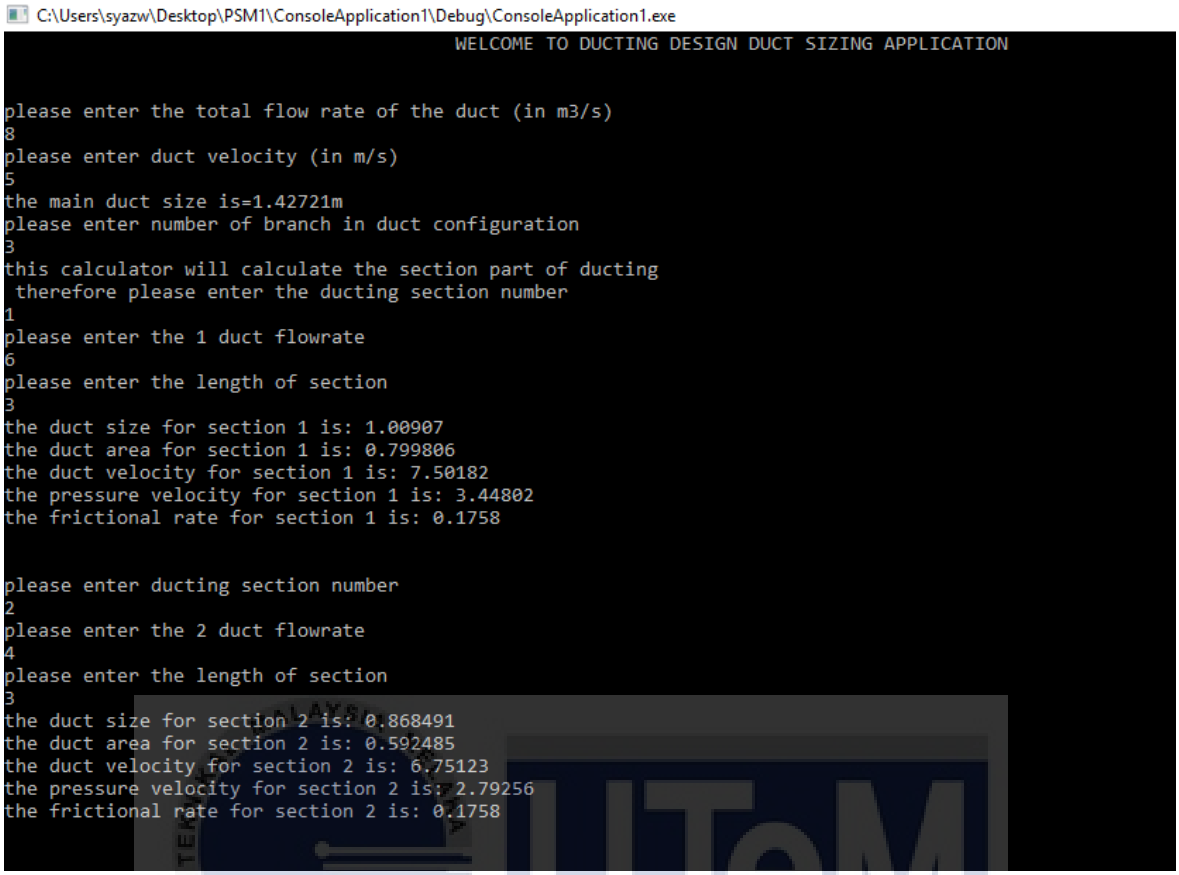

Figure 3.6: Sample calculation in C++ duct calculator

3.5 Interaction in the Course

After adding a module on the course, the course is now completed with documents and videos related to the course. In order to ease the student to interact with the developer, teacher and the other student, an online chatting is equipped in this course. The student can discuss topics regarding the course with the teacher at this platform which make easier for students to ask anything that they doubt in studying the course. As the course might be expanded to become a large participant of student, the manager of the course can insert and recruit new staff and teacher to manage the course. See Figure 3.7.

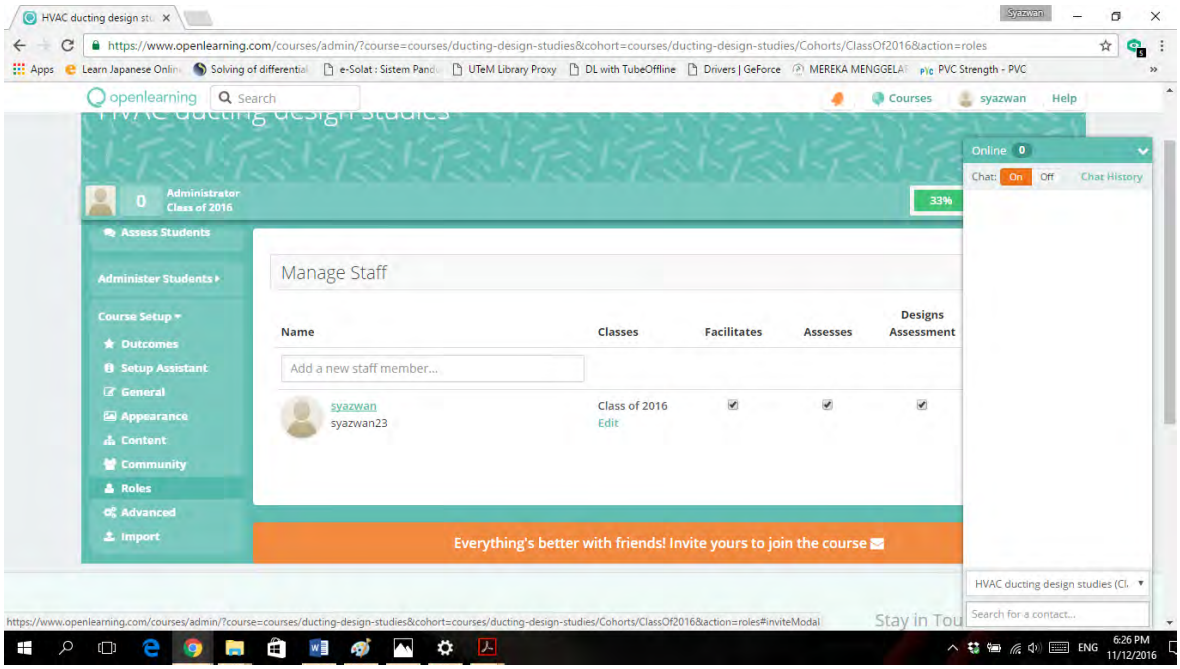

Figure 3.7: The online chatting and add new staff column

3.6 The Completion of Syllabus in Ducting Design Studies

The project has achieved the target when completing covering all the topics in ducting design studies. Upon completing the topics, the assessment is uploaded into the course to find whether the notes and video provided in this project are helpful to the student. The assessment will be covered all the terminologies in ducting design studies.

3.7 Flow Chart of the Methodology

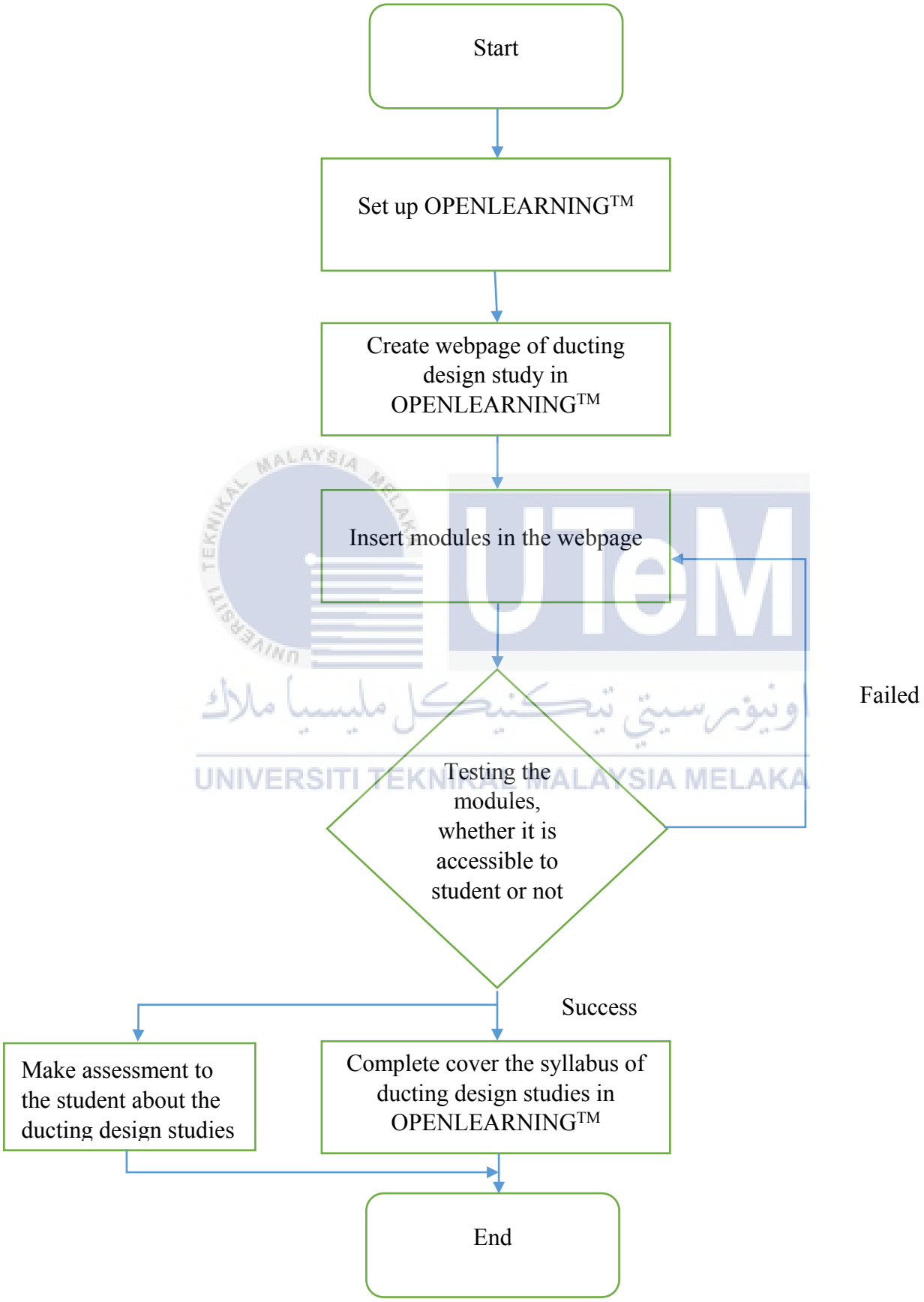

Figure 3.8: Flowchart of the methodology

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Enrolment of Student

After the establishment of the course, the course is set to online and public. The total enrolment of students is 23, which one student is from India and the rest are Malaysian. From 23 students, 14 students are male and 9 students are female. Below is the list of students in HVAC Ducting Design Studies course.

Student Name	Student ID	Student Profile Name	Country
Azfar Souleeh-in		azfarsouleeh-in	Malaysia
Clay Addison		clayaddison	Malaysia
Ismail Thaniyullathil		ismailthaniyullathil	India
Lau shin ying		laushinying	Malaysia
S kathiravan		skathiravan	Malaysia
ahmad adib rosli		ahmadadibrosli	Malaysia
aina farihah mazlan		ainafarihahmazlan	Malaysia
ainur amani ariffin		ainuramaniariffin	Malaysia
aizat fitri ghazali		aizatfitrighazali	Malaysia
asyraf abu bakar		asyrafabubakar	Malaysia
ho bing yang		hobingyang	Malaysia
khalid azri ahmad		khalidazriahmad	Malaysia
lim peng chong		limpengchong	Malaysia
mastura ghazali		masturaghazali	Malaysia
mohd yamin sabri		mohdyaminsabri	Malaysia
nor amira adenan		noramiraadenan	Malaysia
nor liyana ahmad		norliyanaahmad	Malaysia
nurain batrisya kamal arifin		nurainbatrisyakamalarifin	Malaysia
shazuan mansor		shazuanmansor	Malaysia
syahir asri mohamad		syahirasrimohamad	Malaysia
syazwan sobri		ahmad.syazwan.sobri	Malaysia
umi anisah abd halim		umianisahabdhalim	Malaysia
zamira zainal abidin		zamirazainalabidin	Malaysia

Table 4.1: The total student involve in the project

4.2 Comparison of Duct Calculation

There are two types of duct calculation that have been exposed in the course, which are manual calculation and the calculation by computer application. For computer application, there are two types of calculator provided in the course which are an Excel duct calculator, which use Microsoft Excel as a platform, and C++ duct calculator, which use the platform of Visual Studio.

In order to test the calculation between three types of calculation, a sample problem is chosen to know the difference between the results of the calculation. The sample calculation is shown in Figure 4.1.

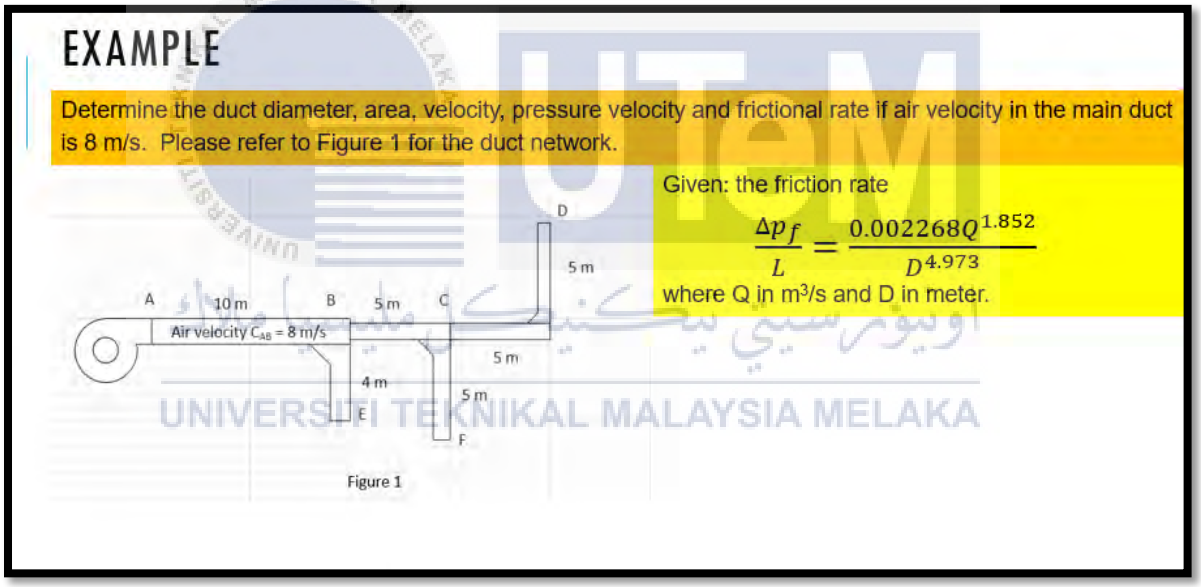

Figure 4.1: The sample question

4.2.1 Manual Calculation

From the figure, total air flow rate is 8 m^3/s

$Q_{total} = Q_{BE} + Q_{CF} + Q_{CD} = 2 + 3 + 3 = 8\ m^3/s$

Main duct size can be determined here namely

$C_{AB} = Q_{AB}/A_{AB}$ Or $8 = 8/A_{AB}$

Then $A = \pi D^2/4$ or D = 1.128 m

Use friction rate formula:

$$\frac{\Delta p_f}{L} = \frac{0.002268Q^{1.852}}{D^{4.973}} \quad (13)$$

$=(0.002268 \times 8^{1.852})/(1.128)^{4.973}$

=0.0586 mm H2O per meter length

By using the formula:

Duct diameter, $D = 0.52Q^{0.372}$ (14)

Duct area = $\pi D^2/4$ (15)

Air velocity Q = AC or C = Q/A (16)

Pressure velocity, $p_v = \left(\frac{C}{4.04}\right)^2$ (17)

Frictional rate, $\Delta p_f = 0.0586L$ (18)

The result for each variable by using manual calculation is

Section	L (m)	Q (m^3/s)	D (m)	A (m^2)	C (m/s)	p_v (mm H2O)	Δp_f (mm H2O)
AB	10	8	1.1270	1	8	3.92	0.586
BE	4	2	0.6729	0.3556	5.6243	1.9381	0.2344
BC	5	6	1.0127	0.8055	7.449	3.4	0.293
CF	5	3	0.7825	0.481	6.237	2.38	0.293
CD	10	3	0.7825	0.481	6.237	2.38	0.586

Table 4.2: The manual calculation

4.2.2 Excel Calculation

From the calculation using Excel duct calculator, the result is as follow:

section	length (m)	flow rate (m^3/s)	duct size (m)	duct area (m^2)	duct velocity (m/s)	pressure velocity (mm H_2O)	frictional rate(mm H_2O)
AB	10	8	1.12239737	0.98955393	8.084450755	4.004407902	0.586
BE	4	2	0.67202347	0.35474401	5.637868243	1.947453579	0.2344
BC	5	6	1.00906538	0.79980627	7.501816702	3.4480231	0.293
CF	5	3	0.78079713	0.47887549	6.264676501	2.40455419	0.293
CD	10	3	0.78079713	0.47887549	6.264676501	2.40455419	0.586

Table 4.3: The result from Excel calculator

4.2.3 C++ Calculation

From the duct calculator of programming C++, the result is as follow.

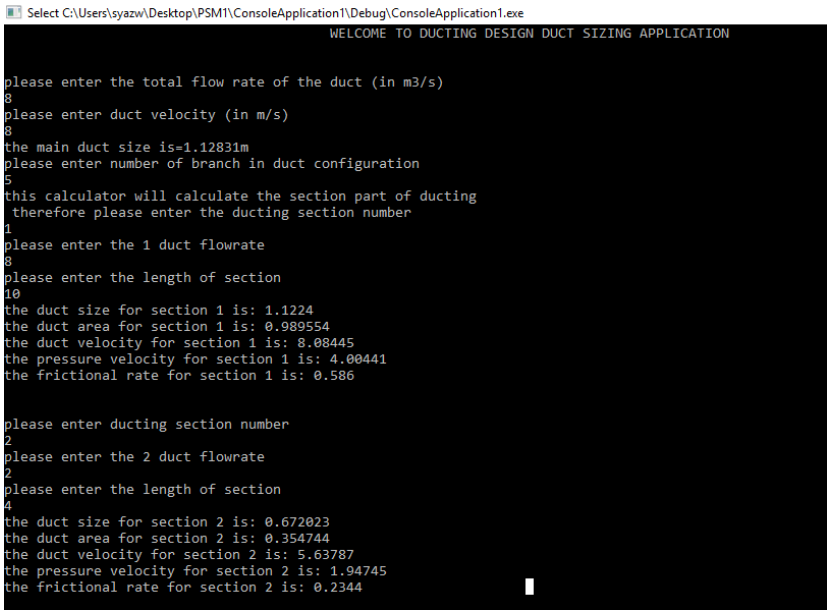

Figure 4.2: the result of C++ calculation (1)

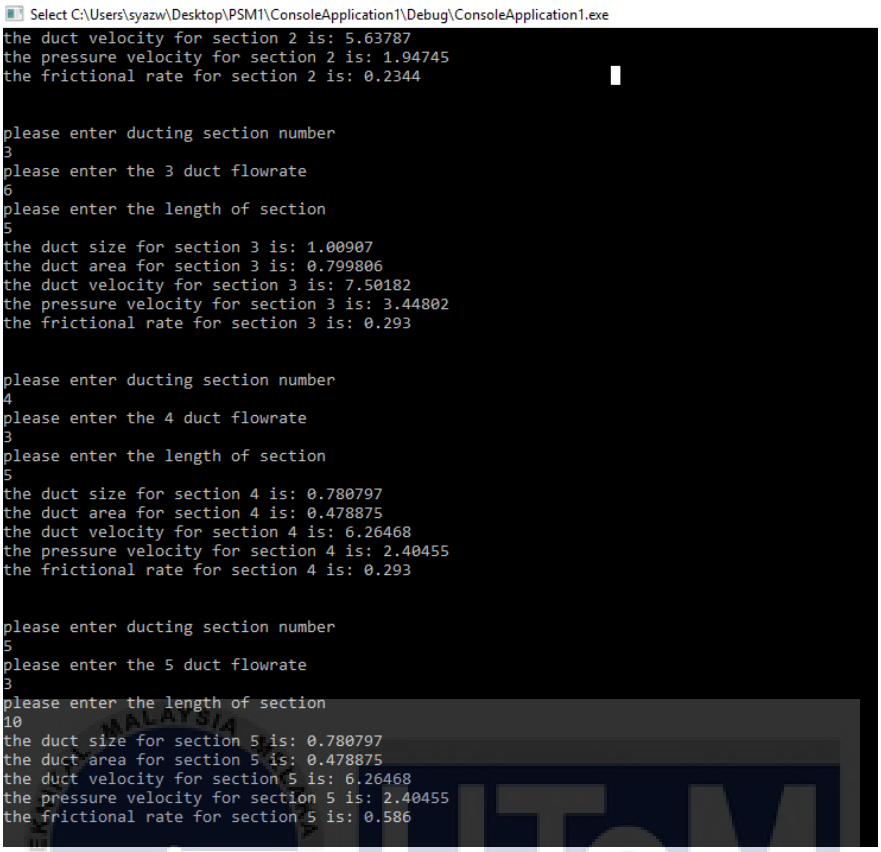

Figure 4.3: the result of C++ calculation (2)

From the figure above, the result can be interpreted into table in order to ease the comparison between the calculations.

Section	Length (m)	Flow rate (m^3/s)	Duct size (m)	Duct area (m^2)	Duct velocity (m/s)	pressure velocity (mm H_2O)	frictional rate(mm H_2O)
AB	10	8	1.1224	0.989554	8.08445	4.00441	0.586
BE	4	2	0.672023	0.354744	5.63787	1.94745	0.2344
BC	5	6	1.00907	0.799806	7.50182	3.44802	0.293
CF	5	3	0.780797	0.478875	6.26468	2.40455	0.293
CD	10	3	0.780797	0.478875	6.26468	2.40455	0.586

Table 4.4: The result of C++ calculation (3)

4.2.4 Comparison of Result

From the result of calculation using manual, Excel and C++, the most precise calculation is by using Excel since it uses up to nine decimal places, while C++ use up to 6 decimal places, while manual calculation normally uses up to four decimal places. Although these three methods are using different decimal places, the solution for each calculation are not much different. A percentage difference is calculated in order to know how much different between manual calculation and application calculation. Thus, result of manual calculation is chosen as a base value while the result from the Excel and C++ calculation are as testing value.

For the Excel calculation, the duct area of section AB is chosen as a test. The formula to use in order to test the percentage difference is

$$percentage\ difference = \frac{|test\ value - base\ value|}{base\ value} \times 100\% \quad (19)$$

Thus, for Excel percentage difference;

$$percentage\ difference = \frac{|0.98955393 - 1|}{1} \times 100\%$$

=1.04% difference

For C++ percentage difference;

$$percentage\ difference = \frac{|0.989554 - 1|}{1} \times 100\%$$

=1.04% difference

From the comparison, either of calculation, whether using Excel or C++, the percentage difference is 1.04% which is a relatively small difference.

4.3 Assessment in the Course

This course consists of four assessments in order to test the understanding of students after they undergo each module in the course. The assessment also implemented to test whether the source of learning which are slide notes, video and duct calculator provided in the course are helping students to understand the topic in ducting design studies. Each assessment is implemented at each module, namely Quiz 1, Quiz 2, Quiz 3 and Quiz 4. The quiz is using the platform of Google Forms whereby the link for quizzes are located in each module. Each time the student undergoing the quizzes, they can check whether their answer is correct or not after they answering the quiz.

Quiz 1 is covering the content of Module 1 which is Introduction to Ducting Design. There are 20 students undergoing Quiz 1 which 3 students are not answering the assessment. The overall result for Quiz 1 are as follows.

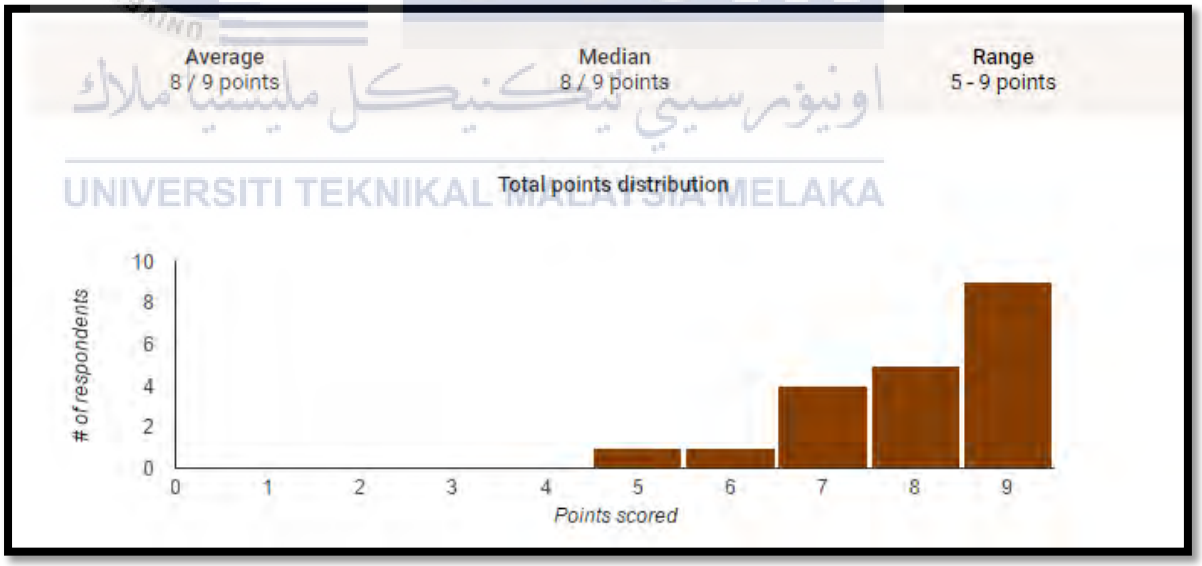

Figure 4.4: The overall result for Quiz 1

The total mark for Quiz 1 is 9 marks. From the bar chart above, the least mark obtains by the student is 5/9 and the only one person are obtaining the least mark. The highest score in the quiz is 9/9 and the total student that are obtaining full mark is 9. In percentage, the

percentage of students who get full mark in Quiz 1 is 45%. The percentage of student who get least mark is 5%. For the least mark, the total mark in percentage are 55.5%, which the mark is above 50%. The average mark obtains by the student is 8/9 which in percentage is 88.9%.

For Quiz 2, the question is covering the topic of Variable in Ducting Design whereby the variable such as pressure in the duct and loss in the duct are discussed in the module. The total student that is answering the assessment is 20, same as Quiz 1. Below is the overall result of Quiz 2.

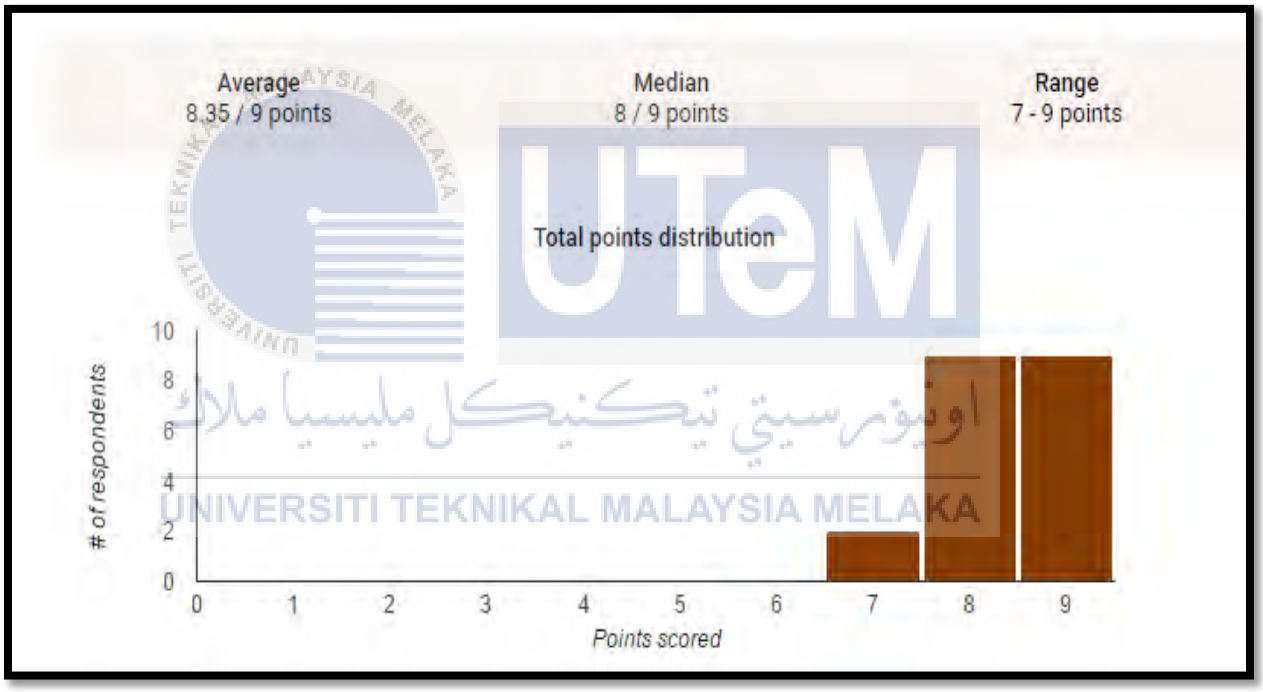

Figure 4.5: the overall result for Quiz 2

From the bar chart representing the overall result for Quiz 2, the least mark obtained by the student is 7/9 which in percentage is 77.8%. The highest mark obtained by the student is full mark, which is 9/9 or 100%. The least mark obtained by the student are above half of the mark of Quiz 2 which is 50%. This means the student can answer well the question

provided in the quiz, which indicate the student are understanding the topic that are assessed in Quiz 2. The average mark obtains by the student is 8.35/9 which in percentage is 92.8%.

Quiz 3 are covering the topic of Ducting Calculation and Estimation, whereby the topic is about the calculation of variable in the duct. In the quiz, the student is given a problem-based questions to test the understanding of student in solving the problem in duct configuration. In the quiz, the problem-based question is as follows.

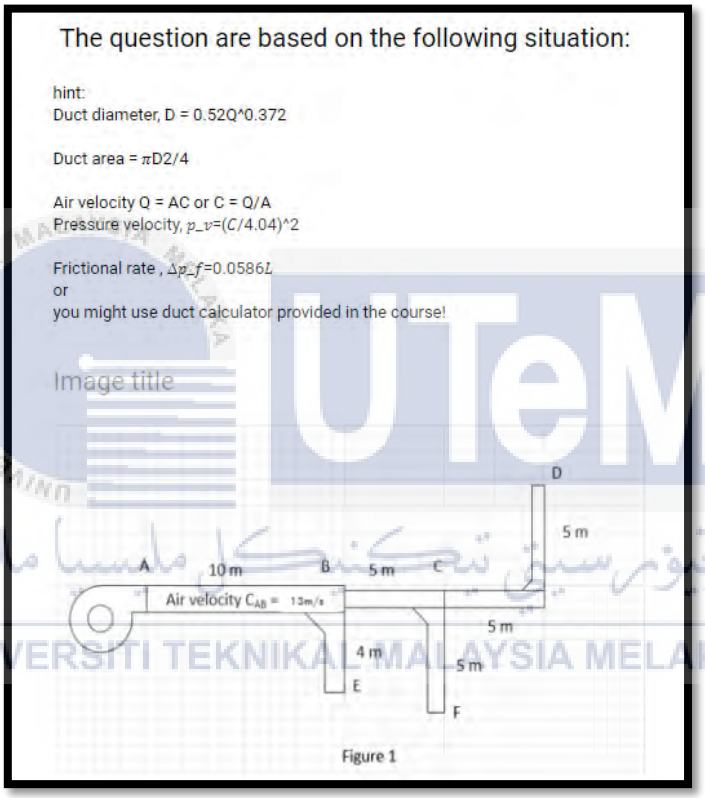

Figure 4.6: Problem-based question in Quiz 3

The quiz also can be solved by using the duct calculator provided in the course as to ease the student to answer the quiz. The total student that is answering Quiz 3 are 20 persons whereby 3 people are not answering Quiz 3. From the problem-based question, the overall result for Quiz 3 are as follows.

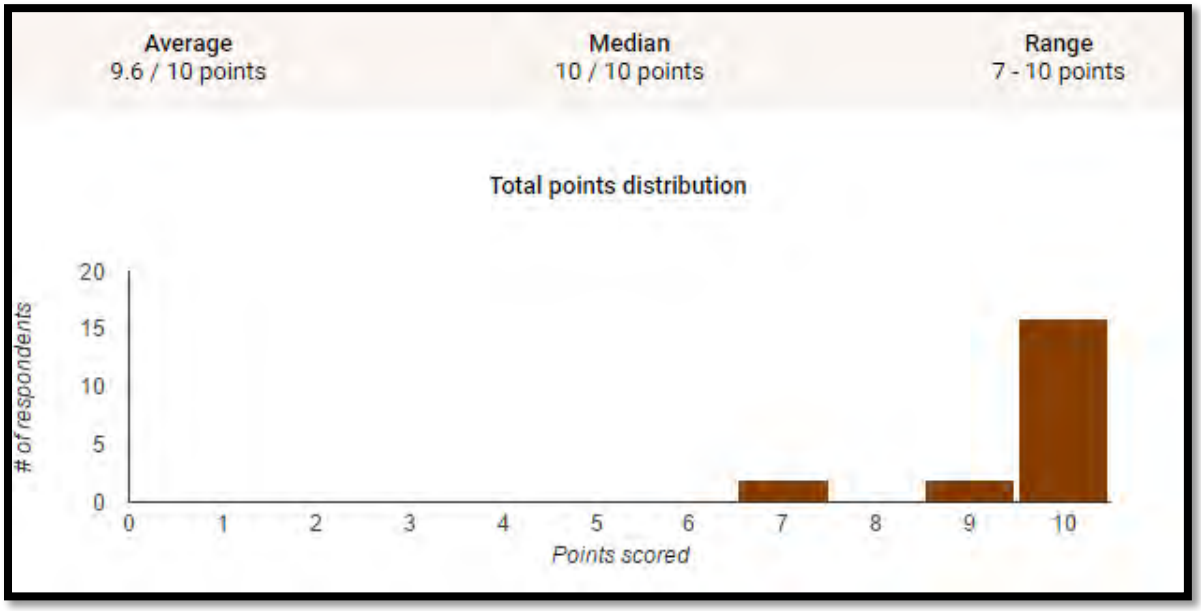

Figure 4.7: The overall result of Quiz 3

From the overall result of Quiz 3, 16 out of 20 students can answer the quiz with a correct answer, which means 80% of the student can answer correctly without any mistake. The least mark obtained by the student is 7/10 and the total student obtained the least mark is two persons. The average mark obtained by the student in Quiz 3 is 9.6/10 which in percentage is 96%.

The last assessment for student in the course is Quiz 4 which the topic that assess in Quiz 4 in Duct Sizing Methods. In this quiz, students are tested with the knowledge of basic parameter of each three method of duct sizing. The duct sizing methods that are covered in the assessment are Static Regain method, Velocity Reduction Method and Equal Friction method. The overall result of Quiz 4 is as follows.

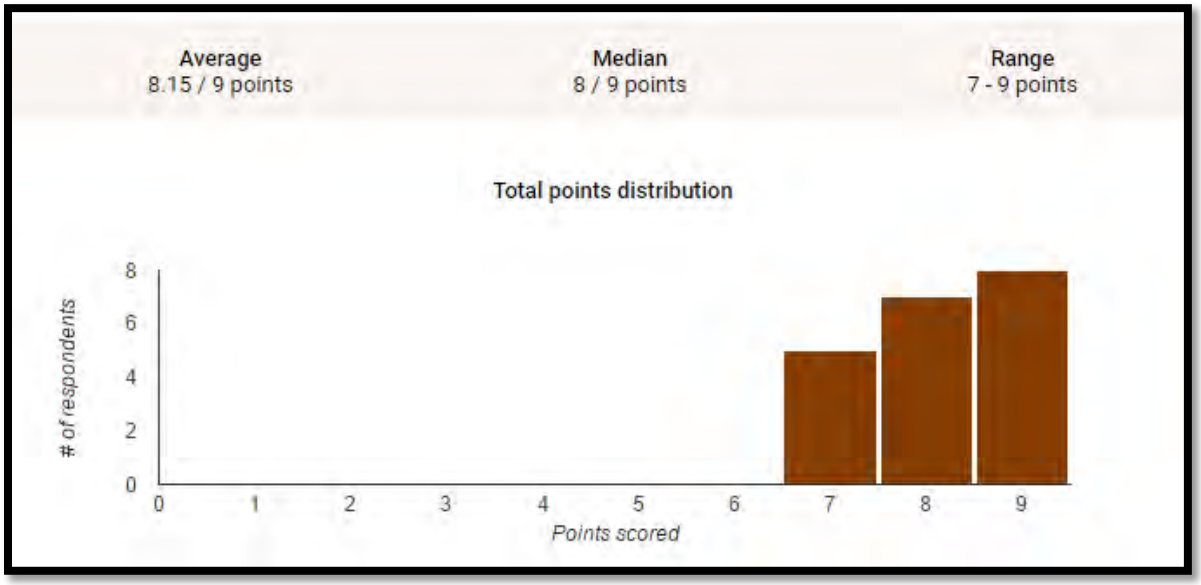

Figure 4.8: The overall result for Quiz 4

From the bar chart above, the total student that taking Quiz 4 is 20 persons. From 20 persons, 8 students are achieving full marks in the quiz. The least mark obtained by the student is 7/9 whereas only 5 students are getting the least mark. The average mark obtained by the student in Quiz 4 is 8.15/9 which in percentage is 90.1%.

4.4 Survey

A survey is conducted once the student is completing their progress in the course. The survey is conducted in order to know how the course are helping the student in learning the ducting design studies of HVAC. The survey consists of 15 questions and 1 recommendation section for the people to write about their recommendation on the course. There are 20 responses that are collected from the survey. Below is the respondent gender that is answering the survey.

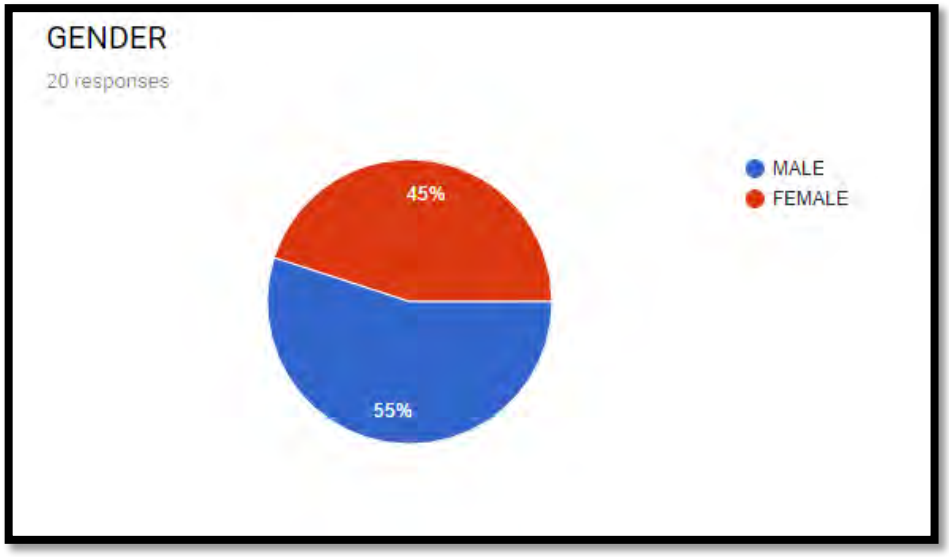

Figure 4.9: The gender of the respondent

Of the 20 respondents in the survey, there are 55% of male respondent, which the total of male respondent is 11 people. Thus, the female respondent carries 45% of total respondent which are 9 persons in total.

The first question in the course survey is to find out whether the course is helping the student to understand ducting design studies in HVAC. From this question, the feedback about the effectiveness of the course can be obtained. Below is the result of the responds for the understanding of a student in ducting design studies of HVAC.

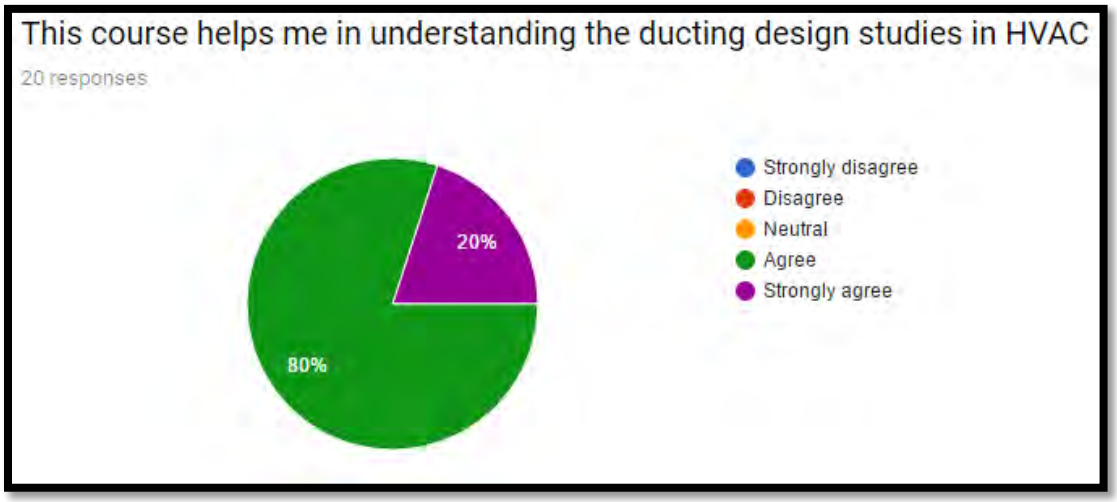

Figure 4.10: Response of Question 1

Figure 4.10 shows that 80% of the respondent are agreeing that the course helped them in understanding the ducting design studies of HVAC. While the other 20% of respondent are strongly agreeing that the course are helping them in understanding the ducting design studies in HVAC. No respondent is answering disagree for the first question.

The second question in the course survey is asking the respondent whether the respondent is leaving the course with a greater knowledge in ducting design or not. The result of the question is as follows.

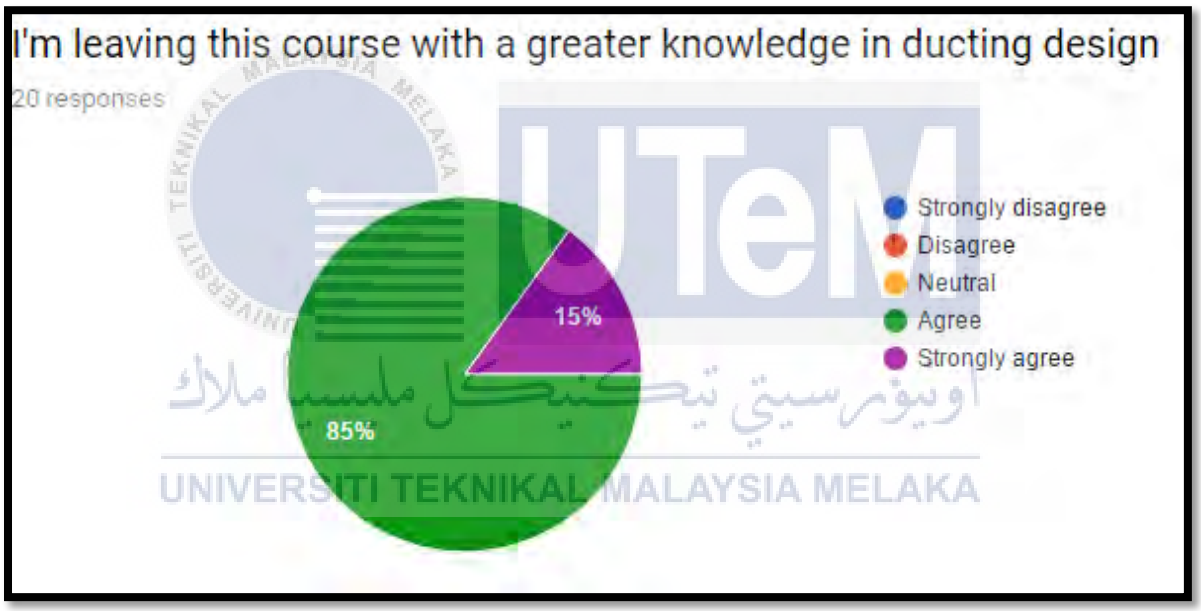

Figure 4.11: Response of Question 2

With the result, 85% of the respondent are agreeing that the course gives the respondent a greater knowledge in ducting design while the other 15% are strongly agreeing that the course are giving them greater knowledge in ducting design studies. The total respondent that is answering agree are 17 persons and for the respondent that answering strongly agree are 3 persons.

The third question in the survey is asking about the lecture notes provided in the course, whether it is attractive or not. By implementing this question, the result will indicate whether the lecture note is attractive or not. Below is the result for the third question.

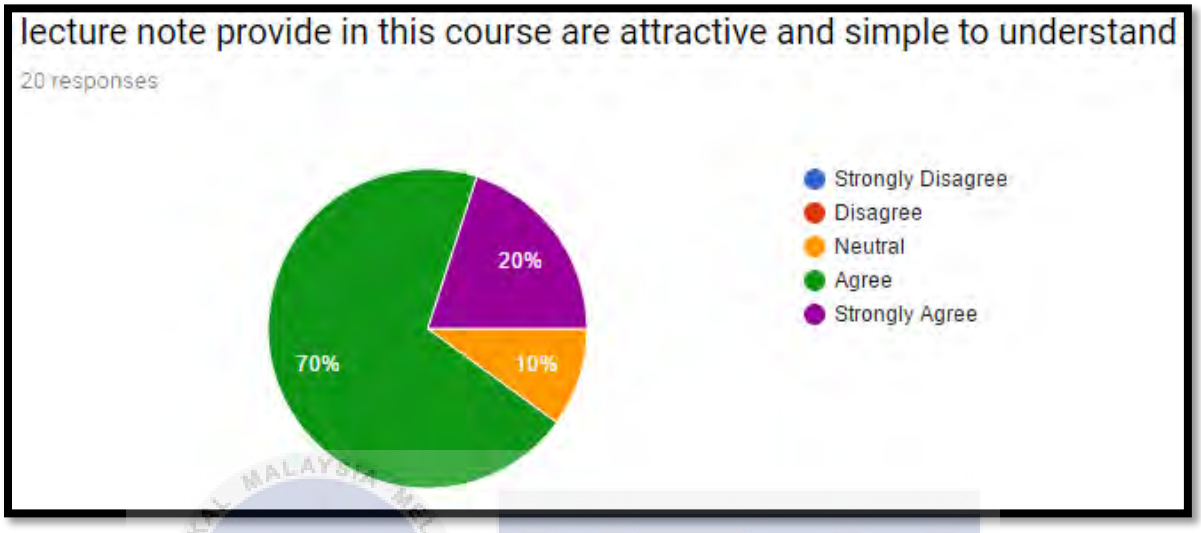

Figure 4.12: Response of Question 3

From the result of the third question in the course survey, there are 10% of respondent that are neutral for the question, 70% are agreed and 20% are strongly agreeing that the lecture note provide in the course are attractive and simple to understand. In a number form, there are only 2 persons which are neutral, 14 persons are agreeing and 4 persons strongly agree. This indicates that most of the people that undergo this course are agreed that the lecture notes provided in this course are attractive and simple to understand.

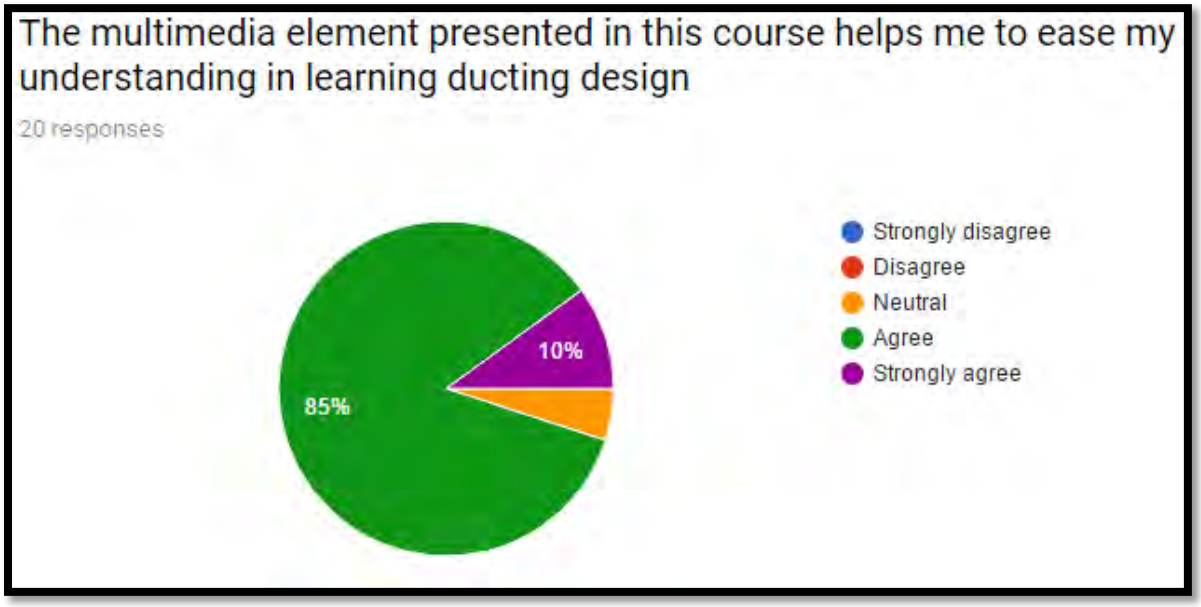

Figure 4.13: Response of Question 4

From the figure above, the fourth question in the course survey is asking the respondent about the multimedia element that are presented in the course, whether it is helping the respondent to understand the topic in ducting design studies of HVAC. From the result, only 5% (1 respondent) are stating that they are neutral to the question, 85% (17) are agreed with the statement and 10% (2 respondent) are strongly agreeing with the statement.

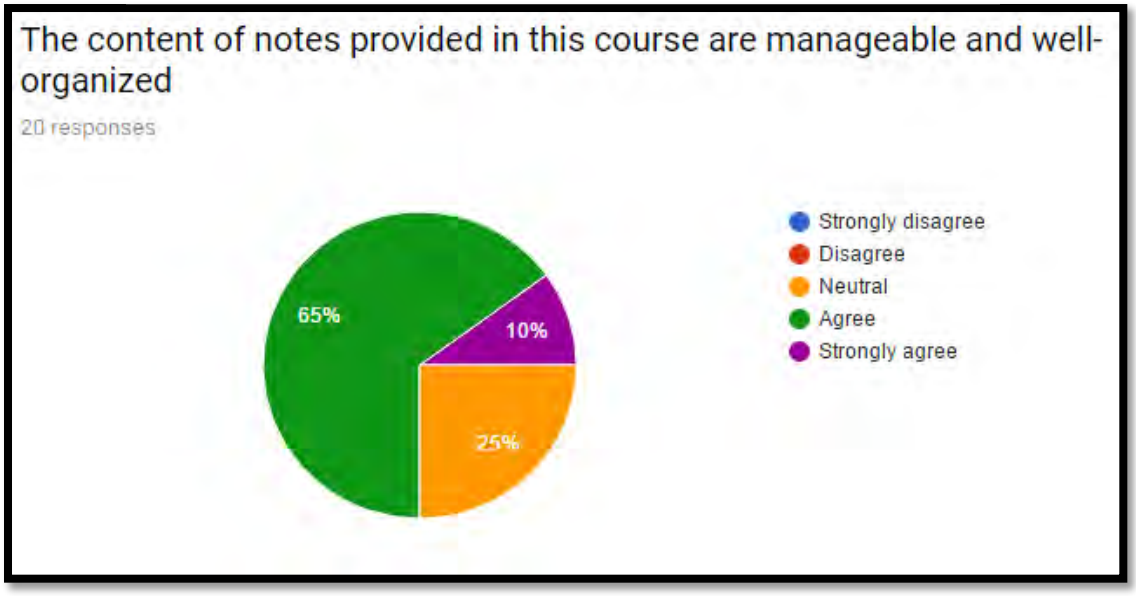

Figure 4.14: Response of Question 5

The fifth question in the survey are to test whether the content of the notes provided in the course are manageable and well-organized. The note's content is manageable and well organized are important so that the student is easier to understand the content of the slide notes. From 20 respondents, 65% are agree, 10% strongly agree while 25% are acting neutrally to the question. Numerically, 13 respondents agreed, 5 respondents are neutral and 2 respondents are strongly agreed.

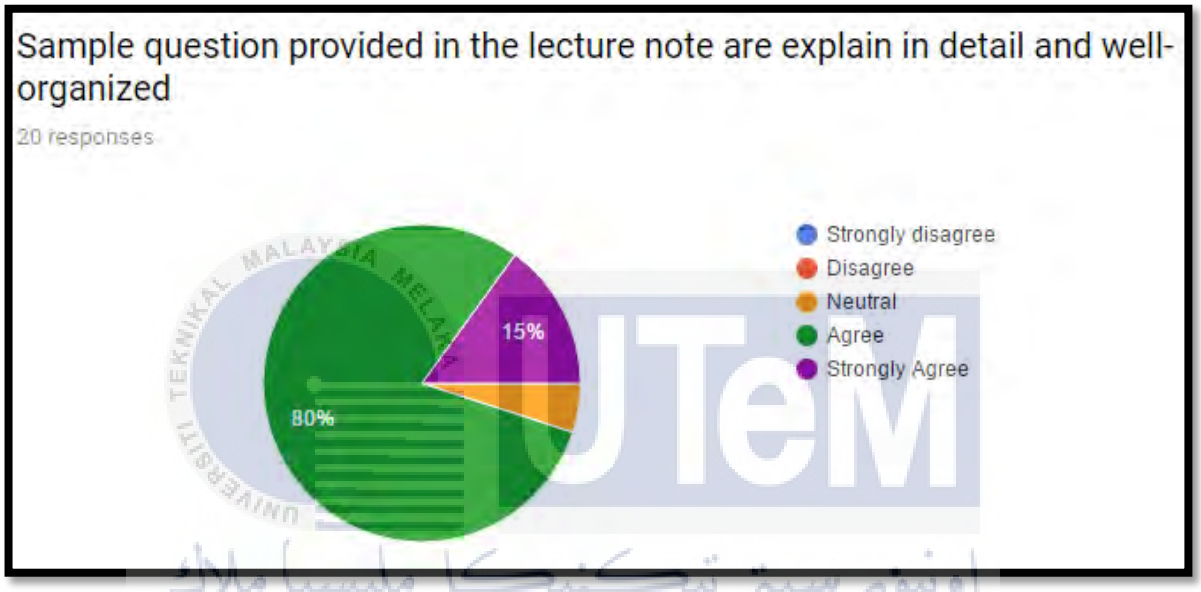

Figure 4.15: Response of Question 6

The sixth question in the course survey are to know the sample question provided in the notes are explained in detail and well organized. From the survey, only 5% (1 respondent) are acting neutral to the question, while 80% (16 respondent) are agreed with the statement and the other 15% (3 respondent) are strongly agreeing that the sample question are explained in detail and well-organized.

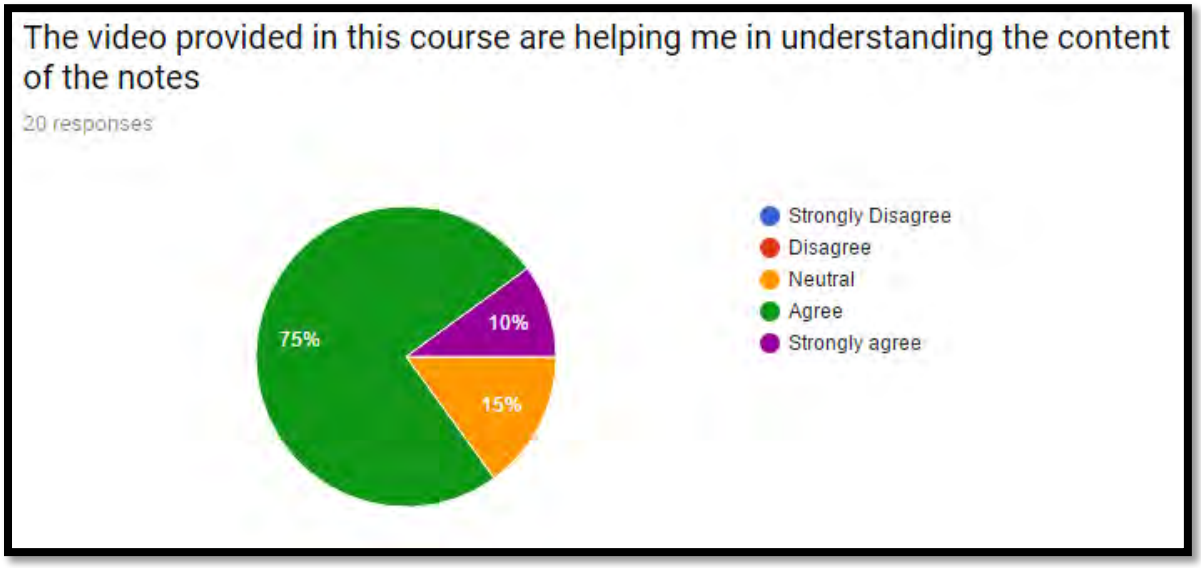

Figure 4.16: Response of Question 7

The seventh question in the course survey is about the video provided in the course, whether the video is helping the student in understanding the content of the notes. There are four videos are inserted in the course as each module consists a video. Form the survey, 15% of the respondent are neutral to the statement, 10% have strongly agreed with the statement while 75% of the student are agree with the statement. Adding up the number of agree and strongly agree responses, there are 90% of respondent that are agreeing the video are helping them in understanding the notes provided in the course.

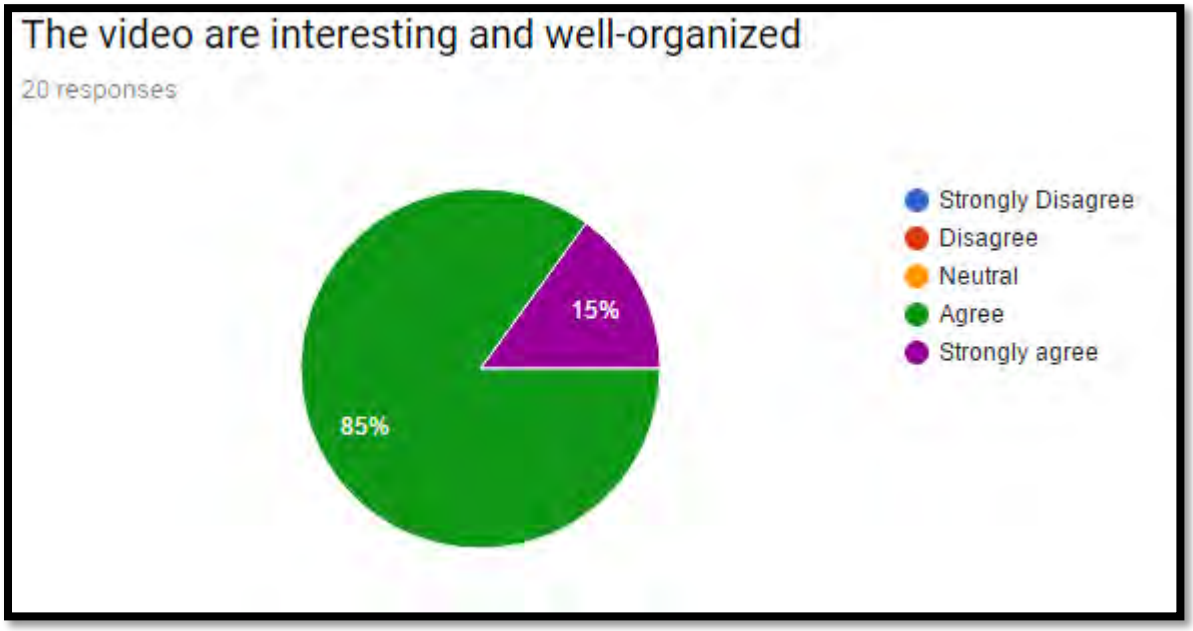

Figure 4.17: Response of Question 8

The eighth question are about the arrangement of video that are provided in the course. The arrangement of the video is crucial in order to let the student understand the content of the video. From the survey, 85% of the respondent are agreed and the other 15% are strongly agreeing that the video are interesting and well-organized.

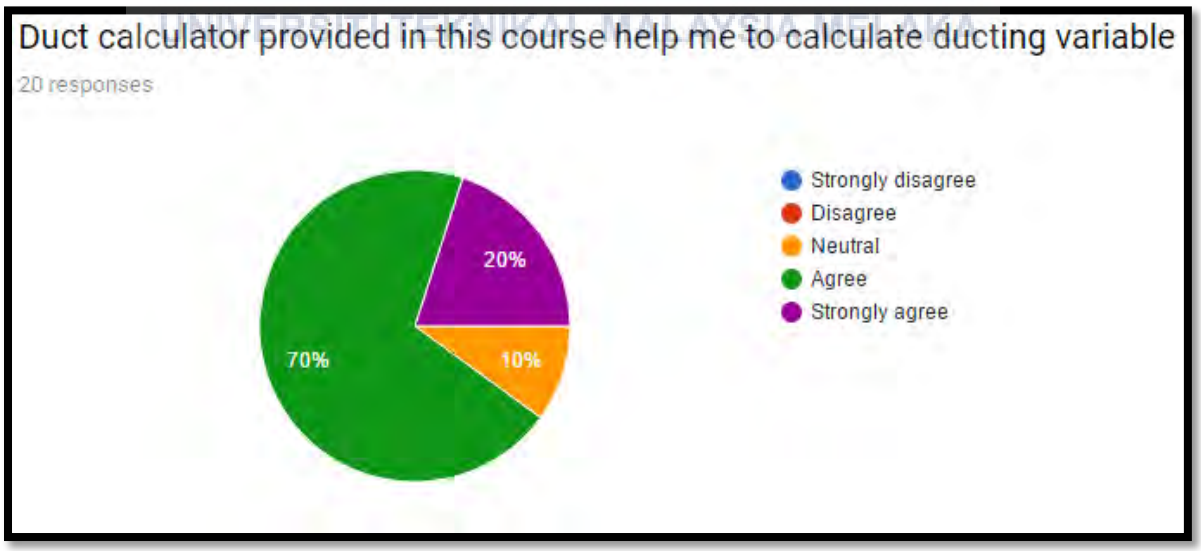

Figure 4.18: Response of Question 9

On the ninth question of the survey, there are 70% of respondent agree that the duct calculator provided in the course helps them in calculating the duct variable. There are two types of duct calculator that are provided in the course, which are Excel duct calculator and C++ duct calculator. In the survey, there are 20% of the respondent strongly agree that the duct calculator is helping them in calculating the duct variable. The other 10% of the respondent are acting neutral toward the question.

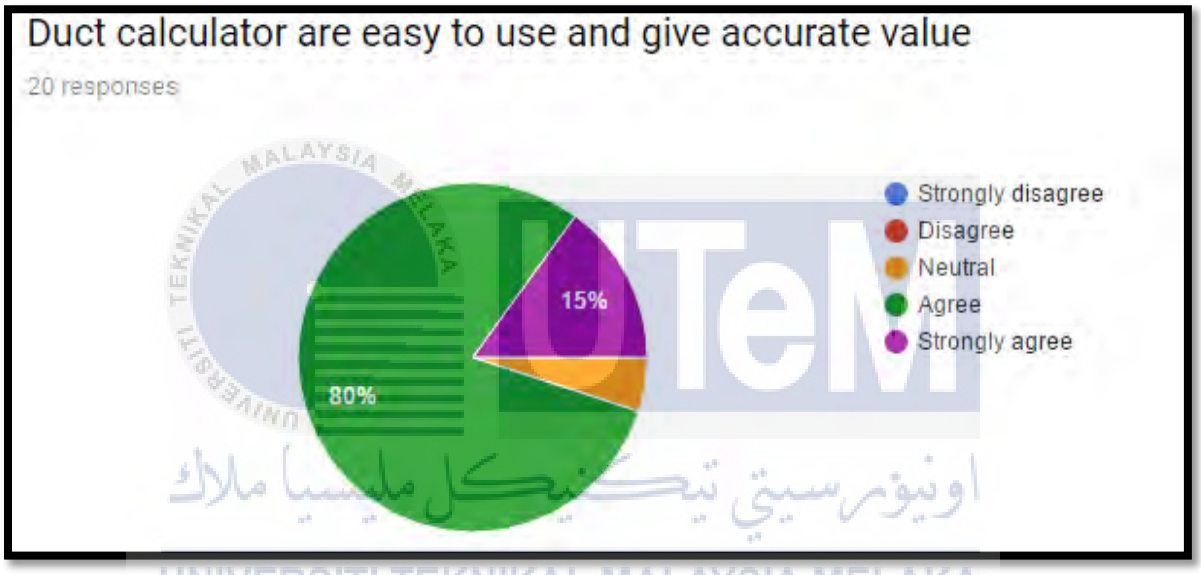

Figure 4.19: Response of Question 10

The duct calculator is important to be accurate as the calculation of the duct variable are easier to use the duct calculator than the manual method. The tenth question is to find out whether the duct calculator is operating accurately to the respondent when the respondent uses it. 80% of the respondent are agreeing the duct calculator are easy to use and provide an accurate value for each of duct variable. 15% of the respondent have strongly agreed with the statement while only 5% are neutral to the statement.

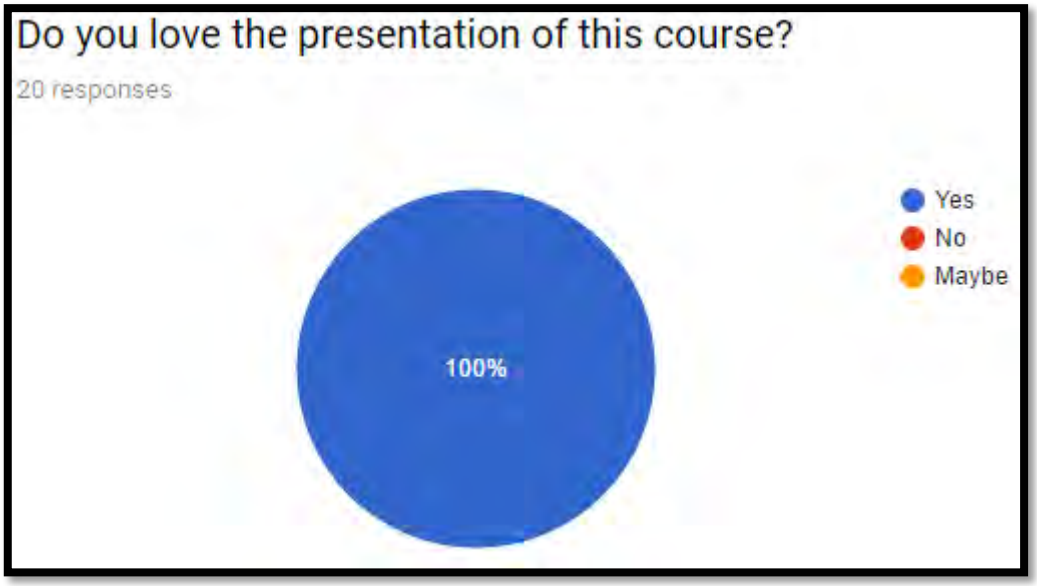

Figure 4.20: Response of Question 11

Figure 4.24 shows the eleventh question in the survey, which to know whether the respondent like the way of the presentation of the course. From the survey, all the respondents agreed that they like the presentation of the course. The implemented course using multimedia platform and element is attracting student getting interesting and enjoy learning process.

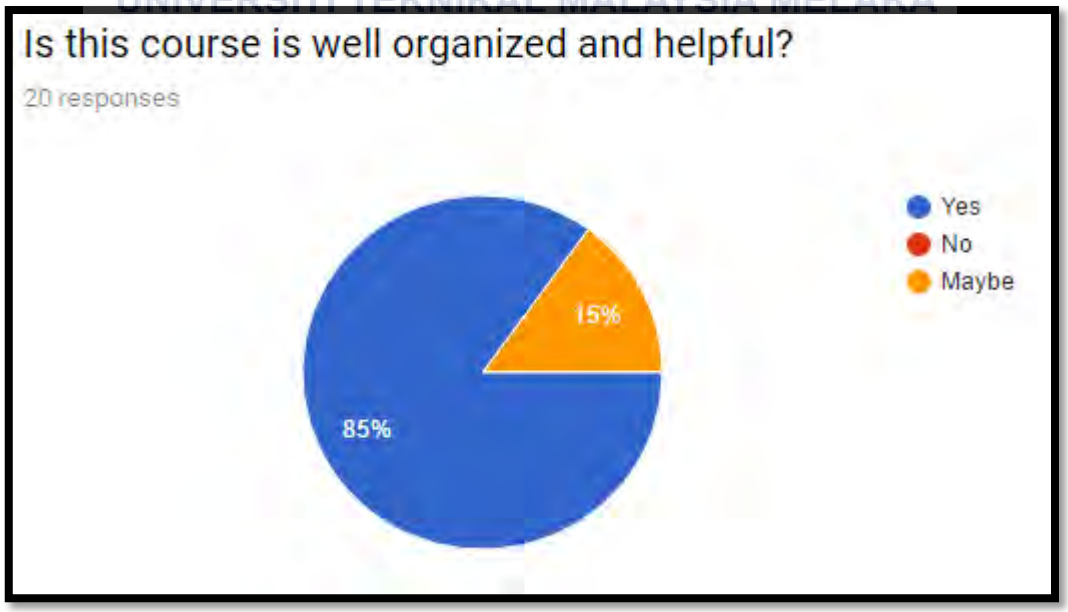

Figure 4.21: Response of Question 12

The twelfth question in the survey are to find out whether the course is well organized and helpful or not for respondent. From the survey, 85% of the respondent are agreeing that the course is well organized and helpful to the respondent. The other 15% of the respondent are stating that the course may be well organized and helpful to the respondent.

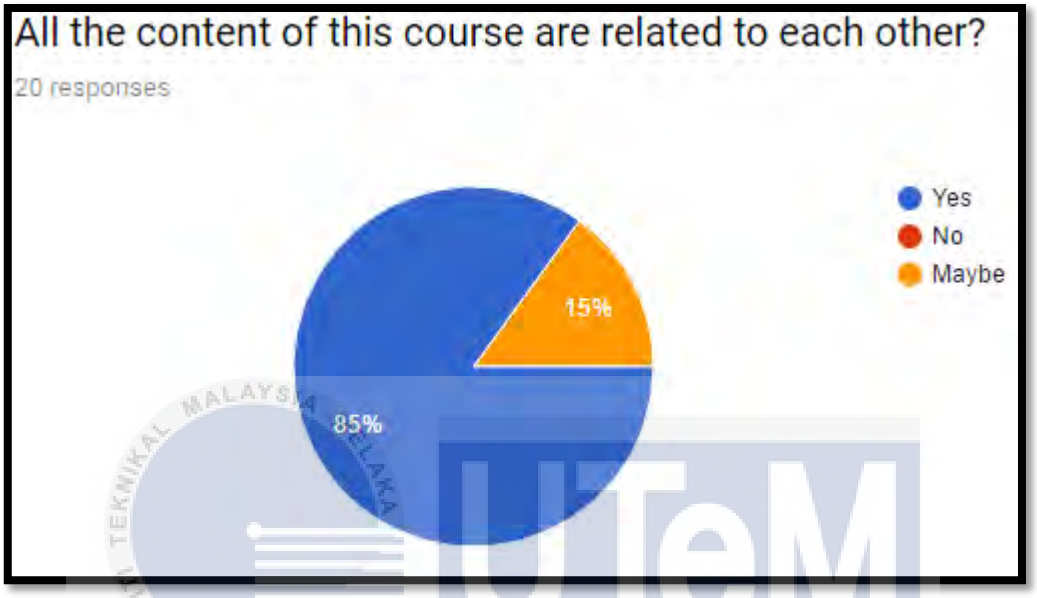

Figure 4.22: Response of Question 13

Question thirteenth in the survey is to find whether the content of the course is related to each other according to the respondent. From 20 respondents of the survey, it is found that 85% of the respondent are agreeing that the content in the course are related to each other while 15% of the respondent stated that maybe the content of the course is related.

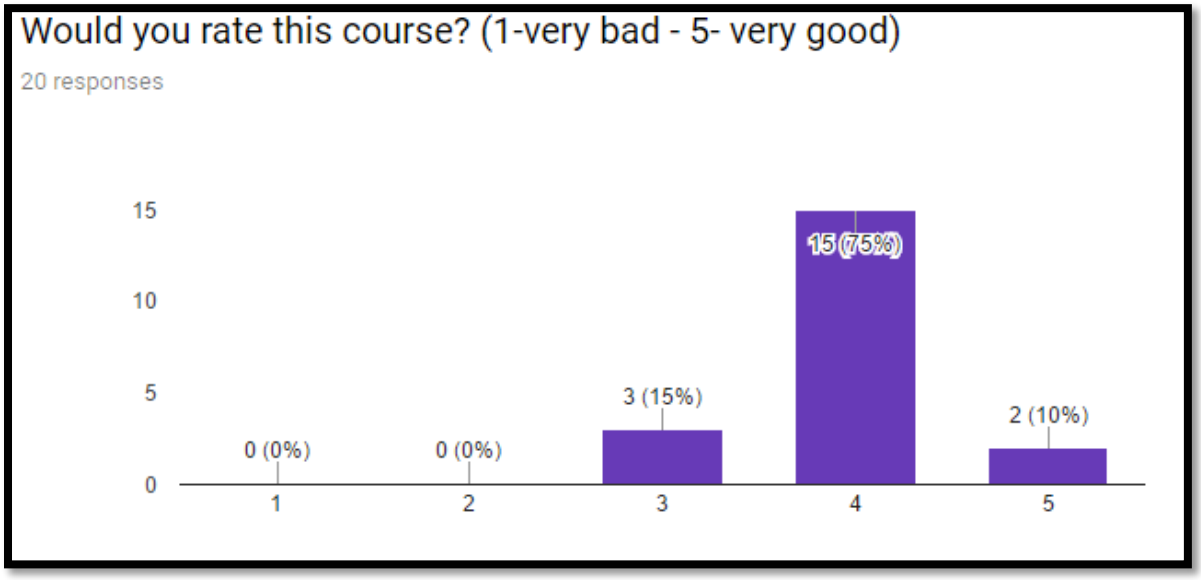

Figure 4.23: Response of Question 14

The fourteenth question of the survey is asking the respondent to rate the course, with scale starting from 1 which indicate the course is very bad, for 5 which indicate the course is very good. From the survey, there are 3 respondents which rate the course to point 3, which are intermediate. The highest rate is for point 4, which are representing the course is good, and the other 2 are rated the course as very good.

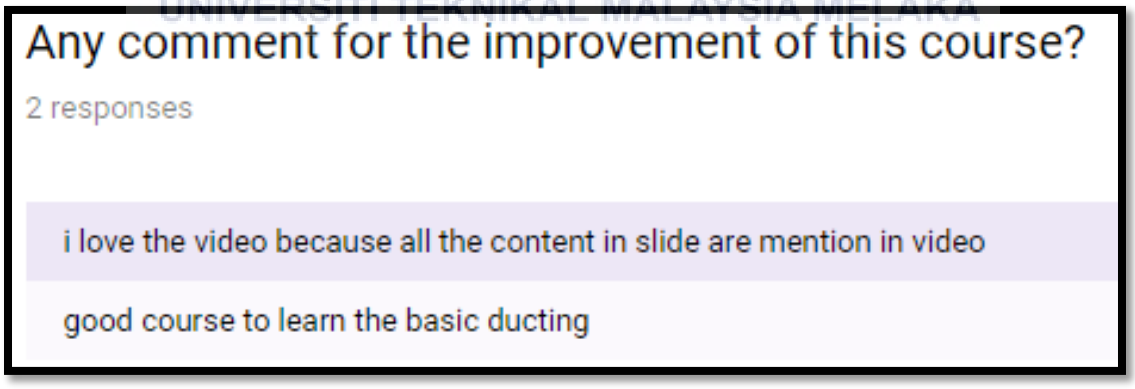

Figure 4.24: Response of Question 15

The last question in the survey is asking the respondent to give their comments in order to improve the course. The response that is obtained from the respondent are more to feedback on the course than the comment for improvement of the course.

From the survey conducted in the course, the responds that achieve in the course are positive because there are no responses that are rated negatively for the course. There are 20 respondents that are undergoing the survey and each question are established to know whether there is any lack in the course. Each of the questions in the survey have been discussed in order to know the feedback from the respondent. From the fourteenth question of the survey, most of the respondents suggesting with scale of 4 over 5 marks for overall course. Thus, this indicate that the respondent is satisfied with the course.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

The project is aimed to achieve two objectives which are the first objective is to propose a multimedia platform for an engineering educational purpose in the field of ducting design studies. In order to achieve the first objective, there are three mediums of media that are used to complete the project. The first media that implemented in the project are the slide notes. The slide note that used in this project are a simple but at the same time, the content of the notes can be delivered. Each slide notes are a maximum of 10 pages in order to lighten the process of understanding of the student. The slide notes are designed to have a lot of colour in order to attract the interest of student to understand the slide. Each slide consists of subtopic of ducting design studies in HVAC, so it makes the student easier to find their desired topic in ducting design studies.

In order to know the effectiveness of the slide notes in the project, a survey is conducted to know the feedback from the respondent, which also the student in the course. From the survey, 65% are agreed and 10% are strongly agree that the slide note presented in the course are manageable and well organized. In addition, the survey from the respondent also indicate that 70% are agree and 20% are strongly agreeing that the lecture note provide in the course are attractive and simple to understand.

The second media that are implemented in this project are by using video presentation for each module in the course. There are four modules implemented in this

course, thus there are four video used to help the understanding of the student in this course. The video basically explains the exact content of the slide note, but in order to attract the student interest, video platform is established. Each video duration are not more than five minutes, so the content of video is packed but presented in an attractive way. From the survey, there are 90% of respondent that are agreeing that the video is helping them in understanding the notes provided in the course. In addition, the result of the survey indicates that 85% of the respondent are agreed and 15% strongly agree that the video is interesting and well-organized.

The third media implemented in the project is by using duct calculator. There are two different software that are used to build the duct calculator which are Microsoft Excel and Visual Studio C++. From the duct calculator, the calculator will help to calculate the duct variable such as duct diameter, duct area, air velocity, pressure velocity and the frictional rate of the duct. By implementing the duct calculator, the student can use the duct calculator as their validation for the manual calculation of the duct variable because the result of the manual calculation and using duct calculation is small, which is 1.04%. From the survey, there are 70% of respondent agree that the duct calculator provided in the course helps them in calculating the duct variable and 80% of the respondent are agreeing the duct calculator are easy to use and provide an accurate value for each of duct variable.

The second objective of the project is to use the internet-based learning platform for the ducting design studies of HVAC. In order to achieve the second objective, the learning platform that are used to implement the project is OPENLEARNING™. OPENLEARNING™ is chosen as the learning platform because it is simple and broadly used in Malaysia as MOOC. Besides, by using OPENLEARNING™, the other student from different universities can join the course to learn about ducting design studies in HVAC. OPENLEARNING™ are using the internet as the platform, whereby the content of

OPENLEARNING™ can be accessed at everywhere which the internet service is provided. After the establishment of the course, the course is set to online and public so that the student that are interested to join the course can enroll the course. The total enrolment of students is 23, which from 23, one student is from India. This shows that there is no limit of geography to enroll the course by using the platform of OPENLEARNING™.

As the recommendation for future, this project can be benefited a lot to student by implementing the multimedia element into the educational platform. By implementing a lot of multimedia element into various education based learning, the rate of learning of the student can be enhanced. According to Leow et al, (2014), using multimedia can boost up the learning interest of the student toward the subject that they take in the classroom and can enhance their knowledge as their learning process become more interesting. The use of multimedia for engineering educational purpose is suggested as the nature of engineering course are pack of fact and formula for calculation. By implementing the multimedia element in engineering education, it can foster the student understanding of the complicated topics in engineering.

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