

# **Web-Based Adaptive Learning System to Enhance VET in Post-Secondary Education**

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requirements for the degree of B.Sc. (Hons.) Software  
Development*

## **Authorship Statement**

This dissertation is based on the results of research carried out by myself, is my own composition, and has not been previously presented for any other certified or uncertified qualification.

The research was carried out under the supervision of Mr Jean Paul Tabone.

Aaron Cutajar

June, 2021

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# Dedication

*I would like to dedicate my work put in for this dissertation to my parents Carmelo and Carmela Cutajar, and all my family and friends that supported and helped throughout this journey, even those that did not have the opportunity to support me till the end.*

# Acknowledgements

Firstly, I would like to thank every participant that responded to the online survey as well as the direct observation to help me generate data for this research.

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## Abstract

The motivations of this research are threefold, with each contributing to the researcher's personal motivation for the choice of the research theme. Firstly, the researcher has a great interest in education and e-learning systems. Secondly, adaptive learning systems are an emerging technology in the education field. Also, due to the current circumstances of COVID-19 the use of online learning, especially in post-secondary education, has increased, and a more adaptive approach to help and support learners with more interactive styles is required. Finally, there are few types of research on the study on how this new technology can help and support learners in VET (Vocational Education and Training) to better gain the crucial characteristics for effective learning. Therefore, this allowed the researcher to look into this in more detail. To gather data and to support the research questions for this research, a quantitative methodology was used. The first research question was, *How can a web-based adaptive learning-system enhance VET education in a post-secondary environment when compared to a traditional e-learning system?*”, the second research question: “*How can a web-based adaptive learning system adopt different learning styles to accommodate different learners' characteristics?*”, and the third research question: “*How can a web-based adaptive learning system support learner with learning difficulties?*”. The online survey was related to the learner's current learning trajectory using traditional e-learning systems, and also was a way to gather their learning styles.

The researcher designed and developed a prototype to prove or disprove that a web-based adaptive learning system can enhance VET education in a post-secondary environment. The main functionality of the prototype was developed after the analysis of the online survey, where the prototype was revised in a way that will make the most of facilitating active learning by providing various representations of the learning content.

Additionally, a direct observation was conducted to test the prototype and gather feedback. This was done to ensure that the features of the prototype achieved the objectives of the learners. After it was made certain that they understood the concept and functionality of the system, the researcher gave the direct observation survey. This assessed whether the system achieved the expected outcomes and to prove or disprove the hypothesis, which stated: “*A web-based adaptive learning system enhances VET education in a post-secondary environment*”.

Furthermore, this study may later be used as a reference by other researchers conducting similar studies; in other words, to obtain relevant and suitable information about the adaptive learning systems in VET education. It may also be used as reading material for any person who is interested in this area of study.

# **Chapter 1**

## **Introduction**

This chapter will introduce the research topic chosen, which will include: the research background, research purpose, hypothesis and research questions, significance of this research, importance of research, research methodology, research boundaries, research outline, and conclusion.

### **1.1 Research Background**

As stated by Ennouamani and Mahani (2017), an adaptive e-learning system is another way to teach and learn using internet technology by gathering learning styles and possible learning difficulties. VET (Vocational Education and Training) is also considered in this study, where Pranesti et al. (2017) stated that it aims to guide the learners during technical education, in which learners can have hands-on experience based on practicals, vocations, or jobs according to their course speciality for their careers.

Elmabaredy, Elkholly and Tolba (2020) applied a study to compare two different adaptive presentation techniques, which are the multimedia-based technique and the frame-based technique. At the end of this study, by investigating the effects of both techniques, the technique which most enhanced the learners' outcomes was identified. Basic media such as videos and infographics were embedded (together

with the other technique which adapts to each learners' preferences) were used for the multimedia-based technique. While multiple paths were included to direct each learner to suitable material according to their needs, and previous knowledge was used for the frame-based technique.

Nowadays, one can notice that there is a lack of studies which cater for adaptive e-learning systems to enhance VET by gathering learning styles and possible learning difficulties. Therefore, the researcher is proposing a web-based adaptive learning system to enhance VET in post-secondary education. Information overload is a situation in which learners are bombarded with an overwhelming amount of learning material, therefore we are facing the fact that learners struggle to find the appropriate learning resources. A web-based adaptive learning system tackles this problem by providing interactive courses based on learner's crucial characteristics for effective learning (Ennouamani and Mahani, 2017).

## 1.2 Research Purpose

This research is being undertaken for the purpose of determining whether a web-based adaptive learning system can enhance VET in post-secondary education when compared to a traditional e-learning system. Another important factor in this research is that it also gathers learning styles and possible learning difficulties for learners, which gives them the ability to learn with less obstacles.

### 1.2.1 Hypothesis and Research Questions

The hypothesis of this research is: "*A web-based adaptive learning system enhances VET education in a post-secondary environment*". This study will attempt to prove or disprove whether a web-based adaptive learning system can truly increase the success rate of VET learners in achieving their qualification when compared to a traditional LMS (Learning Management System).

The research questions in this study are:

RQ1: *“How can a web-based adaptive learning-system enhance VET education in a post-secondary environment when compared to a traditional e-learning system?”* RQ1 will be attempted by designing and developing a web-based prototype. Four learners and a lecturer will test the prototype and provide feedback through the use of observation.

RQ2: *“How can a web-based adaptive learning system adopt different learning styles to accommodate different learners’ characteristics?”* RQ2 will be tackled in two ways, where a minimum of 96 learners are asked to fill in an online survey related to the learners’ current learning trajectories using traditional e-learning systems. Also, a web-based prototype will be designed and developed. Statistical tests and descriptive analysis will be conducted to analyse these results.

RQ3: *“How can a web-based adaptive learning system support learner with learning difficulties?”* RQ3 will also be tackled in two ways, where a minimum of 96 learners are asked to fill in an online survey related to the learners’ current learning trajectories using traditional e-learning systems. Also, a web-based prototype will be designed and developed. Statistical tests and descriptive analysis will be conducted to analyse these results.

### **1.2.2 Significance of this Research**

The key objective of this research is to see if web-based adaptive learning systems can enhance the learning environment of VET post-secondary learners. As stated by Ennouamani and Mahani (2017), adaptive learning systems can enhance the learning environment either by integrating learning style models or through combinations of such. For this to be possible, the system needs collaborative learning and sharing, as well as lecturers, are to be able to follow-up with their learners.

For this research, a web-based adaptive learning system will be developed, which would be helpful for VET learners when compared to traditional e-learning systems. This research can aid learners with different learning styles and potential learning difficulties. Furthermore, this study may later be used as a reference by other re-

researchers conducting similar studies; in other words, to obtain relevant and suitable information about the adaptive learning systems in VET education. It may also be used as reading material for any person who is interested in this area of study.

### **1.3 Importance of Research**

The motivations of this research are threefold, with each contributing to the researcher's personal motivation for the choice of the research theme. Firstly, the researcher has a great interest in education and e-learning systems. Secondly, adaptive learning systems are an emerging technology in the education field. Also, due to the current circumstances of COVID-19 the use of online learning, especially in post-secondary education, has increased, and a more adaptive approach to help and support learners with more interactive styles is required. Finally, there are few types of research on the study on how this new technology can help and support learners in VET to better gain the crucial characteristics for effective learning. Therefore, this will allow the researcher to look into this in more detail.

The researcher will seek to provide an original contribution of this research: to help learners enhance their learning using a web-based adaptive learning system. Moreover, this study will contribute to MCAST (Malta College of Arts, Science and Technology) and any other private educational institution by developing a solution using the latest web technologies, and paradigms to try to enhance their learning when accessing educational material. Moreover, more learners will not give up on their studies and continue furthering their education in post-secondary VET education.

### **1.4 Research Methodology**

The researcher will make use of quantitative data analysis as a way of collecting and studying data. Quantitative data analysis was chosen for the advantages of

having a very large sample size. It is the more appropriate analysis type given that in this research a minimum of 96 learners will be participating and results will be determined and based on statistics. The data must be analysed quantitatively with the following methods: descriptive analysis of the data in a meaningful way such that relationships might emerge from the data, cross tabulation to analyse the relationship between variables or questions by splitting them on x and y-axis, and statistical tests to evaluate the evidence of the data, to either reject or not reject the null hypothesis.

## 1.5 Research Boundaries

The researcher intends to focus his study on a web-based adaptive learning system to enhance VET in post-secondary education when compared to a traditional e-learning system. The proposed solution will focus on a single unit taught at MCAST at Level 3 Diploma in iGaming. This unit covers 4 LO's (learning outcomes) with 10 knowledge, 5 understanding and 3 application criteria. This research aims to assist post-secondary VET learners. Therefore, this will not cater for primary and secondary institutions. It will also not cater for post-secondary institutions who do not provide VET education.

## 1.6 Research Outline

This research will contain the following chapters:

1. Introduction

This chapter has given a brief explanation of the research topic chosen. The research background, research purpose, hypothesis and research questions, significance of this research, importance of research, research methodology, and research boundaries.

## 2. Literature Review

In this chapter, the key literature used to build a solid basis for this research will be outlined. This chapter will include principles of web-based adaptive systems, e-learning platforms, VET environment, learning styles, learning difficulties, teaching methodologies, current web-based adaptive systems, and proposed system design and components.

## 3. Research Methodology

In the research methodology, the structure and processes used to create the proposed solution will be detailed by discussing the chosen research strategy, research method and data collection tools. Also, the major aspects of the development of the prototype will be detailed along with a clarification of the logic behind the implementation.

## 4. Analysis of Results and Discussion

In this chapter, the finding and results are presented and discussed to express how the research helped to reach the objective by including the data analysis method, analysis and discussion of the online survey, demographics, analysis and discussion of the experiment, analysis and discussion of the observation, analysis and discussion in relation to the literature, and analysis and discussion in relation to the hypothesis and research questions.

## 5. Conclusions and Recommendations

In this chapter, a summary of the research is given and some recommendations for areas which could be researched further are put forward.

## 1.7 Conclusion

In this chapter, the researcher gave an introduction to the research topic chosen, which included: the research background, research purpose, hypothesis and

research questions, significance of this research, importance of research, research methodology, research boundaries, and research outline. In the next chapter, the key literature used to build a solid basis for this research will be outlined. This chapter will include principles of web-based adaptive systems, e-learning platforms, VET environment, learning styles, learning difficulties, teaching methodologies, current web-based adaptive systems, and proposed system design and components.

# Chapter 2

## Literature Review

This chapter will give an overview of the literature that is related to the research topic chosen, which will include: the principles of web-based adaptive systems, traditional e-learning platforms, VET environment, learning styles, learning difficulties, teaching methodologies, current web-based adaptive systems, and proposed system design and components. This will be followed by a conclusion.

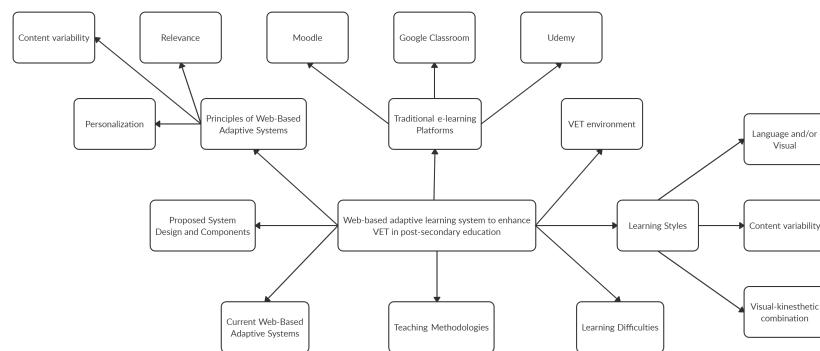


Figure 2.1: Literature Map

## **2.1 Principles of Web-Based Adaptive Systems**

As stated by Bilous (2019), the concept of designing adaptive systems in an electronic environment is based on several principles. The researcher will focus on the following:

### **2.1.1 Personalisation**

By providing personalisation of the educational process, the learner is granted the ability to create an individual educational course and space for learning materials. Salonen and Karjaluoto (2019) stated that matching real-time user preferences, which affect the changing intentions of the learner, are required by providing the right choice at the right time. Similarly, Ennouamani and Mahani (2017) stated that traditional learning is no longer able to provide personalisation, therefore, this is a key to adaptive e-learning systems.

### **2.1.2 Content Variability**

Content variability provides different representations of the learning content. Salonen and Karjaluoto (2019) stated that learning content is used to predict motivational effects to facilitate active learning. Equivalently, Ennouamani and Mahani (2017), stated that the target for adaptive e-learning systems is the varied representations of the learning content itself.

### **2.1.3 Relevance**

The content of the training is relevant to the learners and is in the context of their future professional activities. Salonen and Karjaluoto (2019) stated that for the learning to be more effective, the similarity between the content and the learners' fundamental activities has to be as high as possible. Similarly, Ennouamani and Mahani (2017), stated that the source of adaptive e-learning systems is to achieve the goal of catering to the crucial characteristics of the learner.

## 2.2 Traditional e-Learning Platforms

There are several e-learning platforms which contribute to the online learning environment. Such platforms include:

### 2.2.1 Moodle

Moodle is an e-learning platform designed to offer learners and lecturers with a singular, robust, secure, and integrated system, to allow the creation of personalised learning environments (Moodle, 2020). To prove this, Pavlakou and Kalachanis (2018) conducted several studies which mention in particular the features that Moodle provides for post-secondary education. The lecturer manages courses by adding learning material such as presentations, images, videos, and more, to promote learners' future professional activities, creativity, critical thinking, while also interacting by correlating learning with exploration, reflection, practice, and case study. Lecturers should have the appropriate skills to organize learning material and maintain the interest of the learners, to make the most of the same advantages within this platform.

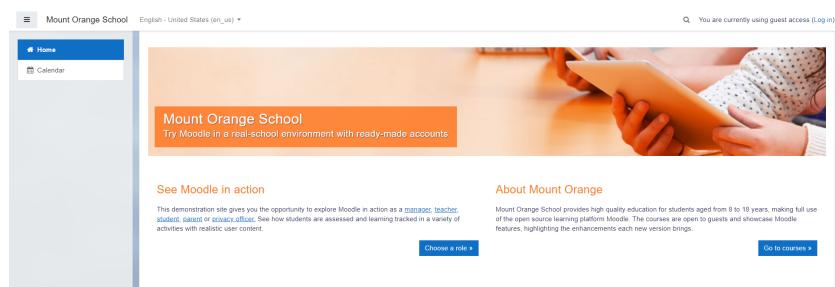


Figure 2.2: Moodle Platform  
(Moodle, 2020)

## 2.2.2 Google Classroom

Google Classroom is an open-source e-learning platform which gives the lecturer the ability to install and set-up the platform, create classes, add materials, create assignments, participant management, and share questions (Google, 2020). To prove this, Cristiano and Triana (2020), conducted several studies in which Google Classroom was presented as an alternative to the Moodle Platform, so that learners may experience another way of learning rather than traditional learning through whiteboards or blackboards. This platform was demonstrated to be a friendly environment by being accompanied by activities based on problem-solving, continuous assistance, assignments to improve various skills, and easy-to-follow learning material.

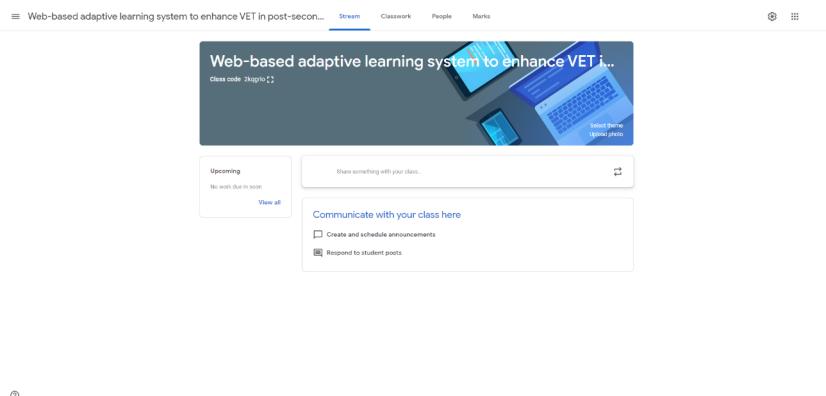


Figure 2.3: Google Classroom Platform  
(Google, 2020)

### 2.2.3 Udemy

Udemy is an e-learning platform which offers lecturers and learners methods of integrating with courses to enhance self-learning and to foster learners' hunger for learning and development. The main goal of this platform is to make learning more accessible and improve lives through learning (Udemy, 2020). To prove this, Goncalves and Goncalves (2018) conducted several studies where it was stated that Udemy is considered to be a MOOC (Massive Open Online Course) in which the development process can be characterized in Technology, Lecturing and Content dimensions, with these focusing on set fundamental stages towards planning and developing MOOCs. These dimensions are all crucial to achieving a quality teaching and learning process, and there is no hierarchical order. These courses allow lecturers to invest in their specific areas to continually improve or update knowledge and skill sets. In turn, learners are motivated as this turned out to be the main source of information and asynchronous interaction.

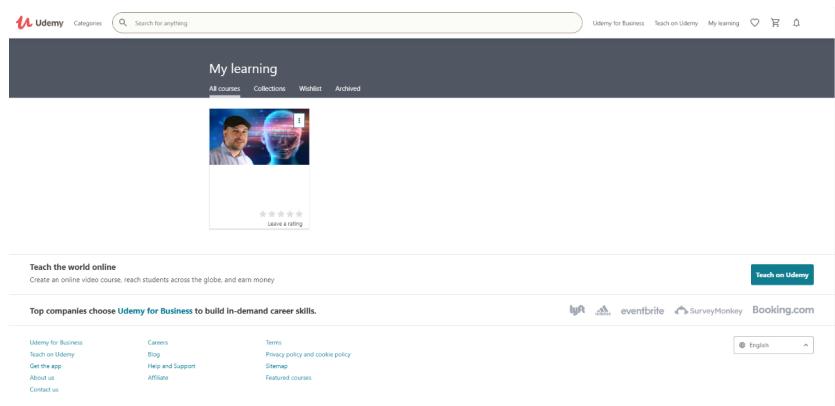


Figure 2.4: Udemy Platform  
(Udemy, 2020)

## **2.3 VET Environment**

As stated by Pranesti et al. (2017), Vocational and Education Training (VET) aims to guide the learners during technical education. In this training, learners may have hands-on experience based on practicals, vocations, or jobs according to their course speciality for their careers.

Three environments are mentioned by the researchers for the purpose of collecting information about the learners and to define the goal of studying a particular course:

1. Learners – The course should be suited to the age of the learners, take into consideration what learners expect to see, and should not be too rigid in order to help them learn.
2. Lecturers – Course language should be able to be understood and modelled by the lecturer.
3. Situation – The number of course lectures should be balanced to the scholastic semester or year. The material in the course should increase the acceptability and usefulness outside the lecture.

In contrast, Miciuliene and Ciuciulkiene (2019) stated that environmental factors are needed for participation and communication, facilitating course adaption based on learner input and the creation of meaningful learning. The environmental factors are created to various degrees by external factors such as teaching strategies and methods, learning materials, and media.

Jayalath and Esichaikul (2019) carried out several studies in which motivational factors such as ARCS (Attention, Relevance, Confidence, Satisfaction) were tested. 'Attention' captures the interest and encouragement of the learners, and makes sure that the way of learning is the best way of gathering the most attention from learners. 'Relevance' shows learning progress while also setting goals, making sure that the learning material matches the interests, and if possible, ties it to

the learner's experience. 'Confidence' balances when taking into consideration the difficulty level with the learner's skills, showing their progress levels, and providing rewards. 'Satisfaction' rewards the achievement in social groups by also setting up a progress leaderboard.

As the name of Vocational and Education Training suggests, it is a two-tiered training program. One part takes place in a vocational school, and the other part is an apprenticeship with a company. The theory is that a learner learns in an institute that which can be directly applied in practice at the company. This system is very flexible. For instance, training times can be reduced and part-time training is also possible. This means individualized arrangements can be found for anyone and the great thing is that learners receive certified training, and at the same time, they are also already earning some income. It is particularly important that besides gaining academic knowledge, learners also gain other skills at the company. Above all, a learner must be able to put their acquired knowledge to practical use, because as a successful employee the learner will later have to manage their projects within the company. Following this, the learner has a variety of prospects, such as advancing within the company or following further education to gain a higher certificate. Learners' prospects are versatile, and they are also attractive to other companies. With this system, learners are ideally equipped for the working industry and their career.

## 2.4 Learning Styles

Heras et al. (2020), introduced the VARK (Visual, Auditory, Read and/or Write, Kinesthetic) model to identify learning styles. They also established the appropriateness of various types of e-learning resources: diagrams, charts, or graphs are appropriate for visual learners, while simulations, videos, and movies of real life are appropriate for kinesthetic learners.

This model is a 16-question questionnaire for learners to try and find out what

their preferred learning styles are from visual, auditory, read and/or write, and kinesthetic. A visual learner is a learner with a visual preference for taking information and prefers to draw something on a paper as an explanation. In terms of gathering information, the learner would much prefer the lecturer to teach using graphs, charts, icons, diagrams, outlines, mind maps so that the information comes in a graphic form. An auditory learner is a learner which likes to listen to information, and they look out for lecturers who can teach orally about the things that they want to learn. Those who are auditory also want to speak, so lecturers need to provide an opportunity not for just themselves to talk but also for the learner to interact. A read and/or write learner is a learner with a visual text preference such as words, lists, bullet points, dictionaries and similar content that lecturers use. A kinesthetic learner is a learner which learns through examples, case studies and real concrete things that they can get a grip on or handle, so they are learners who have a mentality of applying in practice. There are also learners which have several preferences, or they cannot distinguish one preference to another. For example, if a learner prefers visual and auditory then both methods will assist them with their learning. Some learners would prefer all four methods, hence expecting a lot of variety in the presentation not only in receiving it from the lecturer but also in the way in which they can express it back. It is extremely important that learners can identify their preferences and capable of using the strategies that belong to the preferences chosen. Lecturers can take the questionnaire not to see how they are going to teach, but to find out how a learner prefers to learn.

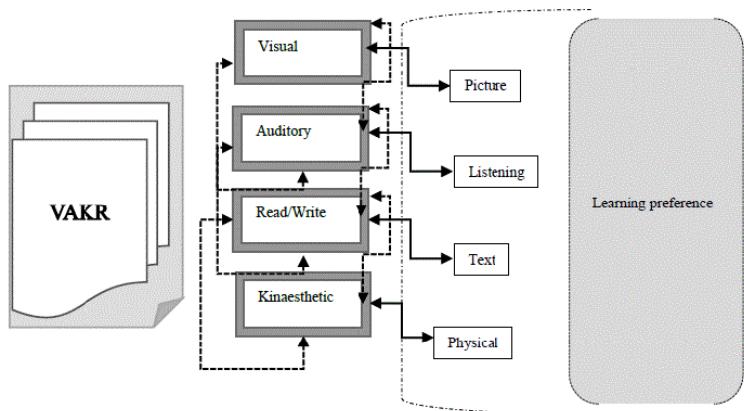


Figure 2.5: VARK Model  
(Alduaies, 2018)

Along similar lines of thought, Shawky and Badawi (2018) carried out several studies concerned with the learning style of the learner. The personalized learning process is supported by adjusting the compatibility level of the learning objects. A questionnaire is a way to gather such learning styles of the learner.

#### **2.4.1 Language and/or Visual**

As stated by Shawky and Badawi (2018), language and/or visual learning style is the graphical illustration of numbers. Similarly, as stated by Chaudhry et al. (2020), visual learners prefer printed information which may include diagrams, flowcharts, and arrows.

These learners prefer to see the information and visualize it in their heads when thinking about the relationships and the ideas, which may include charts, pictures, and other related printed information. Using different colours to make important notes can help learners distinguish different subjects. Another method is the use of flashcards with pictures or formulas which helps to visualize the information, as well as describing it in a preferred way.

## **2.4.2 Language Auditory**

As stated by Shawky and Badawi (2018), for those that prefer language auditory learning style should provide oral explanations and numbers, and games and/or puzzles should be used. In contrast, as stated by Chaudhry et al. (2020), auditory learners prefer methods that can be heard, such as lectures, tutorials, and discussions.

These learners prefer using their ears and like to listen to information rather than reading it, which in most cases they always remember what others have said in the past. Reading out loud when reviewing notes helps the learner remember and learn, or else discussing with someone or a group the idea or information. Listening to podcasts related to the subject and making voice recordings so that it can be revisited over again also helps.

## **2.4.3 Visual-Kinesthetic Combination**

As stated by Shawky and Badawi (2018), visual-kinesthetic combination learning style is by experimenting through self-involvement. Equivalently, as stated by Chaudhry et al. (2020), kinesthetic learners prefer hands-on activities for the best way to internalize information.

These learners prefer to learn by doing hands-on activities, like making and creating things, and do not like long lectures where they cannot do something. If a kinesthetic learner tries to study, it is a good idea to study in blocks, for example, spending 20 minutes of studying with a 5 minutes break in between. Walking while reviewing notes also helps in remembering what was reviewed. A presentation by discussing with others having different opinions also helps by expanding knowledge and remembering what was discussed.

## 2.5 Learning Difficulties

As stated by Azzopardi (2019), learners struggle to succeed in a one-size-fits-all regular education, having diverse needs such as dyslexia. The most useful strategy that is not dyslexia-friendly found in this study was the multisensory approach, which helps learners access learning, increase their interest in learning, and express their knowledge through multiple learning styles. A framework of UDL (Universal Design for Learning) was also found, which helps lecturers understanding how to create an environment that addresses the needs of all learners. Both the strategy and framework implemented together may promote a dyslexia-friendly environment, which allows learners to participate, offering them a comprehensive and inclusive learning experience.

In comparison, Aljojo (2020), stated that dyslexic learners struggle to learn reading as well as visual-spatial attention, which means what should be learnt while reading. Therefore, the researcher developed software programs to overcome these obstacles. The recording of learners' eye movements during reading was taken into consideration, since it was noticed that this research gap is one which was identified in previous studies.

Similarly, Lambert and Dryer (2018) put forward that learners with learning difficulties are effected in their quality of life while making use of online learning environments. The effected factors of quality of life that were revealed by semi-structured interviews were: stress, anxiety, self-esteem, free time, personal relationships, and financial pressure. A key finding is that these factors were frequently correlated with the enormous amount of time and effort learners invested into their learning to manage the encountered learning challenges. Managing emotional and personal issues, time-allocated to studying and time to engage in other activities are all suggestions for learners with learning difficulties, which can be assisted by additional support and services. These suggestions can be taken into consideration for application to an online learning environment.

Learners with particular needs at MCAST are able to develop their full poten-

tial with the provided educational support. This is done by the IEU (Inclusion Education Unit), which forms an integral part of the College's policy to provide an inclusive environment for such learners. The kinds of access arrangements in which a learner should have during TCA (Time-Constrained Assignment) are extra time, a reader, a prompter and a quite room.

## 2.6 Teaching Methodologies

Heras et al. (2020), presented a methodology called C-ERS (Conversational Educational Recommender System), which helps learners find the appropriate learning resources, based on their learning profile and objectives, educational level, and learning style. The recommendation process is built using learning objects by the use of the argumentation-based approach for collection, which allows a greater number of arguments to be generated to validate their suitability. C-ERS is based on the use of TEL (Technology-Enhanced Learning) systems offering different types of learning objects, such as tutorials and videos which may be used online.

ERS (Educational Recommender Systems) is a trending topic for tackling the problem of information overload, which learners can get the most out of by getting the learning objects that are the most appropriate to their educational level, learning objectives, and learning style.

In contrast, Shawky and Badawi (2018) presented a framework called RL (Reinforcement Learning), which investigates the features of the learning content, or a pattern that has not been explored before, to help learners find out what they want. Newly suggested learning patterns can be added by the learners and/or lecturers. It is also able to propose the appropriate learning environment for each learner, by investigating each one's histories of state-action-reward.

Nga (2020) also discussed several teaching methodologies, such as discussion, problem-solving teaching, traditional teaching and textbooks, documents and the internet. The method of discussion makes learning soothing and exciting, by com-

peting and helping each other by collaborating. The main aim of the problem-solving teaching method is to enhance learners' intelligence and the use of collaborative learners. It helps them think creatively, find their knowledge, and forms flexible methods. The method of traditional teaching is still very popular all around the world. It helps learners to analyze, explain, prove, grasp, think logically, and understand complex issues. The method of using textbooks and documents contains standard knowledge and skills related to the prescribed program unit, which supports learners in expanding their knowledge. On the other hand, the internet can support learners reference up-to-date information sources, helping them improve their understanding in the science fields and real life.

## 2.7 Current Web-Based Adaptive Systems

Elmabaredy, Elkholy and Tolba (2020) conducted a study to compare two different adaptive presentation techniques, which are the multimedia-based technique and the frame-based technique. At the end of the study, the technique which most enhanced learners' outcomes was identified by investigating the effect of both techniques. The study concluded that the adaptive multimedia-based technique was the most technique which enhanced the learners' outcomes.

Basic media such as videos and infographics were embedded (together with the other technique which adapts to each learners' preferences) were used for the multimedia-based technique. While multiple paths were included that directs each learner to suitable material according to their needs, previous knowledge was used for the frame-based technique.

Fatahi and Moradian (2018) applied comparison of the adaptive e-learning environment with a simple e-learning environment. Since they are focusing on the learner's personality and emotion, the adaptive e-learning makes use of the models called MBTI (Myers-Briggs Type Indicator) for personality and OCC (Ortony, Clore and Collins) for emotion modelling. Control and experiment groups were put

together to test two versions of the system. A simple e-learning system was used by the control group, while an adaptive e-learning system based on personality, and emotion was used by the experimental group.

Similarly, Hermawan et al. (2018) conducted a study to illustrate and compare types of adaptive learning, the workflow and variations in the input and output generation. In conclusion, the authors provided recommendations on the common factors of building adaptive mobile learning: learners, learning style and purpose, providing the right content or resources, learners' level of skill or distress, and learners' performance. Adaptive learning on a mobile learning platform was implemented, which provides a variety of learning features that support adaptive learning, gamification, collaborative learning, and self-directed learning. The implementation of adaptive learning was based on three methods: learners' learning style and background knowledge, questions may change according to the answer that was previously answered, and analyzing student data in real-time and automatically changes what learners will see next.

In contrast, Alhasan et al. (2017) have used ontology and semantic web technologies, to design a model for an adaptive e-learning course and learning styles. Through pattern analysis of the learner's behaviour while using the model following the FSLSM (Felder-Silverman learning style model), the authors build an adaptive learner profile.

The researchers aim at personalisation to enhance the performance of the personalising procedure in the learning process. It may be possible to determine an accurate learning style by increasing the monitoring of the learner's behaviour and filtering the learning material content to provide to a relevant recommendation. Appropriate types of knowledge resources are also recommended by using semantic rules reasoning.

## **2.8 Proposed System Design and Components**

Based on the literature above, and as stated by Shawky and Badawi (2018), a questionnaire is an appropriate way to gather such learning styles of the learner. Therefore, the researcher will use an online survey to gather the learning styles of the current learners. The researcher intends to focus his study on a web-based adaptive learning system to enhance VET in post-secondary education when compared to a traditional e-learning system. The proposed solution will focus on a single unit taught at MCAST at Level 3 Diploma in iGaming. This unit covers 4 LO's (learning outcomes) with 10 knowledge, 5 understanding and 3 application criteria.

Figure 2.6 below shows the system design, which includes the actions for both learners and lecturers. Both actors are required to register and login, which enables them to read and update their account information, and having access to other functions of the system. Learners can read course content according to their preferred learning style, while lecturers have access to CRUD (Create, Read, Update, Delete) operations, based on learning styles, which enables learners to read the uploaded course content.

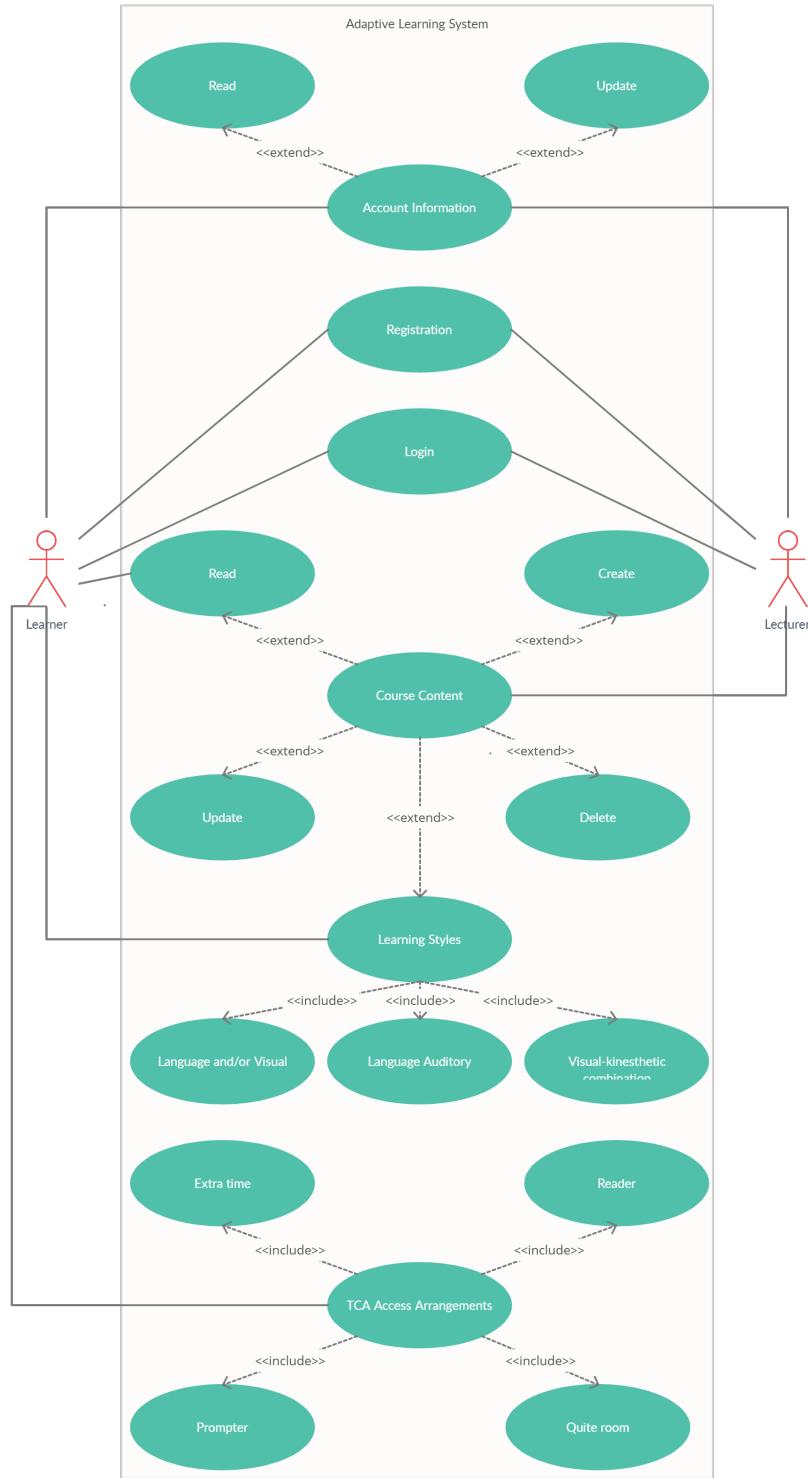


Figure 2.6: System Design

## **2.9 Conclusion**

In this chapter, the researcher gave an overview of the literature that is related to the research topic chosen, which included: the principles of web-based adaptive systems, traditional e-learning platforms, VET environment, learning styles, learning difficulties, teaching methodologies, current web-based adaptive systems, and proposed system design and components. In the next chapter, the research methodology will be outlined. This chapter will include: the research strategy, research and its justification, data collection methods and tools, the advantages and limitations, tools, structure and information, prototype, development tools, implementation, pilot testing, participants and feedback, errors, and ethical considerations.

# **Chapter 3**

## **Research Methodology**

This chapter will give an overview of the research methodology, which will include: the research strategy, research and its justification, data collection methods and tools, the advantages and limitations, tools, structure and information, prototype, development tools, implementation, pilot testing, participants and feedback, errors, ethical considerations, and conclusion.

### **3.1 Research Strategy**

The hypothesis and research questions introduced in the first chapter. Appropriate research methods were chosen and put into practice to assess the hypothesis and verify their statement based on deductive reasoning. A quantitative approach was used to implement the web-based adaptive learning system to enhance VET in post-secondary education, since it is assumed that learners tend to use such systems rather than traditional LMS.

In deductive research, the researcher begins by reviewing a particular social theory, and based on that theory a hypothesis is formed. This hypothesis is then tested with empirical data, and is either accepted or rejected based on the analysis of that data. Deductive research begins with a theory-driven hypothesis, so there might be an existing theory to explain a particular topic upon which to base a new

theory, which then guides the data collection and analysis.

This research will attempt to prove or disprove whether a web-based adaptive learning system can truly increase the success rate of VET learners in achieving their qualification when compared to traditional LMS. An example of a deductive research question is: *“Once artificial intelligence is mature enough, will it be able to assist, or even replace us, in the analysis of patterns emerging from ‘meta-omics’ data? Or even develop hypotheses that explain those patterns?”* This research question is deductive because the research questions and the hypothesis can be formulated from the research question, and to some extent is drawing from an existing social theory. Thus, deductive reasoning is the process of what one would use a proof because given information is used to make a proven statement (Nie and Wu, 2020).

### **3.1.1 Research Method**

The researcher made use of quantitative data analysis as a way of collecting and studying data. Quantitative data analysis was chosen for the advantages of having a very large sample size and that results are determined and based on statistics. The data was analysed quantitatively with the following methods: descriptive analysis, cross tabulation, and statistical tests.

### **3.1.2 Research Method Justification**

The quantitative research method was chosen over the qualitative one as a very large sample size was needed in this study, thus better knowledge will be extracted from this research. This was not possible when choosing a qualitative research, since this method tends to work better on a smaller sample size, usually not more than 10. The large number of responses resulted in having accurate data, and making the prototype more usable, since the resulting development was designed upon the responses of the learners. Quantitative data is more reliable since data

analysis for qualitative methods tend to be more time consuming.

The data was analysed quantitatively with the following methods:

- Descriptive analysis generated descriptive data from the online survey. The data was formulated in a meaningful way, so that relationships emerged. This was done so that the researcher would find it easier and more understandable to develop the ideal solution.
- Cross-tabulation organized the data from the online survey into categories that made it easier to compare. This was done so that the researcher may analyse the relationship between variables or questions, by splitting them on x and y axes.
- Statistical tests were used to evaluate the evidence of the data from the online survey, to either accept or reject the null hypothesis, which was dependent on the data being distributed and the research in question. This was done to help the researcher observe patterns from the gathered data.

## 3.2 Data Collection Methods and Tools

The data in this research was collected to perform data analysis and statistics, in which a prototype, direct observation, and online survey were used as data collection methods. The online survey, containing 101 learners, was related to the learners' current learning trajectory using traditional e-learning systems. The prototype was used to design and develop the web-based adaptive learning system, and was followed by 4 learners and a lecturer observation to test and provide feedback. Statistical tests were performed to analyze the gathered feedback based on the research question "*How can a web-based adaptive learning-system enhance VET education in a post-secondary environment when compared to a traditional e-learning system?*". Statistical tests were conducted to analyse these results through descriptive analysis based on the research questions "*How can a web-based adaptive learning system*

*adopt different learning styles to accommodate different learners' characteristics?", and "How can a web-based adaptive learning system support learner with learning difficulties?".*

### **3.2.1 Advantages and Limitations of the Chosen Data Collection Tools**

The research method was chosen since it is beneficial for the purpose of this research. The main advantage of designing and developing the prototype is that learners had the opportunity to experience the web-based adaptive learning system to have a better idea of how it differs from traditional LMS. It was quite challenging to make sure that the features of the prototype achieved the objectives of the learners, therefore a direct observation was conducted to test and gather feedback.

An online survey was related to the current learning trajectory, which had several advantages. Google Forms was used to conduct this survey, which made it easier to manage and gave the opportunity to operate remotely with no cost. It was very easy for learners to complete, since it was divided into sections, each of which contained different topics and resources. It also greatly simplified the gathering of results for the researcher. Responses were submitted in real time, therefore this helped the researcher to identify the thoughts of the learners on the research topic. On the other hand, it also had a few disadvantages. Learners may have not provided honest responses because they may have felt uncomfortable answering such questions. Although there are sections which provided explanations to areas which learners were not familiar with, they may still have misunderstood the topic hence resulting in an inaccurate or biased answer.

### **3.2.2 Data Collection Tools Structure and Information**

The online survey consisted of six sections, and it may be found in Appendix B. The first section contained the introduction for the survey, where the learner can find the title along with a message for the learners. The message included information about the researcher, purpose of conducting the survey, and the area of study.

The second section included demographic information, which included information about gender, age, location, and level of qualification.

The third section contained knowledge about VET, were the first question asked if the learner knew what VET is, and if not the learner could find an explanation. The second question asked whether VET subjects in secondary education were chosen. This led them to the fourth question where the learner selected the reason why VET (MCAST) was chosen over academic education. The last question was a linear scale of 1 to 6, one being the poorest and six being excellent, where the learner was asked to rate the level of support from administrative and academic staff.

The fourth section included knowledge about learning methodologies, where the first question asked for the preferred learning style. The second question was a linear scale of 1 till 6, with one being the least impact and six the most, where the learner was asked to assess the impact of the COVID-19 pandemic on study. The third question asked if the learner was registered with the IEU at MCAST, and if yes the learner could select what the access arrangements were. The fourth question was a linear scale of 1 till 6, with one being never and six frequently, which asked how often the learner asks questions during lectures. This led them to the last question where the learner was asked the level of shyness and embarrassment felt when asking these questions.

The fifth section contained knowledge about current VLE (Moodle), were the first question was a linear scale of 1 till 6, with one being never and six frequently, where a learner was asked how often was Moodle accessed. From the second till the last question, the learner is asked whether Moodle was helpful, user-friendly,

does it support the learning styles, and learning difficulties if any.

The sixth and final section included knowledge about adaptive learning systems, were the first question asked if the learner knew what an adaptive learning system was, and if not, the learner was presented an explanation with a video. All questions from the second till the last were a linear scale of 1 till 6, with one being not much and six a lot, where the learner was asked to think of how much this system could provide personalisation to have a better user experience, how much this system could provide content variability to facilitate active learning, and how much this system could provide relevant training in the context of future professional activities.

The direct observations, found within Appendix D, consisted of ten questions. All questions from the first till the fifth were linear scale of 1 till 6, with one being the poorest and six being excellent, where the learner and lecturer rated the overall experience of using the proposed web-based adaptive learning system, the layout of the content, the collection of profile information, navigation of the web-based adaptive learning system, and the filtered content according to the learning style. The sixth and seventh questions were also a linear scale of 1 till 6, with one being the least and six the most, where the learner and lecturer wer asked to assess of how much the proposed web-based adaptive learning system provided content variability, and how much the proposed web-based adaptive learning system provided relevant training in the context of future professional activities. The eight question was also a linear scale of 1 till 6, with one being the poorest and six excellent, where the learner and lecturer rated the overall experience of using Moodle. This then led them to the ninth question where the learner and lecturer were asked if accessing the proposed web-based adaptive learning system was more comfortable than Moodle. The tenth and final open question was recommendation for additional functionalities to the proposed web-based adaptive learning system.

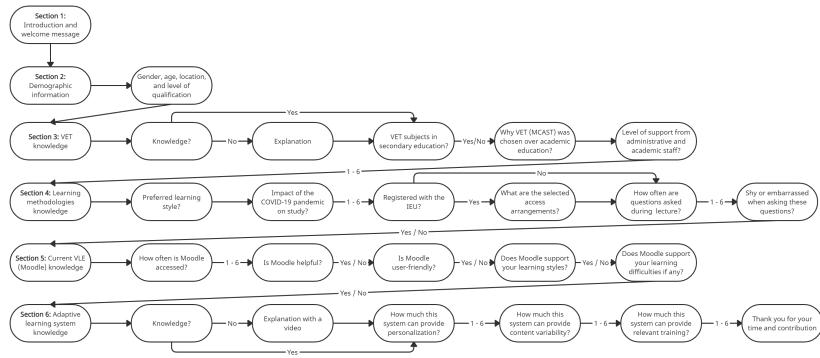


Figure 3.1: Schematic Diagram of Online Survey

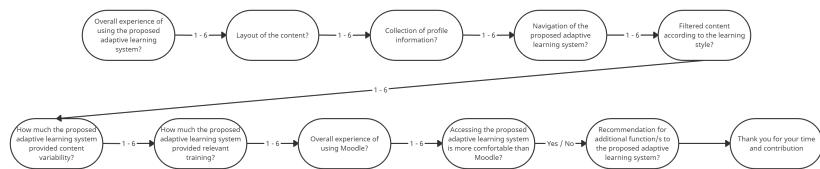


Figure 3.2: Schematic Diagram of Direct Observation

### 3.3 Prototype

For this research, a prototype had to be implemented to prove or disprove whether a web-based adaptive learning system can enhance VET education in a post-secondary environment. The main functionality of the prototype was to facilitate active learning by providing various representations of the learning content. Figure 3.3 below shows the site map of the prototype consisting of nine pages, which included: the landing page, registration for learners, login for both lecturers and learners, read and update access of account information for both user roles, and finally CRUD operations of the course content for lecturers and read access for learners.

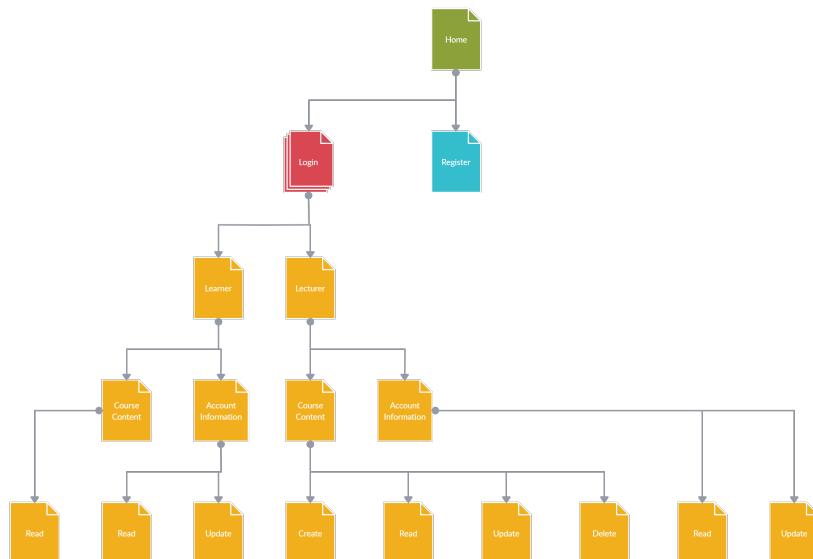


Figure 3.3: Prototype Site Map

### 3.3.1 Development Tools

For the implementation of the prototype, a combination of tools were required to come up with the best solution possible. Such tools included XAMPP, which was used to provide an ideal local development environment for local website hosting. This software package contained Apache, consisting of mainly Apache HTTP Server, MariaDB, PHP, and Perl programming languages. For this research, the Apache Server and MariaDB were used to structure the database, and the CakePHP 4.X web framework (which follows the model-view-controller approach) to develop the website. Within the CakePHP framework, multiple programming languages were used such as, PHP 7.3.11, HTML5, and CSS4. The installation of CakePHP included the folder structure for the website, together with the PHP programming language which took care of the back-end functionality. HTML and CSS were used for the front-end functionality.

### 3.3.2 Implementation

The figure below shows the implementation of the prototype consisting of four stages carried out as follows:

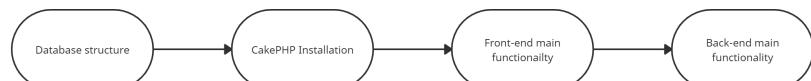


Figure 3.4: Prototype Implementation Stages

#### Stage 1: Database Structure

A MySQL database consisting of six tables was created, namely: users, courses, completions, roles, learning styles, and TCA access arrangements. Figure 3.5 shows the ERD (Entity Relationship Diagram) illustrating that one role may have many users, one learning style may have many users, courses and completions, one TCA access arrangement may have many users, one user may have many courses and

completions, and one course may have many completions.

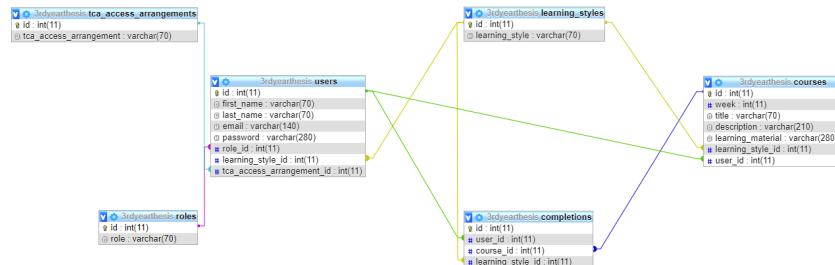


Figure 3.5: ERD (Entity Relationship Diagram)

Roles table fields are id and role. Learning styles table fields are id and learning style. TCA access arrangements table fields are id and TCA access arrangement. Users table fields are id, first name, last name, email, password, role id, learning style id and TCA access arrangement id, where role id, learning style id and TCA access arrangement id are the foreign keys. Courses table fields are id, week, title, description, learning material, learning style id and user id, where learning style id and user id are the foreign keys. Completions table fields are id, user id, course id and learning style id, where user id, course id and learning style id are the foreign keys. All tables have their ids set as the primary key.

The role which users may have is either Lecturer, or Learner. The learning style which learners, courses and completions may have is either Language and/or Visual, Language Auditory, or Visual-kinesthetic combination. The TCA access arrangement which learners may have is either Extra time, Reader, Promoter, or Quite room, and the ability to Drop Access Arrangement if any.

The password value in the users table was hashed so that it is securely stored, and the learning material value in the courses table was a link to material which is stored in an MCAST OneDrive account. The reason that it is being implemented this way was to avoid server storage and cost, taking into consideration the 1TB (Terabyte) OneDrive available storage for both MCAST lecturers and learners.

## **Stage 2: CakePHP Installation**

In this stage, the latest version of CakePHP was installed on the Apache Server. For this to be possible, a composer, which is a dependency management tool as the official supported machine for CakePHP installation, was downloaded. Thereafter, a CakePHP application was created using the composer's "*create-project*" command. Once the download was complete, an application skeleton and the core CakePHP library was created. Lastly, CakePHP had to be connected to the created MySQL database using a port number, the database name, username and password.

## **Stage 3: Front-end Main Functionality**

In this stage the front-end of the main functionality was developed. Within the templates folder a new folder was created with the name of the controller, and a new .php file was created inside the new folder named the same as the function inside the controller. The implementation inside this file catered for both lecturer and learner roles, where a check was performed determining whether a logged in user has their role set to a lecturer or a learner. This page had a title set as the header, together with either the total number of contents in each section, or a message stating that there are no content available. Lecturers had a button available underneath the first headers which had an operation of downloading a .csv file containing learners completed activity based on all content. Course content was presented using tables containing the Week, Title, Description, and Learning Material columns, together with other columns representing either different attributes or operations. The additional column for lecturers representing an attribute is the Learning Style, with other columns representing the operations of downloading a .csv file containing learners completed activity based on a particular content, Edit Content, and Delete Content. The additional column for learners represented an operation was the Complete/Incomplete content. Course content for lecturers was structured in four sections. The first section contained all learning styles content, the second section had content related to the Language and/or Visual learning style, the third section

was content related to the Language Auditory learning style, and the fourth section was content related to the Visual-kinesthetic combination learning style. Course content for learners was filtered according to their individual learning style.

#### **Stage 4: Back-end Main Functionality**

In this stage, the back-end of the main functionality was developed. Within the src, model, table path folder a new .php file was created with the same name as the table inside the database, followed by the Table keyword. Another .php file was created within the src, controller path folder, with the same name as the table inside the database followed by the Controller keyword. The first part of the implementation inside the table file catered for accessing the collection of entities stored in the database table. The initialize() in the table object was used to define associations between different objects in the application. The second part of the implementation inside the controller file was the view() which catered for both lecturer and learner roles, where a check was made whether the currently logged in user had a role set to a lecturer or a learner. The logic inside the view() made use of table objects to access the collection of entities stored in a table. Query builder to create queries using various methods to filter data, and passing the data to the views.

### **3.4 Pilot Testing**

Pilot testing had to be done of the prototype to see if there were any bugs or limitations that need to be investigated. Table 3.1 below demonstrates the tests that were carried out.

Action	Expected	Actual	Test Result
Promotion to sign up while logged out	Shows “Register Now!” while logged out	Showed “Register Now!” while logged out	Pass
Promotion to sign up while logged in	Hide “Register Now!” while logged in	Hidden “Register Now!” while logged in	Pass
Welcome logged in user	Welcome the user by type of role together with first name and last name	Welcomed the user by type of role together with first name and last name	Pass
Profile and edit page for lecturers	Hide learning styles and TCA access arrangements for lecturers	Hidden learning styles and TCA access arrangements for lecturers	Pass
List of lecturer, learner's	Download a .csv file to be able to see lecturer, learner's profile information	Downloaded a .csv file which showed lecturer, learner's profile information	Pass
Add, edit, and delete content	Successfully add, edit, and delete content	Successfully added, edited, and deleted content	Pass

Continuation of Table 3.1			
Action	Expected	Actual	Test Result
List of learner activities	Download a .csv file containing learners completed activity based on all content	Downloaded a .csv file which contained learners completed activity based on all content	Pass
List of learner activities based on a particular content	Download a .csv file containing learners completed activity based on a particular content	Downloaded a .csv file which contained learners completed activity based on a particular content	Pass

Continuation of Table 3.1			
Action	Expected	Actual	Test Result
Structure content page for lecturers	Structure content page for lecturers in four sections (All learning styles, Language and/or Visual, Language Auditory and Visual-kinesthetic combination)	Structured content page for lecturers in four sections (All learning styles, Language and/or Visual, Language Auditory and Visual-kinesthetic combination)	Pass
Total number of contents in each section	Show total number of contents in each section	Showed total number of contents in each section	Pass
Order contents in each section	Show contents in each section in ascending order by the week property	Showed contents in each section in ascending order by the week property	Pass

Continuation of Table 3.1			
Action	Expected	Actual	Test Result
Register, login and edit profile	Successfully register, login and edit profile	Successfully registered, logged in and edited profile	Pass
Error information for unsuccessful registration and edit profile	Successfully show error information for unsuccessful registration and edit profile	Failed to show error information for unsuccessful registration and edit profile	Fail
“ <i>You don’t have TCA Access Arrangement</i> ” in profile page if did not select any or dropped	Show “ <i>You don’t have TCA Access Arrangement</i> ” in profile page if did not select any or dropped	Showed “ <i>You don’t have TCA Access Arrangement</i> ” in profile page if did not select any or dropped	Pass
Filter contents for learners	Filter contents according to the learning style of the learner	Filtered contents according to the learning style of the learner	Pass
Complete and incomplete content	Learners to complete and incomplete content	Learners can complete and incomplete content	Pass

Table 3.1: Pilot Testing

### **3.4.1 Participants and Feedback**

With regards to the first part of the direct observation, the video was presented to the learners and a lecturer so that they could experience and test the system to contribute to this study. During the second part, the researcher gave an opportunity to the learners and a lecturer to ask questions and made sure that they understood the concept and functionality of the system. Lastly, the researcher gave the direct observation survey which assessed if the system achieved the outcomes as expected.

## **3.5 Errors**

During the implementation of the prototype some syntax and logical errors were present. For illustrative purposes, the code snippets have been intentionally modified to provide a better understanding of the error.

### **3.5.1 Error Number 1: Incorrect Table Name While Using the Query Builder**

The view function in the CoursesController.php is responsible for showing the list of content. An error on Chrome's browser stating, "*Table class for alias Course could not be found.*" caused this function to break. The problem was that the query builder could not get the table. This happened because the parameter for the get method was set as singular, thus table could not be found, since CakePHP database conventions set a rule that table names must be plural and underscored.

```
public function view()
{
    $coursesTable = $this->getTableLocator()->get('Course');

    $course = $coursesTable->find()->toArray();

    $this->set('view', $course);
}
```

Figure 3.6: Code Having Wrong Table Name

```
public function view()
{
    $coursesTable = $this->getTableLocator()->get('Courses');

    $course = $coursesTable->find()->toArray();

    $this->set('view', $course);
}
```

Figure 3.7: Code with the Solution of the Error

### 3.5.2 Error Number 2: Incorrect use of variable

The view function in the CoursesController.php is responsible for showing the list of content according to the learning style of the learner. An error on Chrome's browser stating, "*Function name must be a string*" caused this function to break. The problem was that the variable loggedInUser was undefined, and this was noticed with a message stating "*Notice (8): Undefined variable: loggedInUser [APP/Controller/CoursesController.php, line 43]*". This happened because the variable loggedInUser was set in the AppController.php, which was the parent class to the entire application's controller, thus making the variable accessible in template files. A solution for the error is accessing the information of the currently logged in user using the AuthComponent::user().

```

public function view()
{
    $coursesTable = $this->getTableLocator()->get('Courses');

    $course = $coursesTable->find()
        ->where(['Courses.learning_style_id' => $loggedInUser('learning_style_id')])
        ->order(['Courses.week' => 'ASC'])
        ->contain(['LearningStyles', 'Users', 'Completions'])->toArray();

    $this->set('view', $course);
}

```

Figure 3.8: Code with Incorrect Use of Variable

```

public function view()
{
    $coursesTable = $this->getTableLocator()->get('Courses');

    $course = $coursesTable->find()
        ->where(['Courses.learning_style_id' => $this->Auth->user('learning_style_id')])
        ->order(['Courses.week' => 'ASC'])
        ->contain(['LearningStyles', 'Users', 'Completions'])->toArray();

    $this->set('view', $course);
}

```

Figure 3.9: Code with the Solution of the Error

## 3.6 Ethical Considerations

With respect to this research, firstly the researcher ensured that no personal data or confidential data was divulged in this study. The data gathered from the study was stored on the researcher's computer and was only accessible to the researcher. It was also ensured that the learners were kept anonymous. No learner's demographics such as ID, name, and address were necessary for the study, therefore personal data was not asked and thus not stored. Furthermore, the data will not be kept longer than necessary. The maximum amount of time it will be kept is for one year, and afterwards, it will be deleted.

Secondly, the researcher ensured that no physical harm was caused to the learners during the study, since all tests were done online.

Thirdly, the researcher ensured that the learners did not suffer from any moral harm. The researcher provided a clear, and understandable explanation to the learner about the conducted study, by using simple words that the learners were knowledgeable of and highlighting their part in the study.

Lastly, the researcher ensured that there was no business harm as a result of the conductive study, and if there was, the researcher would have provided any businesses who may have a query about business harm with a soft copy of the study. This research investigated educational institutions within the government entities, therefore no business harm was incurred. The researcher made sure that only relevant data was gathered. The data will remain private and used only for the sole purpose of feedback, and improvement of the solution. The researcher made sure to abide by the recently introduced GDPR (General Data Protection Regulation) legislation regarding business and data protection.

### **3.7 Conclusion**

In this chapter, the researcher gave an overview of the research methodology, which included: the research strategy, research and its justification, data collection methods and tools, the advantages and limitations, tools, structure and information, prototype, development tools, implementation, pilot testing, participants and feedback, errors, and ethical considerations. In the next chapter, a discussion about the analysis of results will be outlined. This chapter will include: the data analysis method, analysis and discussion of the online survey, demographics, analysis and discussion of the experiment, analysis and discussion of the observation, analysis and discussion in relation to the literature, and analysis and discussion in relation to the hypothesis and research questions.

# **Chapter 4**

## **Analysis of Results and Discussion**

This chapter will discuss the analysis of results of the quantitative methods used within this research. This chapter includes: the data analysis method, analysis and discussion of the online survey, demographics, analysis and discussion of the experiment, analysis and discussion of the observation, analysis and discussion in relation to the literature, analysis and discussion in relation to the hypothesis and research questions, and conclusion.

### **4.1 Data Analysis Method**

Within this research, several data analysis methods were used for the prototype, direct observation, and online survey. The software used was IBM SPSS, which focused on statistics and helped in using several statistical tools to analyse the data gathered.

### **4.2 Analysis and Discussion of the Online Survey**

In the early stages of this research, an online survey had to be conducted (found in Appendix B). The main reason for conducting this survey was to collect several bits of statistical information. Such information in this survey included, demographics,

knowledge about VET, learning methodologies, their current VLE (Moodle), and adaptive learning system. Afterwards, the data gathered from this survey was gathered using Google Forms and the extracted data was imported to the mentioned IBM SPSS software.

#### **4.2.1 Demographics**

In the early stages of this research, it was mentioned that a minimum of 96 learners were required to cover a 10% margin of error of the Maltese population. A total of 101 responses were gathered, which were used to perform descriptive analysis and statistical analysis. The second section, which is the one after the introduction, for the survey included demographic information including gender, age, and so on. Before the analysis of this demographic data, the researcher had to filter and clean the gathered data. As shown in the table below (Figure 4.1), this was done by converting string values such as male and female to 1s and 2s accordingly. Such questions in the survey were not required, and these were given a value of zero. This had to be done to every column within the data for it to be readable by IBM SPSS.

	A	B	C	D
1	Gender	Age	Where do you live?	Current qualification level at MCAST
2	1	3	3	6
3	1	1	5	2
4	1	1	4	3
5	1	1	1	4
6	1	1	2	4
7	1	1	3	4
8	1	1	3	4
9	1	1	3	4
10	2	1	4	4
11	1	2	4	4
12	2	2	1	3
13	1	1	2	3
14	1	1	3	4
15	1	2	2	4
16	1	1	2	4
17	1	3	4	3
18	1	1	1	4
19	1	1	3	4
20	1	1	1	4
21	1	1	1	6
22	1	2	5	3
23	1	1	1	4
24	1	1	4	6
25	1	3	1	6

Figure 4.1: Cleaned and Filtered Data

As shown in the chart below (Figure 4.2), it can be easily recognized that male learners covered three quarters of the responses, by having 76.2% (77 learners), followed by female learners carrying 23.8% (24 learners) from the total responses.

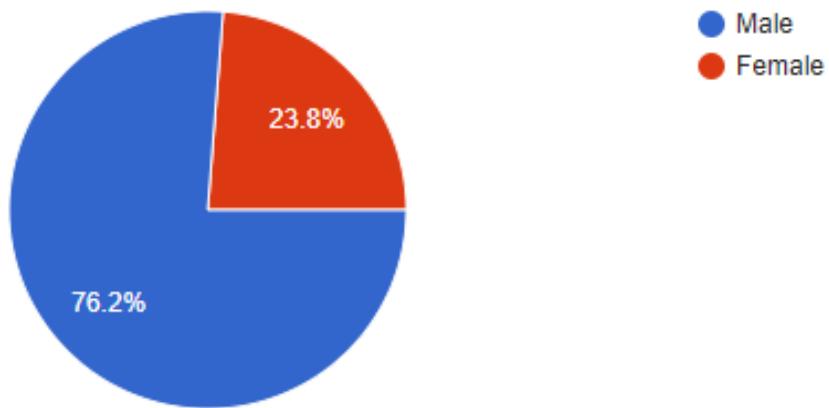


Figure 4.2: Descriptive Statistics Gender

The chart below (Figure 4.3) shows that from a total of 101 responses there were learners from all age groups. The age group that had the most learners was that of between 16 – 18 having 64.4% (65 learners), followed by that of 19 – 21 years of age carrying 24.8% (25 learners). Combining these two age groups together amounts to 89.2% (90 learners) of the total responses, which shows that most of the learners were youngsters. The rest of the learners where over 22 years of age having 10.9% (11 learners). These figures showed that learners contributed had different age groups, and this was a benefit for this research because different age groups provide diverse opinions.

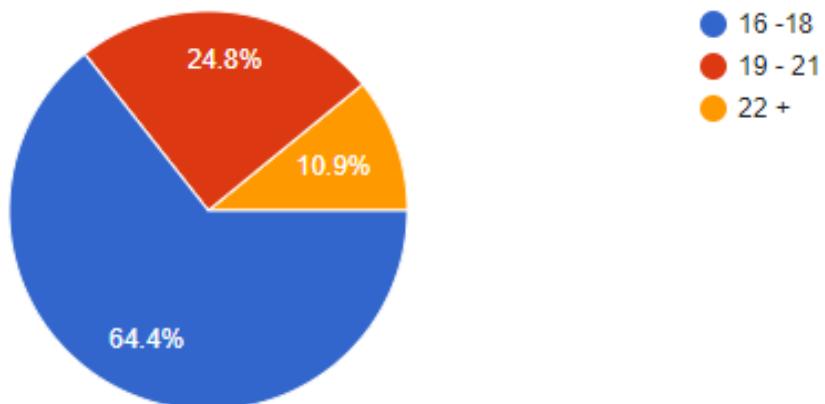


Figure 4.3: Descriptive Statistics Age

As shown in the chart below (Figure 4.4), the statistics about the location of the learners were analysed. The location that had the most learners was that of the southern harbour district carrying 29.7% (30 learners), followed by that of the northern harbour district having 21.8% (22 learners). Combining these two locations together amounts to 51.5% (52 learners) of the total responses, which clearly shows that these two locations covered half of the responses. The rest of the learners were mostly from south eastern district carrying 21.8% (22 learners), and northern district having 15.8% (16 learners). There were also few learners from western district carrying 8.9% (9 learners), and Gozo and Comino district having the remaining percentage of 2% (2 learners).



Figure 4.4: Descriptive Statistics Location

The last chart for the demographics section below (Figure 4.5) shows the analysed statistics about the level of qualification of the learners. From a total of 101 responses, there were learners currently studying on all level of qualifications, apart from level 1. The level of qualification that had the most learners was that of level 3 carrying 45.5% (46 learners), followed by that of level 4 having 32.7% (33 learners). Level 6 carried 17.8% (18 learners), and level 2 had the remaining percentage of 4% (4 learners). Combining level 3 and level 2 learners together amounts to 49.5% (50 learners), and level 4 and level 6 learners together amounts to 50.5% (51 learners) of the total responses, which clearly shows that each of these combinations covered half of the responses.

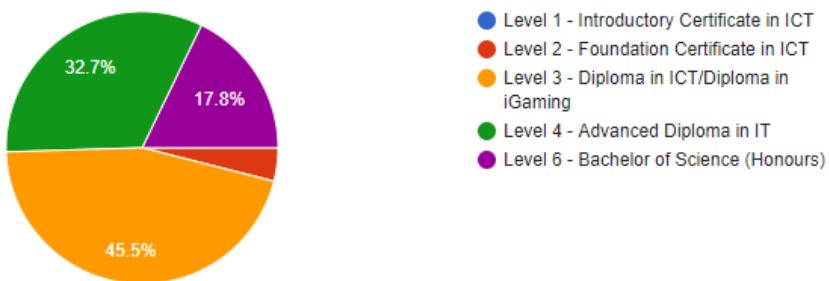


Figure 4.5: Descriptive Statistics Level of Qualification

#### 4.2.2 Chi-Squared Tests

To analyze the gathered data, comparison and contrast between variables, and cross tabulation had to be conducted using IBM SPSS. This data analysis method is used to quantitatively analyze the relationship between variables.

As shown in the table below, the researcher presented the result of the cross tabulation, which shows a statistical analysis between gender and whether learners know what VET is. The result shows that the learners that there was a higher percentage of male learners, 55.8%, that had the knowledge about VET. This is while females learners had a higher percentage of those that do not have knowledge about VET, at 45.8%.

**Gender \* Do you know what is VET? Crosstabulation**

		Do you know what is VET?		
		No	Yes	Total
Gender	1	Count	34	43
		% within Gender	44.2%	55.8%
		% within Do you know what is VET?	75.6%	76.8%
	2	Count	11	13
		% within Gender	45.8%	54.2%
		% within Do you know what is VET?	24.4%	23.2%
Total		Count	45	56
		% within Gender	44.6%	55.4%
		% within Do you know what is VET?	100.0%	100.0%

Table 4.1: Cross Tabulation on Gender \* Do you know what is VET?

After conducting cross tabulation, the researcher conducted statistical analysis between gender and whether learners knew what VET is. In the table below, what the researcher is interested in is the Pearson Chi-Squared, having a p-value of 0.885% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between gender and whether learners know what VET is.

Chi-Square Tests				
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	.021 <sup>a</sup>	1	.885	
Continuity Correction <sup>b</sup>	.000	1	1.000	
Likelihood Ratio	.021	1	.885	
Fisher's Exact Test				1.000 .534
N of Valid Cases	101			

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.69.

b. Computed only for a 2x2 table

Table 4.2: Chi-Square on Gender \* Do you know what is VET?

As shown in the table below, the cross tabulation shows a statistical analysis between age and whether learners chose VET subjects in secondary education. The first age group, the learners between 16 and 18, have the highest percentage of

56.9% when it comes to learners that chose VET subjects in secondary education. On the other hand, the third age group, which are learners aged 22 or over, carried the highest percentage when it comes to learners that did not chose VET subjects in secondary education, at 63.6%.

		Did you choose VET subjects in secondary education?			Total
		No		Yes	
Age	1	Count	28	37	65
	% within Age		43.1%	56.9%	
	% within Did you choose VET subjects in secondary education?		56.0%	72.5%	
2	Count	15	10	25	24.8%
	% within Age		60.0%	40.0%	
	% within Did you choose VET subjects in secondary education?		30.0%	19.6%	
3	Count	7	4	11	10.9%
	% within Age		63.6%	36.4%	
	% within Did you choose VET subjects in secondary education?		14.0%	7.8%	
Total	Count	50	51	101	100.0%
	% within Age		49.5%	50.5%	
	% within Did you choose VET subjects in secondary education?		100.0%	100.0%	

Table 4.3: Cross Tabulation on Age \* Did you choose VET subjects in secondary education?

In the table below, the Pearson Chi-Squared have a p-value of 0.217% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between age and whether learners chose VET subjects in secondary education.

### Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.055 <sup>a</sup>	2	.217
Likelihood Ratio	3.076	2	.215
N of Valid Cases	101		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.45.

Table 4.4: Chi-Square on Age \* Did you choose VET subjects in secondary education?

As shown in the table below, the researcher presented the result of the cross tabulation, which shows a statistical analysis between location and whether learners are registered with the IEU at MCAST. The results show that the location with the highest proportion of IEU-registered learners at MCAST are those of the northern harbour district, the second location group, with 22.7% of them being registered. Learners from the south eastern district, the third location group, are the location group that had the highest proportion not being registered with the IEU at MCAST, with 95.5% not being registered.

**Where do you live? \* Are you registered with the IEU (Inclusion Education Unit) at MCAST? Crosstabulation**

		Are you registered with the IEU (Inclusion Education Unit) at MCAST?		
		No	Yes	Total
Where do you live? 1	Count	27	3	30
	% within Where do you live?	90.0%	10.0%	100.0%
	% within Are you registered with the IEU (Inclusion Education Unit) at MCAST?	30.3%	25.0%	29.7%
2	Count	17	5	22
	% within Where do you live?	77.3%	22.7%	100.0%
	% within Are you registered with the IEU (Inclusion Education Unit) at MCAST?	19.1%	41.7%	21.8%
3	Count	21	1	22
	% within Where do you live?	95.5%	4.5%	100.0%
	% within Are you registered with the IEU (Inclusion Education Unit) at MCAST?	23.6%	8.3%	21.8%
4	Count	7	2	9
	% within Where do you live?	77.8%	22.2%	100.0%
	% within Are you registered with the IEU (Inclusion Education Unit) at MCAST?	7.9%	16.7%	8.9%
5	Count	15	1	16
	% within Where do you live?	93.8%	6.3%	100.0%
	% within Are you registered with the IEU (Inclusion Education Unit) at MCAST?	16.9%	8.3%	15.8%
6	Count	2	0	2
	% within Where do you live?	100.0%	0.0%	100.0%
	% within Are you registered with the IEU (Inclusion Education Unit) at MCAST?	2.2%	0.0%	2.0%
Total		89	12	101
		88.1%	11.9%	100.0%
		100.0%	100.0%	100.0%

Table 4.5: Cross Tabulation on Where do you live? \* Are you registered with the IEU (Inclusion Education Unit) at MCAST?

In the table below, the Pearson Chi-Squared have a p-value of 0.372% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and

therefore there was no significant difference between location and whether learners are registered with the IEU at MCAST.

Chi-Square Tests		df	Asymptotic Significance (2-sided)
	Value		
Pearson Chi-Square	5.378 <sup>a</sup>	5	.372
Likelihood Ratio	5.400	5	.369
N of Valid Cases	101		

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is .24.

Table 4.6: Chi-Square on Where do you live? \* Are you registered with the IEU (Inclusion Education Unit) at MCAST?

As shown in the table below the cross tabulation show a statistical analysis between current qualification level at MCAST and whether learners feel shy and/or embarrassed asking questions during a lecture. The fourth group, which represents the level 4 qualification, had the highest percentage of 57.6% when it comes to learners that feel shy and/or embarrassed asking questions during a lecture. The sixth group, representing the level 6 qualification, were the learners most likely to not feel shy and/or embarrassed when asking questions during a lecture, with a percentage of 55.6%.

**Current qualification level at MCAST \* Do you feel shy and/or embarrassed asking questions during a lecture? Crosstabulation**

		Do you feel shy and/or embarrassed asking questions during a lecture?			Total
Current qualification level at MCAST	2	Count	2	2	4
		% within Current qualification level at MCAST	50.0%	50.0%	100.0%
		% within Do you feel shy and/or embarrassed asking questions during a lecture?	4.1%	3.8%	4.0%
	3	Count	23	23	46
Current qualification level at MCAST		% within Current qualification level at MCAST	50.0%	50.0%	100.0%
		% within Do you feel shy and/or embarrassed asking questions during a lecture?	46.9%	44.2%	45.5%
	4	Count	14	19	33
		% within Current qualification level at MCAST	42.4%	57.6%	100.0%
Current qualification level at MCAST		% within Do you feel shy and/or embarrassed asking questions during a lecture?	28.6%	36.5%	32.7%
	6	Count	10	8	18
		% within Current qualification level at MCAST	55.6%	44.4%	100.0%
		% within Do you feel shy and/or embarrassed asking questions during a lecture?	20.4%	15.4%	17.8%
Total		Count	49	52	101
		% within Current qualification level at MCAST	48.5%	51.5%	100.0%
		% within Do you feel shy and/or embarrassed asking questions during a lecture?	100.0%	100.0%	100.0%

Table 4.7: Cross Tabulation on Current qualification level at MCAST \* Do you feel shy and/or embarrassed asking questions during a lecture?

In the table below, the Pearson Chi-Squared have a p-value of 0.827% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between current qualification level at MCAST and whether learners feel shy and/or embarrassed asking questions during a lecture.

### Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.891 <sup>a</sup>	3	.827
Likelihood Ratio	.894	3	.827
N of Valid Cases	101		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 1.94.

Table 4.8: Chi-Square on Current Qualification Level at MCAST \* Do you feel shy and/or embarrassed asking questions during a lecture?

As shown in the table below the researcher presented the result of the cross tabulation, which shows a statistical analysis between gender and whether learners find Moodle helpful. The results show that learners that found Moodle most helpful were male, with the highest 93.5% agreeing. In contrast, female learners had those higher percentage of those who did not find Moodle helpful, with a percentage of 8.3% disagreeing.

### Gender \* Do you find Moodle helpful? Crosstabulation

		Do you find Moodle helpful?		
		No	Yes	Total
Gender	1	Count	5	72
		% within Gender	6.5%	93.5%
		% within Do you find Moodle helpful?	71.4%	76.6%
	2	Count	2	22
		% within Gender	8.3%	91.7%
		% within Do you find Moodle helpful?	28.6%	23.4%
Total		Count	7	94
		% within Gender	6.9%	93.1%
		% within Do you find Moodle helpful?	100.0%	100.0%

Table 4.9: Cross Tabulation on Gender \* Do you find Moodle helpful?

In the table below, the Pearson Chi-Squared have a p-value of 0.757% and

alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no that the null hypothesis could be accepted, that there was no significant difference between gender and whether learners find Moodle helpful.

Chi-Square Tests				
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	.096 <sup>a</sup>	1	.757	
Continuity Correction <sup>b</sup>	.000	1	1.000	
Likelihood Ratio	.092	1	.761	
Fisher's Exact Test				.669 .529
N of Valid Cases	101			

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 1.66.

b. Computed only for a 2x2 table

Table 4.10: Chi-Square on Gender \* Do you find Moodle helpful?

As shown in the table below the cross tabulation show a statistical analysis between age and whether learners think Moodle is user-friendly. The second age group, which consist of learners between 19 and 21, had the highest percentage of 80.0% when it comes to learners that think Moodle is user-friendly. On the flip side, when it came to learners that do not think Moodle is user-friendly, the third age group, with learners aged 22 or over, carried the highest percentage of 45.5%.

#### **Age \* Do you think Moodle is user-friendly? Crosstabulation**

Age			Do you think Moodle is user-friendly?		Total
			No	Yes	
1	Count		14	51	65
	% within Age		21.5%	78.5%	100.0%
	% within Do you think Moodle is user-friendly?		58.3%	66.2%	64.4%
2	Count		5	20	25
	% within Age		20.0%	80.0%	100.0%
	% within Do you think Moodle is user-friendly?		20.8%	26.0%	24.8%
3	Count		5	6	11
	% within Age		45.5%	54.5%	100.0%
	% within Do you think Moodle is user-friendly?		20.8%	7.8%	10.9%
Total	Count		24	77	101
	% within Age		23.8%	76.2%	100.0%
	% within Do you think Moodle is user-friendly?		100.0%	100.0%	100.0%

Table 4.11: Cross Tabulation on Age \* Do you think Moodle is user-friendly?

In the table below, the Pearson Chi-Squared have a p-value of 0.199% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between age and whether learners think Moodle is user-friendly.

#### **Chi-Square Tests**

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.230 <sup>a</sup>	2	.199
Likelihood Ratio	2.853	2	.240
N of Valid Cases	101		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 2.61.

Table 4.12: Chi-Square on Age \* Do you think Moodle is user-friendly?

As shown in the table below the researcher presented the result of the cross tabulation, which show a statistical analysis between location and whether Moodle

support learners learning styles. The result show that most learners that Moodle support their learning styles are from the south eastern district which is the third location group having the highest percentage of 86.4%. While learners from the Gozo and Comino district which is the sixth location group are most learners that Moodle does not support their learning styles carrying the highest percentage of 50%.

**Where do you live? \* Does Moodle support your learning styles? Crosstabulation**

		Does Moodle support your learning styles?		
		No	Yes	Total
Where do you live?	1	Count	8	22
		% within Where do you live?	26.7%	73.3%
		% within Does Moodle support your learning styles?	32.0%	28.9%
	2	Count	4	18
		% within Where do you live?	18.2%	81.8%
		% within Does Moodle support your learning styles?	16.0%	23.7%
	3	Count	3	19
		% within Where do you live?	13.6%	86.4%
		% within Does Moodle support your learning styles?	12.0%	25.0%
Where do you live?	4	Count	4	5
		% within Where do you live?	44.4%	55.6%
		% within Does Moodle support your learning styles?	16.0%	6.6%
	5	Count	5	11
		% within Where do you live?	31.3%	68.8%
		% within Does Moodle support your learning styles?	20.0%	14.5%
	6	Count	1	1
		% within Where do you live?	50.0%	50.0%
		% within Does Moodle support your learning styles?	4.0%	1.3%
Total		Count	25	76
		% within Where do you live?	24.8%	75.2%
		% within Does Moodle support your learning styles?	100.0%	100.0%

Table 4.13: Cross Tabulation on Where do you live? \* Does Moodle support your learning styles?

In the table below, the Pearson Chi-Squared have a p-value of 0.422% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between location and whether Moodle support learners learning styles.

### Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.949 <sup>a</sup>	5	.422
Likelihood Ratio	4.844	5	.435
N of Valid Cases	101		

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is .50.

Table 4.14: Chi-Square on Where Do You Live? \* Does Moodle support your learning styles?

As shown in the table below, the cross tabulation shows a statistical analysis between current qualification at MCAST and whether Moodle support learners' learning difficulties, if any. The third group, representing the level 3 qualification, have the highest percentage of 63% when it comes to learners that Moodle supported their learning difficulties. A percentage of 6.5% learners in this group did not provide an answer. When it came to learners that Moodle did not support their learning difficulties, the second group, representing the level 2 qualification, carried the highest percentage of 75%. This question was targeted for learners with learning difficulties, and when it came to learners that did not provide an answer the fourth group, representing the level 4 qualification, carried the highest percentage of 24.2%. Learners with learning difficulties may have not provided an answer for this question, hence, this could result in an inaccurate or biased answer.

**Current qualification level at MCAST \* Does Moodle support your learning difficulties, if any?  
Crosstabulation**

		Does Moodle support your learning difficulties, if any?				
		0	No	Yes	Total	
Current qualification level at MCAST	2	Count	0	3	4	
		% within Current qualification level at MCAST	0.0%	75.0%	25.0% 100.0%	
		% within Does Moodle support your learning difficulties, if any?	0.0%	9.1%	1.8% 4.0%	
	3	Count	3	14	29 46	
		% within Current qualification level at MCAST	6.5%	30.4%	63.0% 100.0%	
		% within Does Moodle support your learning difficulties, if any?	23.1%	42.4%	52.7% 45.5%	
	4	Count	8	8	17 33	
		% within Current qualification level at MCAST	24.2%	24.2%	51.5% 100.0%	
		% within Does Moodle support your learning difficulties, if any?	61.5%	24.2%	30.9% 32.7%	
	6	Count	2	8	8 18	
		% within Current qualification level at MCAST	11.1%	44.4%	44.4% 100.0%	
		% within Does Moodle support your learning difficulties, if any?	15.4%	24.2%	14.5% 17.8%	
Total		Count	13	33	55 101	
		% within Current qualification level at MCAST	12.9%	32.7%	54.5% 100.0%	
		% within Does Moodle support your learning difficulties, if any?	100.0%	100.0%	100.0% 100.0%	

Table 4.15: Cross Tabulation on Current Qualification Level at MCAST \* Does Moodle support your learning difficulties, if any?

In the table below, the Pearson Chi-Squared have a p-value of 0.098% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, therefore there was no significant difference between current qualification at MCAST and whether Moodle support learners learning difficulties, if any.

### Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.703 <sup>a</sup>	6	.098
Likelihood Ratio	10.407	6	.109
N of Valid Cases	101		

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is .51.

Table 4.16: Chi-Square on Current Qualification Level at MCAST \* Does Moodle support your learning difficulties, if any?

As shown in the table below, the researcher presented the results of the cross tabulation, which shows a statistical analysis between gender and whether learners know what an adaptive learning system is. The results show that the male learners were more likely to know what an adaptive learning system is, with a percentage of 44.2%. This is while female learners had a higher percentage of learners that did not know what an adaptive learning system is, at 70.8%.

**Gender \* Do you know what is an Adaptive learning system?  
Crosstabulation**

		Do you know what is an Adaptive learning system?		
		No	Yes	Total
Gender	1	Count	43	34
		% within Gender	55.8%	44.2%
		% within Do you know what is an Adaptive learning system?	71.7%	82.9%
	2	Count	17	7
		% within Gender	70.8%	29.2%
		% within Do you know what is an Adaptive learning system?	28.3%	17.1%
Total		Count	60	41
		% within Gender	59.4%	40.6%
		% within Do you know what is an Adaptive learning system?	100.0%	100.0%

Table 4.17: Cross Tabulation on Gender \* Do you know what is an Adaptive learning system?

In the table below, the Pearson Chi-Squared have a p-value of 0.192% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between gender and whether learners know what an adaptive learning system is.

Chi-Square Tests				
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2- sided)
Pearson Chi-Square	1.705 <sup>a</sup>	1	.192	
Continuity Correction <sup>b</sup>	1.140	1	.286	
Likelihood Ratio	1.755	1	.185	
Fisher's Exact Test				.238 .143
N of Valid Cases	101			

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.74.

b. Computed only for a 2x2 table

Table 4.18: Chi-Square on Gender \* Do you know what is an Adaptive learning system?

### 4.2.3 ANOVA Tests

The researcher also presented another test, the One-Way ANOVA, between age and a question. The ANOVA test was used for multiple questions.

The first question: “*Why did you choose VET MCAST over academic education?*” having multiple choice options of: “*Small number of students in class*”, “*Practical nature*”, “*Apprenticeship/Internship*”, “*Student Support*”, and “*Had no qualifications to go to academic education*”. In the table below, the Pearson Chi-Squared for the first three options had a p-value greater than 0.05%. This meant that the null hypothesis could be accepted, and therefore there is no significant difference between age and the options having these percentages. However, the last option, “*Had no qualifications to go to academic education*”, had a p-value of 0.007%. This meant that we could reject the null hypothesis and therefore there is significant difference between age and this option.

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Why did you choose VET (MCAST) over academic education? (Small number of students in class)	Between Groups	.085	2	.042	.296	.744
	Within Groups	14.054	98	.143		
	Total	14.139	100			
Why did you choose VET (MCAST) over academic education? (Practical nature)	Between Groups	.331	2	.165	.674	.512
	Within Groups	24.026	98	.245		
	Total	24.356	100			
Why did you choose VET (MCAST) over academic education? (Apprenticeship/Internship)	Between Groups	.110	2	.055	.247	.781
	Within Groups	21.752	98	.222		
	Total	21.861	100			
Why did you choose VET (MCAST) over academic education? (Student Support)	Between Groups	.532	2	.266	2.131	.124
	Within Groups	12.240	98	.125		
	Total	12.772	100			
Why did you choose VET (MCAST) over academic education? (Had no qualifications to go to academic education)	Between Groups	1.558	2	.779	5.273	.007
	Within Groups	14.481	98	.148		
	Total	16.040	100			

Table 4.19: One-Way ANOVA on Age \* Why did you choose VET MCAST over academic education?

The table below shows the One-Way ANOVA between location and the second question “*What kind/s of access arrangements do you have?*” having multiple

choice options of: “*Extra time*”, “*Reader*”, “*Prompter*”, “*Quite room*”, and “*No*” (Learners which are not registered with the IEU). The Pearson Chi-Squared for all options have a p-value greater than 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between location and these options.

ANOVA					
		Sum of Squares	df	Mean Square	F
What kind/s of access arrangement/s do you have? (Extra time)	Between Groups	.796	5	.159	2.643
	Within Groups	5.719	95	.060	
	Total	6.515	100		
What kind/s of access arrangement/s do you have? (Reader)	Between Groups	.131	5	.026	.673
	Within Groups	3.710	95	.039	
	Total	3.842	100		
What kind/s of access arrangement/s do you have? (Prompter)	Between Groups	.000	5	.000	.
	Within Groups	.000	95	.000	
	Total	.000	100		
What kind/s of access arrangement/s do you have? (Quite room)	Between Groups	.270	5	.054	1.142
	Within Groups	4.483	95	.047	
	Total	4.752	100		
What kind/s of access arrangement/s do you have? (No)	Between Groups	.563	5	.113	1.069
	Within Groups	10.011	95	.105	
	Total	10.574	100		

Table 4.20: One-Way ANOVA on Location \* What kind/s of access arrangements do you have?

#### 4.2.4 T-Tests

The researcher presented a similar test to the One-Way ANOVA, the T-Test, between gender and the question “*How do you rate the level of support from administrative and academic staff?*”. The main difference between the One-Way ANOVA and the T-Test, is that One-Way ANOVA makes use of three or more variables, for example age groups 16-18, 19-21, and 22+, in contrast to the T-Test making use of only two variables, for example gender, Male and Female. For this test, the researcher had to consider the value of Leven’s Test for Equality of Variances, where when its value is greater than 0.05, the researcher had to consider the first row, while when its value is less than 0.05, the second row had to be considered. Since the value is 1.088, the researcher had to follow the row with Equal Variances

assumed. In the table below, the Pearson Chi-Squared have a p-value of 0.716% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between gender and their rating level of support from administrative and academic staff.

Independent Samples Test								
How do you rate the level of support from administrative and academic staff?	Levene's Test for Equality of Variances				t-test for Equality of Means			
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
	1.088	.299	-.364	99	.716	-.105	.288	-.677 .467
Equal variances assumed								
Equal variances not assumed			-.325	38.834	.747	-.105	.323	-.762 .552

Table 4.21: T-Test on Gender \* How do you rate the level of support from administrative and academic staff?

The table below shows the T-Test between gender and the question “*What is your preferred learning style?*”. Since the value of Leven’s Test for Equality of Variances was 0.068, the researcher had to follow the row with Equal Variances assumed, having the Pearson Chi-Squared with a p-value of 0.756% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between gender and their preferred learning style.

Independent Samples Test								
What is your preferred learning style?	Levene's Test for Equality of Variances				t-test for Equality of Means			
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
	.068	.795	.312	99	.756	.064	.206	-.345 .474
Equal variances assumed								
Equal variances not assumed			.312	38.424	.757	.064	.207	-.354 .482

Table 4.22: T-Test on Gender \* What is your preferred learning style?

The table below shows the T-Test between gender and the question “*How do you assess the impact of the COVID-19 pandemic on your studies?*”. The value of Leven’s Test for Equality of Variances was 2.855, therefore the researcher had to follow the row with Equal Variances assumed. The Pearson Chi-Squared has a p-value of 0.194% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between gender

and the impact of the COVID-19 pandemic on their studies.

Independent Samples Test								
	Levene's Test for Equality of Variances				t-test for Equality of Means			
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
	2.855	.094	1.308	99	.194	.385	.295	-.199 970
How do you assess the impact of the COVID-19 pandemic on your studies?	Equal variances assumed Equal variances not assumed		1.156 32.440	32.440 256	.256 .385	.333 -.293	.1064	

Table 4.23: T-Test on Gender \* How do you assess the impact of the COVID-19 pandemic on your studies?

The table below shows the T-Test between gender and the question “*How often do you ask questions during a lecture?*”. Since the value of Levene’s Test for Equality of Variances was 0.658, the researcher had to follow the row with Equal Variances assumed, having the Pearson Chi-Squared with a p-value of 0.952% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between gender and the amount of questions they ask during a lecture.

Independent Samples Test								
	Levene's Test for Equality of Variances				t-test for Equality of Means			
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
	0.658	.419	-.060	99	.952	-.018	.295	-.604 .568
How often do you ask questions during a lecture?	Equal variances assumed Equal variances not assumed		-.058 36.432	36.432 954	.954 .018	.306 -.638	.603	

Table 4.24: T-Test on Gender \* How often do you ask questions during a lecture?

The table below shows the T-Test between gender and the question “*How often do you access Moodle?*”. The value of Levene’s Test for Equality of Variances was 0.001, therefore the researcher had to follow the row with Equal Variances not assumed. The Pearson Chi-Squared had a p-value of 0.122% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between gender and the amount of access in Moodle.

Independent Samples Test								
How often do you access Moodle?	Levene's Test for Equality of Variances				t-test for Equality of Means			
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
	.001	.978	-1.571	99	.119	.418	.266	.945 .110
Equal variances assumed								
Equal variances not assumed			-1.579	38.736	.122	.418	.265	.953 .118

Table 4.25: T-Test on Gender \* How often do you access Moodle?

The table below shows the T-Test between gender and the question “*How much do you think that this system can provide personalization to have a better user experience?*”. Since the value of Levene’s Test for Equality of Variances was 5.977, the researcher had to follow the row with Equal Variances assumed, having the Pearson Chi-Squared with a p-value of 0.594% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between gender and the level of personalisation that an adaptive learning system can provide.

Independent Samples Test								
How much do you think that this system can provide personalization to have a better user experience?	Levene's Test for Equality of Variances				t-test for Equality of Means			
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
	5.977	.016	.535	99	.594	.130	.243	.352 .611
Equal variances assumed								
Equal variances not assumed			.440	29.978	.663	.130	.295	.473 .733

Table 4.26: T-Test on Gender \* How much do you think that this system can provide personalization to have a better user experience?

The table below shows the T-Test between gender and the question “*How much do you think that this system can provide content variability to facilitate active learning?*”. The value of Levene’s Test for Equality of Variances was 1.644, therefore the researcher had to follow the row with Equal Variances assumed. The Pearson Chi-Squared has a p-value of 0.575% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between gender and the level of content variability that an adaptive learning system can provide.

Independent Samples Test								
	Levene's Test for Equality of Variances				t-test for Equality of Means			
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
	1.644	.203	.562	99	.575	.130	.231	.329 .588
How much do you think that this system can provide content variability to facilitate active learning?	Equal variances assumed			.494	32.255	.624	.130	.263 -.405 .665
	Equal variances not assumed							

Table 4.27: T-Test on Gender \* How much do you think that this system can provide content variability to facilitate active learning?

The table below shows the T-Test between gender and the question “*How much do you think that this system can provide relevant training in the context of your future professional activities?*”. Since the value of Levene’s Test for Equality of Variances was 0.409, the researcher had to follow the row with Equal Variances assumed, having the Pearson Chi-Squared with a p-value of 0.355% and alpha level of 0.05%. This meant that the null hypothesis could be accepted, and therefore there was no significant difference between gender and the level of relevant training that an adaptive learning system can provide.

Independent Samples Test								
	Levene's Test for Equality of Variances				t-test for Equality of Means			
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
	.409	.524	-.928	99	.355	-.221	.238	-.694 .252
How much do you think that this system can provide relevant training in the context of your future professional activities?	Equal variances assumed			.857	34.239	.398	.221	.258 -.746 .304
	Equal variances not assumed							

Table 4.28: T-Test on Gender \* How much do you think that this system can provide relevant training in the context of your future professional activities?

## 4.3 Analysis and Discussion of the Experiment

By the analysis of the online survey, the experiment was revised in a way that will make the most of facilitating active learning. After the revision, a direct observation was conducted to test and gather feedback, to make sure that the features of the prototype achieved the objectives of the learners. A video was presented to the learners and a lecturer so that they could experience and test the system to contribute to this study, followed by an opportunity for these participants to

ask questions. After it was made sure that they understood the concept and functionality of the system, the researcher gave the direct observation survey which assessed whether the system achieved the expected outcomes. As shown in the bar charts below (Figures 4.6 and 4.7), the questions were not only based on observing feedback of the web-based adaptive learning system, but also comparing it with Moodle, which represented the traditional e-learning system. The average ratings for the filtered content according to the learning style and the collection of profile information share the highest results of 5.6 out of 6. The relevant training, content variability and overall experience of using the adaptive learning system all share an average rating of 5.2. This was followed by an average result of 5 for the navigation and a 4.8 for the layout of the content. The lowest average rating of 3.8 was for the overall experience of using Moodle. These results show that the objectives for the prototype features were met for the participants, and the observation feedback showed 100% agreement that the participants felt more comfortable accessing this adaptive learning system than Moodle. Additional functionalities for this system were recommended in the final open question, including recommendations such as “*The option to add more than one learning style*”, and “*Use of TCA access arrangements, more detailed description of the unit content, use of push notifications, visibility to know the lecturers teaching you*”.

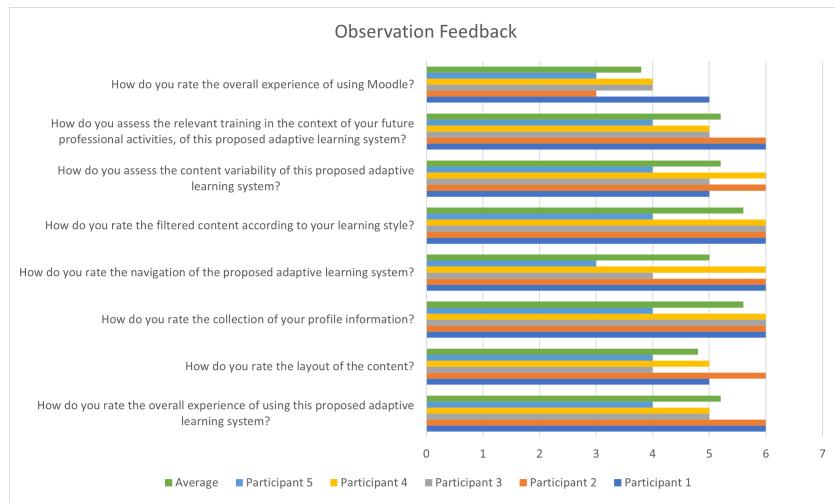


Figure 4.6: Observation Feedback Part 1

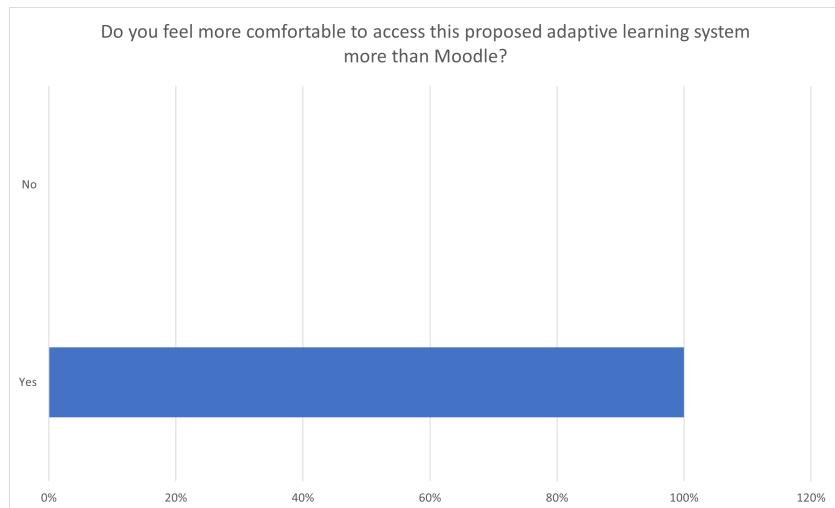


Figure 4.7: Observation Feedback Part 2

The Moodle logs access statistics, split into monthly periods from September 2018 to January 2021, were generated into the bar chart below (Figure 4.8) to analyse access statistics. It is common that learners tend to access Moodle more often in the periods when they have assignments and TCA's. The lack of access and confidence during the year of 2019 can be seen in using a traditional VLE. The null hypothesis in the T-Tests for personalisation, content variability, and relevant

training in relation to an adaptive learning system were all accepted, therefore this shows that these systems can increase access and confidence in using such systems. Given the current circumstances of COVID-19, a peak in Moodle access has increased from the period of March 2020 onward when VET education started to operate remotely.

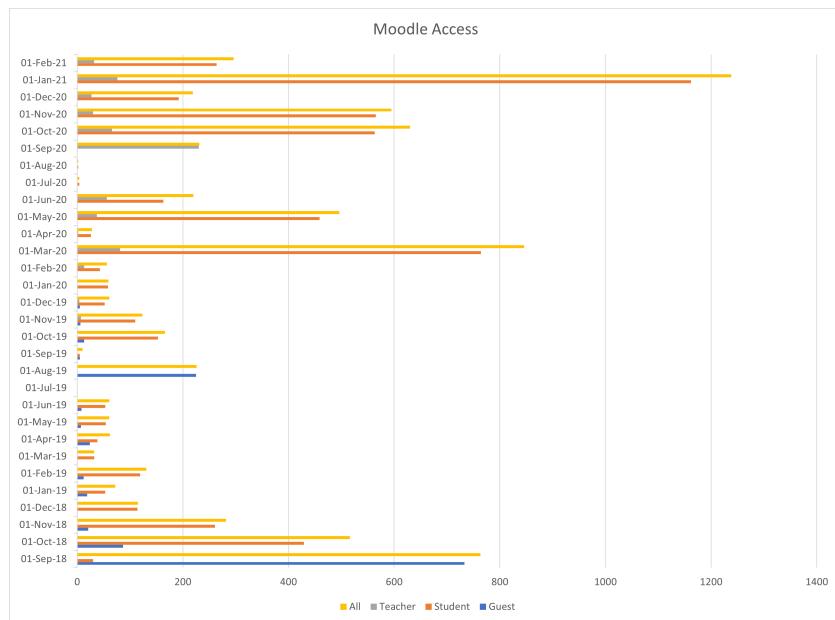


Figure 4.8: Moodle Access Statistics

## 4.4 Analysis and Discussion in Relation to the Literature

A comparison with the literature review had to be conducted, after the analysis of results for both the online survey and the experiment. What Salonen and Karjalaloto (2019) and Ennouamani and Mahani (2017) said are similar, that providing content according to the learners preferences affects learning in a good way. Figure 4.6 shows the highest average rating of 5.6 out of 6 when it came to the filtered content according to the learning style, which proves these authors' statement to

be true. Content variability was also discussed by these authors, where it was said that the target for learning adaptive systems is the various representation of the learning content in which it is used to predict motivational effects to facilitate learning. This was proven to be true, having an average rating of 5.2 when it came to the content variability of the adaptive learning system. Relevance was also similarly discussed by these authors, where they was said that content and learners currently fundamental activities similarity must be as high as possible for learning to achieve the goal to cater to the crucial characteristics of the learner. This was also proven to be true, having the same average rating of 5.2 when it came to the relevant training in the context of their future professional activities of the adaptive learning system.

With reference to Figure 4.6, an overall experience of using an adaptive learning system had an average rating of 5.2, together with reference to Figure 4.7, show that it is in 100% agreement that learners felt more comfortable accessing this adaptive learning system more than Moodle. Figure 4.8 also supports this claim, showing that there was a lack of access and confidence during the year of 2019 using Moodle. This shows that adaptive techniques which was stated by Elmabaredy, Elkholy and Tolba (2020) truly enhances learners' outcomes.

Pavlakou and Kalachanis (2018) included several studies which mention in particular the features that Moodle provides for post-secondary education, in which it was proved that Moodle also allows the creation of personalized learning environments. Figure 4.6 shows the lowest average rating of 3.8 out of 6 when it came to the overall experience of Moodle, were these authors showed that there is room for improvement for these traditional e-learning platforms, since this research showed that learners feel more comfortable to access an adaptive learning system. Speaking of this, Moodle lacks functionality to adapt TCA access arrangements when compared to the currently implemented solution. This can be shown on Figure 4.7 where 100% of the participants feel more comfortable to access this adaptive learning system more than Moodle.

## **4.5 Analysis and Discussion in Relation to the Hypothesis and Research Questions**

For the hypothesis to be tested, the researcher needed to conduct discussion and analysis of results. This was done by using a working solution, with the research questions also being answered. As stated earlier in this study, the hypothesis of this research was “*A web-based adaptive learning system enhances VET education in a post-secondary environment*”. This hypothesis has a web-based adaptive learning system as the direct variable, and VET education and post-secondary environment both as the indirect variables. The implemented solution covered the direct variable, while the online survey and direct observation were implemented to cover the indirect variables. This emphasized whether a web-based adaptive learning system can truly increase the success rate of VET learners in achieving their qualification when compared to traditional LMS. It was noted that Figure 4.6 showing the average ratings of filtered content, content variability and relevant training were quite high when compared to the overall experience of using Moodle, and participants felt more comfortable accessing this adaptive learning system than Moodle, as shown by Figure 4.7. Therefore, these prove this hypothesis to be true, meaning this system will give an advantage for VET education in a post-secondary environment once they see an increase of the success rate of VET learners achieving their qualifications.

Three research questions had to be tackled, where the first research question was, “*How can a web-based adaptive learning-system enhance VET education in a post-secondary environment when compared to a traditional e-learning system?*”, the second research question, “*How can a web-based adaptive learning system adopt different learning styles to accommodate different learners’ characteristics?*”, with the third research question being, “*How can a web-based adaptive learning system support learner with learning difficulties?*”. To tackle RQ1, a web-based adaptive learning system was developed. RQ2 and RQ3 were also tackled through the pro-

totype in conjunction with the conducted online survey. Figure 4.6 showed the average ratings of filtered content, content variability and relevant training to be quite high, so this demonstrates that these factors are a good solution to enhance VET education in a post-secondary environment. Table 4.13 showed that 75.2% of the participants stated that Moodle supported their learning styles, therefore this study focused on current content learning styles to adapt to these learners, making the difference when such content was filtered by their chosen learning style. While Table 4.5 showed that only 11.9% of the participants are registered with the IEU at MCAST, this study gave the option for learners to choose their learning difficulties, allowing their lecturer to have better visibility of their learners, including the ones with such difficulties.

## 4.6 Conclusion

In this chapter, the researcher discussed the analysis of results of this research, which included: the data analysis method, analysis and discussion of the online survey, demographics, analysis and discussion of the experiment, analysis and discussion of the observation, analysis and discussion in relation to the literature, and analysis and discussion in relation to the hypothesis and research questions. In the next and final chapter, a conclusion and recommendations will be outlined. This chapter will include: the limitations, and future work.

# **Chapter 5**

## **Conclusions and Recommendations**

This chapter will give conclusions and recommendations, which will include: the limitations, future work, and conclusion.

### **5.1 Limitations**

During this research, there were still some limitations that could be tackled. This said, there was still a successful online survey and the provision of a working version of the experiment, resulting in accurate results from the direct observation. Due to lack of time, one of the limitations that might have prevented better results was that RQ3, supporting learner with learning difficulties, was not fully implemented. However, this study still gave the ability for learners to choose their learning difficulties, allowing their lecturer to have visibility to their learners including the ones with such difficulties. In addition, the user experience may have been improved if the UI (User interface) was enhanced, since the researcher focused on the main functionalities. The final limitation, which did not affect only this research but the whole world, was COVID-19. This pandemic forced educational institutes to shut down, therefore the researcher was not allowed to go to the institute or

have meetings with his mentor in person. Despite these limitations, meetings with the mentor were conducted remotely, where the mentor provided consistent and dedicated support.

## 5.2 Future Work

One of the limitations mentioned above was that this study did not fully support learners with learning difficulties. Calculation of amount for extra time can be part of a solution for these learners. Therefore, this will increase the overall experience for such learners of using an adaptive learning system. The user experience can also be improved if the UI were enhanced, and this would be possible by having a more interactive design, together with standard navigation structure. Another additional functionality for this system could be an integration with a MIS (Management Information System) such as Classter, and with a LMS such as Moodle. This will result in an advantage that a user can sign up to a single system and then will have a flexibility by choosing the right system depending on their needs. A more detailed profile could be formed, for example adding a profile picture, including learner history which could include joined date, activities completed and achievements. This will give the ability for learners to navigate through their profile and have as much information as possible. The final recommendation is that this system could have assignment scheduling and uploading. This can help learners organize time more efficiently, prioritize tasks, shared deadlines between all learners, and reduce hard copies.

## 5.3 Conclusion

In this chapter, the researcher gave conclusions and recommendations, which included: the limitations, and future work. This research has helped the researcher improving both personal and educational skills, such as: proper researching, prob-

lem solving, ways of communicating in an understandable and convincing way, and keeping calm under pressure. Challenges were also faced while conducting this research, although the researcher did his best to overcome these challenges to deliver this research in its best possible form. Throughout this research, the researcher gained knowledge about web-based adaptive learning system, VET education, Overleaf, and IBM SPSS. The researcher now knows that an adaptive e-learning system is another way to teach and learn using internet technology, by gathering learning styles, and possible learning difficulties. VET aims to guide the learners during technical education, in which learners can have hands-on experience based on practicals, vocations, or jobs according to their course speciality for their careers. Overleaf is a collaborative cloud-based LaTeX editor which was used for writing this research using an official journal LaTeX template. IBM SPSS is a software that was used for statistics and helped in using several statistical tools to analyse the data gathered. The manner in which the prototype's .csv file download functionality had to be researched as this was never done before using the CakePHP framework. Research about the integration with a MIS and LMS can be done, since this was never done before using any of the programming languages.

# Appendix A

## Ethics Consent Form

Title of Research: Web-based adaptive learning system to enhance VET in post-secondary education

Name of Researcher: Aaron Cutajar

Please initial box

1. I confirm that I have read and understand the Information Letter for the above study and have had the opportunity to ask questions.
2. I understand that my/my charge's participation is voluntary and that I/my charge am/are free to withdraw at any time without giving any reason.
3. I agree to allow my daughter/son/charge to take part in the above study.

*(Statement 3 is to be included only when guardians/parents are involved in giving consent)*

---

Name of Participant/  
Guardian

---

Date

---

Signature

Figure A.1: Ethics Consent Form

## Appendix B

### Online Survey Questions

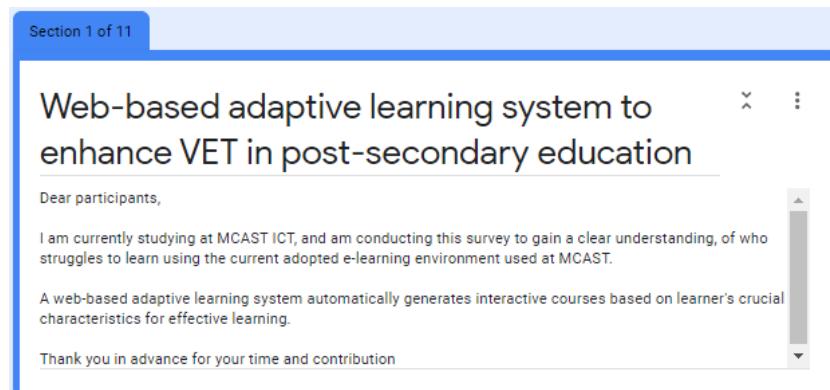


Figure B.1: Online Survey Introduction and Welcome Message

**Demographic Information**

This section includes information about gender, age, location, and qualification.

**Gender \***

- Male
- Female

**Age \***

- 16 -18
- 19 - 21
- 22 +

**Where do you live? \***

- Southern Harbour District (Birgu (Vittoriosa), Bormla (Cospicua), Fgura, Floriana (Furjana), Senglea (Isla), K...)
- Northern Harbour District (Birkirkara, Il-Gżira, Il-Hamrun, L-Imsida, Pembroke, Tal-Pietà, Hal Qormi, San Ĝilj...)
- South Eastern District (Birżeppuġa, Hal Ghaxaq, Il-Gudja, Hal Kirkop, Marsaskala (Wied il-Ğajnej), Marsaxlo...)
- Western District (H'Attard, Hal Balzan, Hal-Dingli, L-Ikklin, Hal Lija, L-Imdina, L-Imtarfa, Ir-Rabat, Is-Sigġiewi, ...)
- Northern District (Hal Għarġur, Il-Mellieħha, L-Imġarr, Il-Mosta, In-Naxxar, San Pawl il-Baħar)
- Gozo and Comino District (Gozo, Comino)

**Current qualification level at MCAST \***

- Level 1 - Introductory Certificate in ICT
- Level 2 - Foundation Certificate in ICT
- Level 3 - Diploma in ICT/Diploma in iGaming
- Level 4 - Advanced Diploma in IT
- Level 6 - Bachelor of Science (Honours)

Figure B.2: Online Survey Demographic Information

Section 2 of 11

## VET (Vocational and Education Training)

This section includes knowledge about VET.

Do you know what is VET? \*

Yes

No

After section 2 Continue to next section

Section 3 of 11

## VET

VET (Vocational and Education Training) aim to guide the learners during technical education, in which learners can have hands-on experience based on practical's, vocations, or jobs according to their course speciality for their careers.

Figure B.3: Online Survey VET Knowledge Part 1

Section 4 of 11

## VET

Description (optional)

Did you choose VET subjects in secondary education? \*

Yes  
 No

Why did you choose VET (MCAST) over academic education? \*

Small number of students in class  
 Practical nature  
 Apprenticeship/internship  
 Student Support  
 Had no qualifications to go to academic education

How do you rate the level of support from administrative and academic staff? \*

1      2      3      4      5      6

Poor                                    Excellent

Figure B.4: Online Survey VET Knowledge Part 2

Section 5 of 11

## Learning Methodologies

This section includes knowledge about Learning Methodologies.

What is your preferred learning style? \*

Language and/or Visual (Graphical illustration of numbers)

Language Auditory (Oral explanations and numbers, and games and/or puzzles)

Visual-kinesthetic combination (Experiment with self-involvement)

How do you assess the impact of the COVID-19 pandemic on your studies? \*

1      2      3      4      5      6

Least impact                                    Most impact

Are you registered with the IEU (Inclusion Education Unit) at MCAST? \*

Yes

No

Figure B.5: Online Survey Learning Methodologies Knowledge Part 1

Section 6 of 11

## Learning Methodologies

Description (optional)

What kind/s of access arrangement/s do you have? \*

Extra time  
 Reader  
 Prompter  
 Quite room

After section 6 Continue to next section

Section 7 of 11

## Learning Methodologies

Description (optional)

How often do you ask questions during a lecture? \*

1      2      3      4      5      6

Never      Frequently

Do you feel shy and/or embarrassed asking questions during a lecture? \*

Yes  
 No

Figure B.6: Online Survey Learning Methodologies Knowledge Part 2

Section 8 of 11

## Current VLE (Moodle)

This section includes knowledge about Current VLE.

How often do you access Moodle? \*

1      2      3      4      5      6  
Never                                     Frequently

Do you find Moodle helpful? \*

Yes  
 No

Do you think Moodle is user-friendly? \*

Yes  
 No

Does Moodle support your learning styles? \*

Yes  
 No

Does Moodle support your learning difficulties, if any?

Yes  
 No

Figure B.7: Online Survey Current VLE (Moodle) Knowledge

Section 9 of 11

## Adaptive learning system

This section includes knowledge about Adaptive learning system.

Do you know what is an Adaptive learning system? \*

Yes

No

After section 9 Continue to next section

Section 10 of 11

## Adaptive learning system

Adaptive learning systems can enhance the learning environment either by integrating learning style models, or combinations of such. This means that these systems adapt the learning unit content and/or level based on learners learning styles, to increase learners learning performance.

Adaptive learning system



Adaptive Learning

Figure B.8: Online Survey Adaptive Learning System Knowledge Part 1

Section 11 of 11

## Adaptive learning system

Description (optional)

How much do you think that this system can provide personalization to have a better user experience? \*

1      2      3      4      5      6

Not much                                     A lot

How much do you think that this system can provide content variability to facilitate active learning? \*

1      2      3      4      5      6

Not much                                     A lot

How much do you think that this system can provide relevant training in the context of your future professional activities? \*

1      2      3      4      5      6

Not much                                     A lot

Figure B.9: Online Survey Adaptive Learning System Knowledge Part 2

# Appendix C

## Code Snippets



```
view.php
templates > courses > view.php
1 <h1>Content</h1>
2
3 <?php
4     if (count($view) == 0) {
5         echo "<h2>There are no available content</h2>";
6     }
7     else {
8         echo "<h2>Available content: " . count($view) . "</h2>";
9     }
10    </?php
11    if($loggedInUser['role_id'] == 1) {
12        echo "<a href="#">Download all Learner Activities</a>" .
13            "<a href='courses/exportAll'>Courses</a>" .
14            "[class => 'btn btn-primary']";
15    }
16    </?php
17    <table class="table table-striped">
18        <thead>
19            <tr>
20                <th>Week</th>
21                <th>Title</th>
22                <th>Description</th>
23                <th>Learning Material</th>
24            </tr>
25        </thead>
26        <tbody>
27            if($loggedInUser['role_id'] == 1) {
28                <th>Learning Style</th>
29                <?php
30                    if($loggedInUser['role_id'] == 2) {
31                        <th>Complete/Incomplete</th>
32                    }
33                </?php
34            }
35            </tbody>
36        </table>
37    </?php
38
```

Figure C.1: Front-end Main Functionality Part 1



```
(tbody)
1 <?php
2     foreach ($view as $v) {
3         echo "<tr>";
4             echo "<td>" . $v->week . "</td>";
5             echo "<td>" . $v->title . "</td>";
6             echo "<td>" . $v->description . "</td>";
7             echo "<a href='" . $this->HTML->link($v->title, $v->learning_material, array('download' => $v->title, 'target' => '_blank')) . "'></td>";
8         if($loggedInUser['role_id'] == 1) {
9             echo "<td>" . $v->learning_style[1] . "</td>";
10        }
11        if($loggedInUser['role_id'] == 2) {
12            foreach ($allCompletions as $completion) {
13                $completions[] = Komplettion($course_id);
14            }
15            if (isset($completions) && in_array($v['id'], $completions)) {
16                echo "<a href='" . $this->HTML->link(
17                    'Complete',
18                    '/courses/complete/' . $v->id,
19                    [class => 'btn btn-success']
20                ) . "'></td>";
21            }
22            else {
23                echo "<a href='" . $this->HTML->link(
24                    'Complete',
25                    '/courses/complete/' . $v->id,
26                    [class => 'btn btn-danger']
27                ) . "'></td>";
28            }
29        }
30        echo "</tr>";
31    }
32 </tbody>
33 </table>
34 </?php
35 }
36 </?php
37
```

Figure C.2: Front-end Main Functionality Part 2

```

79  </php>
80  if($loggedInUser['role_id'] == 1) {
81      echo "<h3>Language and/or Visual Content</h3>";
82
83      if (count($viewLanguageVisual) == 0) {
84          echo "<h4>There are no available Language and/or Visual content</h4>";
85      }
86      else {
87          echo "<h4>Available Language and/or Visual content: ".count($viewLanguageVisual)."</h4>";
88      }
89  }
90  </table>
91  <thead>
92      <tr>
93          <th>Week</th>
94          <th>Title</th>
95          <th>Description</th>
96          <th>Learning Material</th>
97          <th>Learner Activities</th>
98          <th>Edit Content</th>
99          <th>Delete Content</th>
100     </tr>
101 </thead>

```



Figure C.3: Front-end Main Functionality Part 3

```

102  <tbody>
103  </php>
104  foreach($viewLanguageVisual as $v) {
105      echo "<tr>";
106      echo "<td>$v->week</td>";
107      echo "<td>$v->title.</td>";
108      echo "<td>$v->description.</td>";
109      echo "<td><a href='index.php?view=languagevisual&id=$v->title, $v->learning_material, array('download'=>$v->title, 'target'=> '_blank')'></a>";
110          .Download",
111          .CoursesEdit"/> $v->id,
112          [<button type='button' class='btn btn-primary'>
113          ].</td>";
114      echo "<td><a href='index.php?view=languagevisual&id=$v->title, $v->learning_material, array('download'=>$v->title, 'target'=> '_blank')'></a>";
115          .Edit",
116          .CoursesEdit"/> $v->id,
117          [<button type='button' class='btn btn-success'>
118          ].</td>";
119      echo "<td><a href='index.php?view=languagevisual&id=$v->title, $v->learning_material, array('download'=>$v->title, 'target'=> '_blank')></a>";
120          .Delete",
121          .CoursesDelete"/> $v->id,
122          [<button type='button class='btn btn-danger'>
123          ].</td>";
124      echo "</tr>";
125  }
126  </tbody>
127  </table>
128 </php>
129 }

```



Figure C.4: Front-end Main Functionality Part 4

```

130  echo "<h3>Language Auditory Content</h3>";
131
132  if (count($viewLanguageAuditory) == 0) {
133      echo "<h4>There are no available Language Auditory content</h4>";
134  }
135  else {
136      echo "<h4>Available Language Auditory content: ".count($viewLanguageAuditory)."</h4>";
137  }
138
139  <table class='table table-striped'>
140  <thead>
141      <tr>
142          <th>Week</th>
143          <th>Title</th>
144          <th>Description</th>
145          <th>Learning Material</th>
146          <th>Learner Activities</th>
147          <th>Edit Content</th>
148          <th>Delete Content</th>
149      </tr>
150  </thead>

```



Figure C.5: Front-end Main Functionality Part 5

```

151  <tbody>
152  </php>
153  foreach($viewLanguageAuditory as $v) {
154      echo "<tr>";
155      echo "<td>$v->week</td>";
156      echo "<td>$v->title.</td>";
157      echo "<td>$v->description.</td>";
158      echo "<td><a href='index.php?view=languageauditory&id=$v->title, $v->learning_material, array('download'=>$v->title, 'target'=> '_blank')'></a>";
159          .Download",
160          .CoursesEdit"/> $v->id,
161          [<button type='button class='btn btn-primary'>
162          ].</td>";
163      echo "<td><a href='index.php?view=languageauditory&id=$v->title, $v->learning_material, array('download'=>$v->title, 'target'=> '_blank')'></a>";
164          .Edit",
165          .CoursesEdit"/> $v->id,
166          [<button type='button class='btn btn-success'>
167          ].</td>";
168      echo "<td><a href='index.php?view=languageauditory&id=$v->title, $v->learning_material, array('download'=>$v->title, 'target'=> '_blank')></a>";
169          .Delete",
170          .CoursesDelete"/> $v->id,
171          [<button type='button class='btn btn-danger'>
172          ].</td>";
173      echo "</tr>";
174  }
175  </tbody>
176  </table>
177 </php>
178 }

```



Figure C.6: Front-end Main Functionality Part 6

```

183     echo "<h3>Available Visual-kinesthetic combination content</h3>";
184
185     if (count($view->visualKinestheticCombination) == 0) {
186         echo "<h4>There are no available visual-kinesthetic combination content</h4>";
187     } else {
188         echo "<h4>Available Visual-kinesthetic combination content: ".count($view->visualKinestheticCombination)."</h4>";
189     }
190
191     >>>
192     <table class="table table-striped">
193         <thead>
194             <tr>
195                 <th>Week</th>
196                 <th>Title</th>
197                 <th>Description</th>
198                 <th>Learning Material</th>
199                 <th>Edit Content</th>
200                 <th>Delete Content</th>
201             </tr>
202         </thead>

```



Figure C.7: Front-end Main Functionality Part 7

```

203     <tbody>
204         <php>
205             foreach ($view->visualKinestheticCombination as $v) {
206                 echo "<tr>";
207
208                 echo "<td>$v->week</td>";
209
210                 echo "<td>$v->description</td>";
211                 echo "<td>$v->html->link($v->title, array('download'=>$v->title, 'target'=> '_blank'))</td>";
212
213                 echo "<td><a href='/courses/export/' $v->id,";
214                     '><button type="button" class="btn btn-primary"';
215                     '>Edit';
216                 echo "<td><a href='/courses/delete/' $v->id,";
217                     '><button type="button" class="btn btn-success"';
218                     '>Delete';
219
220                 echo "</td></tr>";
221             }
222         </tbody>
223     </table>
224     <php>
225 }
226

```



Figure C.8: Front-end Main Functionality Part 8

```

Model > Table > CoursesTable.php
src > Model > Table > CoursesTable.php
1 <?php
2 namespace App\Model\Table;
3
4 use Cake\ORM\Table;
5 use Cake\Validation\Validator;
6
7 class CoursesTable extends Table
8 {
9     public function initialize(array $config): void
10    {
11        $this->belongsTo('Users');
12        $this->belongsTo('LearningStyles');
13        $this->hasMany('Completions');
14    }
15 }

```



Figure C.9: Back-end Main Functionality Part 1

```

Controller > CoursesController.php
src > Controller > CoursesController.php
1 <?php
2 namespace App\Controller;
3
4 use Cake\ORM\Locator\LocatorAwareTrait;
5
6 class CoursesController extends AppController
7 {
8     public function view()
9     {
10        $courseTable = $this->getTableLocator()->get('Courses');
11        $completionTable = $this->getTableLocator()->get('Completions');
12
13        if($this->Auth->user('role_id') == 1) {
14            $course = $courseTable->find()
15                ->order(['Courses.week' => 'ASC'])
16                ->contain(['Learningstyles', 'Users', 'Completions'])->toArray();
17
18            $courseLanguageVisual = $courseTable->find()
19                ->where(['Courses.learning_style_id' => 1])
20                ->order(['Courses.week' => 'ASC'])
21                ->contain(['Learningstyles', 'Users', 'Completions'])->toArray();
22
23            $courseLanguageAuditory = $courseTable->find()
24                ->where(['Courses.learning_style_id' => 2])
25                ->order(['Courses.week' => 'ASC'])
26                ->contain(['Learningstyles', 'Users', 'Completions'])->toArray();
27
28            $courseVisualAuditory = $courseTable->find()
29                ->where(['Courses.learning_style_id' => 3])
30                ->order(['Courses.week' => 'ASC'])
31                ->contain(['Learningstyles', 'Users', 'Completions'])->toArray();
32
33            $this->set('view', $course);
34            $this->set('languageVisual', $courseLanguageVisual);
35            $this->set('languageAuditory', $courseLanguageAuditory);
36            $this->set('visualAuditory', $courseVisualAuditory);
37            $this->set('availableVisualKinestheticCombination', $course->availableVisualKinestheticCombination);
38
39        } else {
40
41            $course = $courseTable->find()
42                ->where(['Courses.learning_style_id' => $this->Auth->user('learning_style_id')])
43                ->order(['Courses.week' => 'ASC'])
44                ->contain(['Learningstyles', 'Users', 'Completions'])->toArray();
45
46            $allCompletions = $completionTable->find()
47                ->where(['Completions.user_id' => $this->Auth->user('id')])
48                ->contain(['Users', 'Courses']);
49
50            $this->set("allCompletions", $allCompletions);
51
52        }
53
54        $this->set('view', $course);
55    }
56
57 }

```



Figure C.10: Back-end Main Functionality Part 2



# Appendix D

## Direct Observation Questions

How do you rate the overall experience of using this proposed adaptive learning system? *						
	1	2	3	4	5	6
Poor	<input type="radio"/> Excellent					
How do you rate the layout of the content? *						
	1	2	3	4	5	6
Poor	<input type="radio"/> Excellent					
How do you rate the collection of your profile information? *						
	1	2	3	4	5	6
Poor	<input type="radio"/> Excellent					
How do you rate the navigation of the proposed adaptive learning system? *						
	1	2	3	4	5	6
Poor	<input type="radio"/> Excellent					
How do you rate the filtered content according to your learning style? *						
	1	2	3	4	5	6
Poor	<input type="radio"/> Excellent					

Figure D.1: Direct Observation Part 1

How do you assess the content variability of this proposed adaptive learning system? \*

1      2      3      4      5      6

Least Content Variability                                          Most Content Variability

How do you assess the relevant training in the context of your future professional activities, of this proposed adaptive learning system? \*

1      2      3      4      5      6

Least Training                                          Most Training

How do you rate the overall experience of using Moodle? \*

1      2      3      4      5      6

Poor                                          Excellent

Do you feel more comfortable to access this proposed adaptive learning system more than Moodle? \*

Yes

No

What is/are the additional function/s you will recommend to the proposed adaptive learning system? ("None" if there is no recommendation) \*

Long-answer text

Figure D.2: Direct Observation Part 2

# List of References

- Alduaies, A. (2018), ‘Teaching and learning vocabulary: Insights from learning styles and learning theories’.
- Alhasan, K. Chen, L. & Chen, F. (2017), ‘Semantic modelling for learning styles and learning material in an e-learning environment’.
- Aljojo, N. (2020), ‘Understanding the sequence of learning in arabic text – saudi arabian dyslexics and learning aid software.’.
- Azzopardi, C. (2019), ‘What constitutes dyslexia-friendly practice? a case study of a maltese primary school.’.
- Bilous, V. (2019), ‘Basic principles for developing an adaptive learning system.’.
- Chaudhry, N. Ashar, A. & Ahmad, S. (2020), ‘Association of visual, aural, read/write, and kinesthetic (vark) learning styles and academic performances of dental students’.
- Cristiano, K. & Triana, D. (2020), ‘Google classroom as a tool-mediated for learning’.
- Elmabaredy, A. Elkholly, E. & Tolba, A. (2020), ‘Web-based adaptive presentation techniques to enhance learning outcomes in higher education.’.
- Ennouamani, S. & Mahani, Z. (2017), ‘An overview of adaptive e-learning systems.’.

Fatahi, S. & Moradian, S. (2018), ‘An empirical study on the impact of using an adaptive e-learning environment based on learner’s personality and emotion.’.

Goncalves, V. & Goncalves, B. (2018), ‘The process of planning and building a xmooc: A practical review’.

Google. (2020), ‘Google classroom’. [Accessed 12 12 2020].

**URL:** <https://edu.google.com/products/classroom/>

Heras, S. Palanca, J. R. P. D.-M. N. & Julian, V. (2020), ‘Recommending learning objects with arguments and explanations.’.

Hermawan, H. Wardani, R. C. J. D.-A. & Yarmatov, M. (2018), ‘Adaptive mobile learning in the nearby wisdom app’.

Jayalath, J. & Esichaikul, V. (2019), ‘Gamification in e-learning for technical and vocational education and training’.

Lambert, C. & Dryer, R. (2018), ‘Quality of life of higher education students with learning disability studying online’.

Miciuliene, R. & Ciuciulkiene, N. (2019), ‘Vocational teachers’ standpoints on educational interaction.’.

Moodle. (2020), ‘About moodle’. [Accessed 12 12 2020].

**URL:** <https://docs.moodle.org/311/en/AboutMoodle>

Nga, P. (2020), ‘Change the teaching methodologies to improve e-learning quality’.

Nie, Y. & Wu, X. (2020), ‘Getting back to the nature of the microbial world: from the description and inductive reasoning to deductive study after ‘meta-omics”.

Pavlakou, E. & Kalachanis, K. (2018), ‘Adult education using the moodle e-learning platform: The role of the trainer’.

Pranesti, D. Kurniawati, A. & Nurhayati. (2017), ‘The content and sequencing analysis of english for office skills program in vocational and education training center in pekalongan.’.

Salonen, V. & Karjaluoto, H. (2019), ‘A motivation-based complementary framework for temporal dynamics in web personalization.’.

Shawky, D. & Badawi, A. (2018), ‘A reinforcement learning-based adaptive learning system.’.

Udemy. (2020), ‘About udemy’. [Accessed 12 12 2020].

**URL:** <https://about.udemy.com/?locale=en-us>

# Bibliography

- Alduais, A. (2018), ‘Teaching and learning vocabulary: Insights from learning styles and learning theories’.
- Alhasan, K. Chen, L. & Chen, F. (2017), ‘Semantic modelling for learning styles and learning material in an e-learning environment’.
- Aljojo, N. (2020), ‘Understanding the sequence of learning in arabic text – saudi arabian dyslexics and learning aid software.’.
- Azzopardi, C. (2019), ‘What constitutes dyslexia-friendly practice? a case study of a maltese primary school.’.
- Bilous, V. (2019), ‘Basic principles for developing an adaptive learning system.’.
- Chaudhry, N. Ashar, A. & Ahmad, S. (2020), ‘Association of visual, aural, read/write, and kinesthetic (vark) learning styles and academic performances of dental students’.
- Cristiano, K. & Triana, D. (2020), ‘Google classroom as a tool-mediated for learning’.
- Elmabaredy, A. Elkholly, E. & Tolba, A. (2020), ‘Web-based adaptive presentation techniques to enhance learning outcomes in higher education.’.
- Ennouamani, S. & Mahani, Z. (2017), ‘An overview of adaptive e-learning systems.’.

Fatahi, S. & Moradian, S. (2018), ‘An empirical study on the impact of using an adaptive e-learning environment based on learner’s personality and emotion.’.

Goncalves, V. & Goncalves, B. (2018), ‘The process of planning and building a xmooc: A practical review’.

Google. (2020), ‘Google classroom’. [Accessed 12 12 2020].

**URL:** <https://edu.google.com/products/classroom/>

Heras, S. Palanca, J. R. P. D.-M. N. & Julian, V. (2020), ‘Recommending learning objects with arguments and explanations.’.

Hermawan, H. Wardani, R. C. J. D.-A. & Yarmatov, M. (2018), ‘Adaptive mobile learning in the nearby wisdom app’.

Jayalath, J. & Esichaikul, V. (2019), ‘Gamification in e-learning for technical and vocational education and training’.

Lambert, C. & Dryer, R. (2018), ‘Quality of life of higher education students with learning disability studying online’.

Miciuliene, R. & Ciuciulkiene, N. (2019), ‘Vocational teachers’ standpoints on educational interaction.’.

Moodle. (2020), ‘About moodle’. [Accessed 12 12 2020].

**URL:** <https://docs.moodle.org/311/en/AboutMoodle>

Nga, P. (2020), ‘Change the teaching methodologies to improve e-learning quality’.

Nie, Y. & Wu, X. (2020), ‘Getting back to the nature of the microbial world: from the description and inductive reasoning to deductive study after ‘meta-omics”.

Pavlakou, E. & Kalachanis, K. (2018), ‘Adult education using the moodle e-learning platform: The role of the trainer’.

Pranesti, D. Kurniawati, A. & Nurhayati. (2017), ‘The content and sequencing analysis of english for office skills program in vocational and education training center in pekalongan.’.

Salonen, V. & Karjaluoto, H. (2019), ‘A motivation-based complementary framework for temporal dynamics in web personalization.’.

Shawky, D. & Badawi, A. (2018), ‘A reinforcement learning-based adaptive learning system.’.

Udemy. (2020), ‘About udemy’. [Accessed 12 12 2020].

**URL:** <https://about.udemy.com/?locale=en-us>