

# A Personality-Based Virtual Tutor for Adaptive Online Learning System

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**Abstract**—E-learning has become one of the most extensively used electronic systems in the field of education. Despite its benefits, there are some capabilities and concerns that may have a negative impact on students' performance. As a result, personalized e-learning systems are being developed, which adapt e-learning systems to the users' personality, knowledge, behavior, interests, or preferences. This will improve the overall learning experience and performance of the students. This study created and tested an e-learning system, called "Cybele" to help students learn cybersecurity in an online mode of learning. "Cybele" is a personality-based virtual instructor for cybersecurity online learning that includes a chatbot built using Rasa Open Source. The paper used Myers-Briggs Type Indicator (MBTI) personality model for initial learner assessment to address various student learning styles for a better online learning experience. Testing was done for the system functionality and the traditional learning approach was compared to the personalized e-learning system. Results show that students who participated in the developed adaptive e-learning environment performed better than those who pursue the traditional learning method.

**Index Terms**—Personalized e-learning, adaptive learning environment, learning styles, Myer-Briggs type indicator theory

## I. INTRODUCTION

As the globe deals with a pandemic, the notion of e-learning has grown in popularity. It was already a well-known practice prior the outbreak, but it has gotten a lot of attention lately since individuals must remain confined. It was adopted as a method of learning for the majority of institutions globally and may be described as "any learning that incorporates the use of the internet or intranet" [1]. Furthermore, there are issues with traditional e-learning systems, not everyone learns in the same manner. As a result, learning materials and settings should be tailored to the student's talents and personality [2]. This is where an adaptive e-learning system comes in; an adaptive e-learning system may adjust to the particular learner depending on specific characteristics, such as the student's personality [3], learning methods [4], or other aspects of their identity [5].

The study has adopted the learning models which utilized the Myers-Briggs Type Indicator (MBTI) personalities in the system as the basis of the adoption of learning approach [6].

This paper covers the cybersecurity lesson as the subject matter or content materials in the e-learning website, which was proven to be in demand and has massive importance in

today's time. In cybersecurity, the human factor is often seen as a weak point. Many organizations have done everything possible to help their staff become less vulnerable to phishing and other cyber-attacks. This can include placing systems and procedures in place, as well as training and education for employees. However, a "one size fits all solution" may not always be effective; in all facets of human nature, individual variations exist, and cyber-security is unlikely to be the exception.

Moreover, there are also opportunities to enhance the traditional e-learning methods due to the fact that not all individuals learn the same way [7]. As such, learning materials and environments should be personalized according to the capabilities and identity of the student [5]. Students' learning preferences can be related to personalities in the matter of how certain personalities can intake information based on their preferred learning styles [8].

The system developed also integrated with chatbot utilizing Rasa Open Source. The system went to various testing like cross-browser testing, vulnerability assessment, load testing, usability testing, and functionality testing.

### A. Objective of the Study

The objective of this study is to create a virtual tutor platform in the form of a website that consists of learning materials about and adapts its learning path based on the student's personality, as well as to create a chatbot using Rasa Open Source 2.0 into the virtual tutor platform as an assistant that contains definitions and terms for each of the lesson. The effectiveness of the virtual tutor platform was evaluated from the respondents of Mapua University Makati IT College Students who are preparing for the cybersecurity Specialization on the CompTIA Security+.

### B. Scope of the Study

The personality model that was used as the basis for the learning assistant is personalities under the four dominant preferences sixteen personality types of the personalities of Myer-Briggs type indicator (MBTI) as defined [5]. The sixteen types are typically referred to by an abbreviation of four letters—the initial letters of each of their four type preferences (except in the case of intuition, which uses the abbreviation N to distinguish it from Introversion). Combining the initial letters will create 16 combinations. For instance:

- **ESTJ**: extraversion (**E**), sensing (**S**), thinking (**T**), judgment (**J**)
- **INFP**: introversion (**I**), intuition (**N**), feeling (**F**), perception (**P**)

The terms used for each dichotomy have specific technical meanings relating to the MBTI which does not literally mean the common understanding usage of word. For example,

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people who prefer Judgment over Perception are not necessarily more judgmental or less perceptive. The MBTI instrument does not measure aptitude but only indicates one preference over another. The four pairs of preferences or dichotomies are the following:

- Extraversion (E) - (I) Introversion
- Sensing (S) - (N) Intuition
- Thinking (T) - (F) Feeling
- Judgment (J) - (P) Perception

The platform used in developing the chatbot centered around Rasa Open-Source version 2.0, and no other dialogue system builder used. The chatbot's name is *Cybele*. The chatbot responses are predefined and set by the developers, with the responses being based around the definition of terms using the Chapter exam topic review of the CompTIA Security+ Get Certified Get Ahead: SY0-501 Study Guide.

## II. RELATED LITERATURES

### A. Adaptive Learning

There are three basic models that make up an adaptive e-learning system. The first is the Domain Model, which includes an outline of the contents of the learning materials, such as the subject and fields, as well as the information or learning materials that will be taught. The domain's organization is generally separated into chapters. Following that, those chapters are subdivided into ideas, which are then subdivided into learning objects, which are defined as distinct units of information portrayed through various ways such as presenting activities and examples. These learning items can be provided in a variety of formats, including picture, audio, text, and video [2, 8].

The learner model is the second component, which determines the learner's identity based on personal characteristics such as personality, learning style, learning preferences, age, and educational level. The identification of the user will then be utilized to determine their learning preferences [2].

The Adaptation Model is the third component, it specifies the teaching tactics that will be utilized to teach each subject based on the student's learning preferences and entails constructing multiple frameworks for the learning objectives [2, 8]. In the case of dynamic scaffolding, when the student's learning path is constantly altering to meet the student's needs, the Adaptation model also contains the rules for updating the model [9].

### B. Macro Adaptive Approach

The Macro Adaptive Approach is an approach in adaptive e-learning that adapts based on several components such as the delivery system, detail level, and learning objectives. In addition, these alternatives are stated to be based on the academic capabilities of the student and parts of their identity such as their personalities, goals, learning styles, and general abilities [10].

### C. Virtual Tutor

Virtual tutoring systems are existing programs that imitate tutors on specific tasks that involves the learner's well-being

such as teaching them. These virtual tutors can be used for many purposes extending on being a foundation of a support system for many other purposes. A benefit of using these virtual tutors is that it is appropriate for courses that do not require instructors. With the existing virtual tutoring system, it is possible to reach learners who have real-life tutors in an improved way with reduced cost of resources, also making it possible to use its methods in multiple courses at a time. The virtual tutors are made to be feature-full, for the most part, but they often end up leaving motivational features aside. However, studies relating to the development of new, sociable tutors that can engage learners are already presented in literature today. Among several kinds of tutors available, one of the most prevalent is those who guide the learner through some assessments of how they utilize the instrument, as they enable the virtual tutor to identify methods to engage them in the course. The most common way for the users to interact with these virtual tutors is through text boxes [11].

## III. METHODOLOGY

The focus of this study is to create a Web Application that teaches cybersecurity concepts through a combination of Learning Paths and a chatbot component. There are four learning paths which correspond to dominant personality preferences based on El Bachari *et al.* [2]. These are the Sensing (S), Intuitive (N), Feeling (F), and Thinking (T) personalities [first]. The Learning Path is a learning curriculum that consists of lessons, activities and examinations available for the respondents to study and use. The purpose of the Chatbot is to serve as a guide for the respondents by answering their questions regarding cybersecurity by providing definitions and examples. The respondents communicate with the chatbot through a Chat component on the website.

### A. System Design

The basis of the User Interface (UI) design of the website is based from Subaramaniam and Yeganeh's study [12]. which is about linking web interface design to MBTI personality types. The study determined through a survey that personality types had a specific preferred website design. These design components are as follows, background color, font type, font color, font size and the shape of the components [13].

There are different Learning Paths for each MBTI personality type according to learning designs based on Dominant Personality Preferences [5]. These are the following:

**Sensing:** Learners in this personality type rely heavily on knowledge to take in their five senses: hearing, touching, and seeing what they are learning. Where appropriate, they enjoy hands-on activities, computer-assisted guidance, materials that can be handled, and audio-visual materials. They know better when the content is linked to real-life circumstances. Sensing styles can understand more quickly if the provided facts and abilities are essential to their present lives. They want concrete facts, structure, and organization. They are good, typically practical, relatively traditional methods, and memorizing. The students of Sensing are 'why before what'

students. The flowchart showing the learning flow of *Sensing Learners* are shown in Fig. 1.

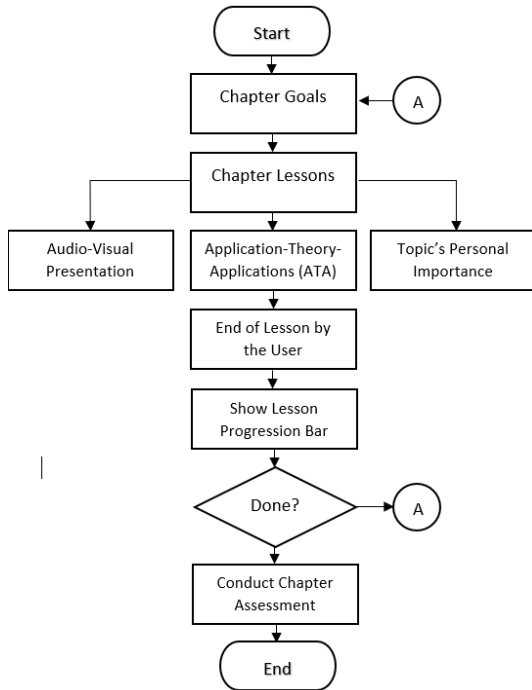


Fig. 1. Learning design flowchart for sensing learners.

As shown in Fig. 1, before actually teaching the subject matter, the instructor must get the learner to see the importance of the content. Because the theory is often complex, some research studies have proposed the application-theory-application (ATA) method for detecting students. The students strive to examine and solve the issue without the aid of the theory of the upcoming course. The instructor then introduces the approach or thoughts of the chapter and then applies them to the original application. The teacher then presents additional applications to make the learning process more efficient. Concerning the subject of the study, which is teaching cybersecurity, security+ certification guide to be specific, presented in Fig. 2 is the learning design based on the learning preferences of a sensing student. As shown in Fig. 2, the Sensing Learning Path has a black background color, Times New Roman font type, white font color, font size of ten pixels and curved line shapes.

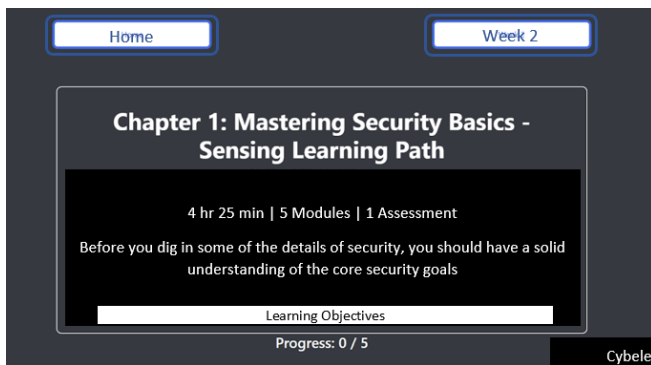


Fig. 2. Sample learning design for sensing learners.

**Intuitive:** By insight, intuitive students see the world. Before agreeing that facts are essential, they want to know the theory. They are imaginative, inventive, and they work with bursts of energy. Their emphasis is on conceptual

knowledge. They sometimes miss the specifics because they see the big picture. Before determining that facts are relevant, intuitive students want to know the theory, concentrating on general principles rather than information and practical matters. They see associations and interpretations quickly, relying more on intuition rather than observation, and they want a general overview only, and they enjoy new content. Tasks that cater to their intellectual interests are better for them, and they call for understanding general concepts, seeing relationships, and using creativity. When they refer to a pattern, they may recall details. Before something else, they would still wonder 'why.' Before putting them into effect, they want to illustrate concepts and theories. They do well with self-training opportunities, both individually and with a group. Several studies have proposed Theory-Application-Theory (TAT) for intuitive students. The instructor begins by introducing the principle or concept of the chapter before the submission. Then, the students try using the knowledge of the course, evaluating them, and solving the problem. To promote the learning process, the teacher should reuse the principle. For conventional face-face instruction, this technique (TAT) is also used. Intuitive students like the TAT form as well. With relation to the subject of the study, which is cybersecurity, security+ certification guide to be specific, presented in Fig. 3 is the learning design based on the learning preferences of an intuitive student. As shown in Fig. 3, the Intuitive Learning Path features a green background color, Arial Font Type, white font color, a font size of ten pixels and sharp line shapes.

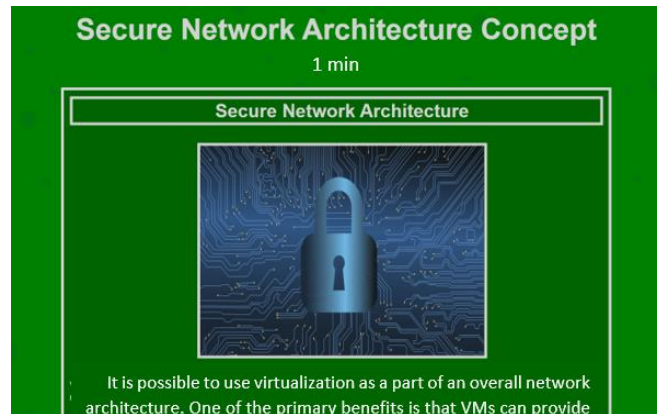


Fig. 3. Sample learning design for intuitive learners.

**Thinking:** The lessons for the two chapters will be delivered in two weeks and will not be time-restricted. It will be up to the students to meet the deadline before the Chapter Assessment and, ultimately, the post-test. Based on the given research, the Thinking group will want a presentation of the goals per chapter, meaning what they need to learn. Then, the lesson will start after the said presentation, and the methods for the delivery of the classes will include pictures, brief and concise speeches, and links to videos relevant to the chapter. The said delivery methods of the lesson are based on the theory application problem solving (TAPS) approach. After the delivery of the tasks or if the user intentionally stops the class, a progress bar will be there to measure their progress for the chapters, and it will be up to the user when they continue as long as they meet the deadline. As shown in

Fig. 4, the Thinking Learning Path UI Design consists of blue background color, Arial font type, black font color, sixteen pixels font size and angled line shapes.

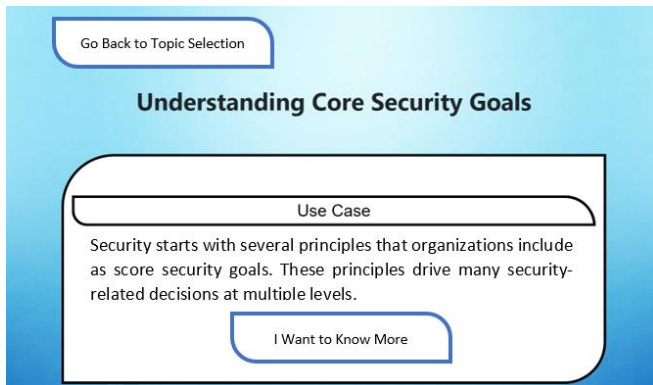


Fig. 4. Sample learning design for thinking learners.

**Feeling:** The process of lesson delivery for the Feeling group will not significantly differ from the Thinking group, as indicated in Fig. 5. The difference will be that the delivery method of lessons will include the link of other study materials relevant to the chapters and the relation of real-life scenarios to the tasks. The links to relevant videos to the branches will be retained as a mode of lesson delivery. Also, the presentation of goals for the chapters will be removed as it will be irrelevant for the Feeling Group. The methods of delivery will also be based on the theory application problem solving (TAPS) approach. As shown in Fig. 5, the Feeling Learning Path has a blue background color, Times New Roman font type, black font color, font size of twelve pixels and a mixed line shape.

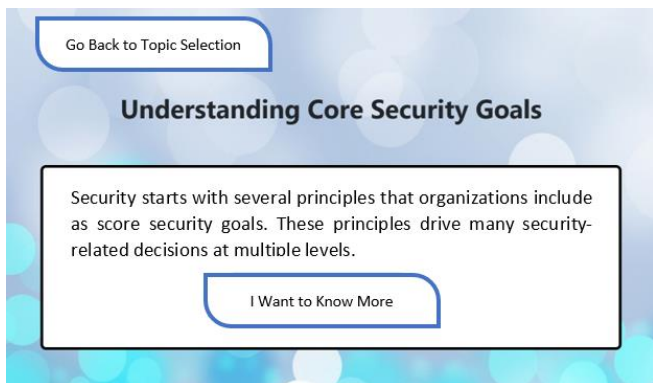


Fig. 5. Sample learning design for feeling learners.

**B. Development**

The development in this study was initiated by creating the Web Application using the programming language of PHP, specifically using the Laravel framework which is a model view controller (MVC) framework for the PHP programming language. The integrated development environment (IDE) used to develop the system is Visual Studio Code which is an open-source IDE. The engine used for developing the chatbot is Rasa which has an open-source software development kit for developing AI's and chatbots [12]. The website was hosted using Microsoft Azure Virtual Machines (VM) and is connected to an SQL Database also hosted in Azure. The chatbot was deployed to Azure in a Virtual machine and

communicated to the Website using a WebSocket library and port-forwarding the chatbot endpoints using a VM hosting Apache in Azure. The simplified structure of the website is illustrated in Fig. 2. The materials used for making the questions and lessons are taken from Chapters 1 and 2 of CompTIA Security+ Get Certified Get Ahead: SY0-501 Study Guide by Darril Gibson.

All Learning Path's while having different content and design have similar flows, before the respondent begins the Learning Path, all respondents must take a Pre-test with the same questions. There are two chapters, Chapter 1 and Chapter 2, and two assessments, the Chapter 1 Assessment and the Chapter 2 Assessment. After all respondents have completed the Learning Paths, they must take a Post-test to identify if they have learned. The estimated time for reading a lesson is also displayed in order to notify the respondent how much time they need to allot to complete a lesson. The table of summary of learning designs based on dominant personality preferences [5] and used in the development of the study is shown in Table I.

TABLE I: SUMMARY OF LEARNING DESIGNS BASED ON DOMINANT PERSONALITY PREFERENCES [5]

Sensing	
Dominant Function	
MBTI Personalities	ISTJ, ISFJ, ESTP, ESFP
Learning Approach	Application-Theory-Application (ATA)
Preference Learning Characteristics	Prefer step-by-step and traditional methods in the curricula. Using experience and normalized ways to solve problems. Giving and evaluating suggestions that are straight and feasible. Giving and evaluating realistic applications. Applying already known methods by giving examples and details. Giving and evaluating an agenda.
Electronic Media	Chat, Forums, Animation, Pictures, Internet research, Web-blog, Wikis
Intuitive	
Dominant Function	
MBTI Personalities	INFJ, INTJ, ENFP, ENTJ
Learning Approach	Theory-Application-Theory (TAT)
Preference Learning Characteristics	They focus on conceptual understanding. Self-studying Solving complex problems. Learning new skills. Following own insights Giving and evaluating novel suggestions. Giving and evaluating to do new things. Preferring global schemes.
Electronic Media	Chat function, - E-mail function, Forum pages, Online learning availability, Pictures
Thinking	
Dominant Function	
MBTI Personalities	ISFP, INFP, ESFJ, ENFJ
Learning Approach	Theory-Application-Problem Solving (T-A-PS)
Preference Learning Characteristics	Logically analyzing to reach conclusions. Prefers teacher-guidance Working unharmoniously Being solid-minded and giving criticism. Feeling rewarded when a task is done.

Characteristics	Task seeker. Brief and concise. Methodically presenting objectives
Electronic Media	Chat function, - E-mail function, Forum pages, Online learning availability, Pictures
	Feeling Dominant Function
MBTI Personalities	ISFP, INFP, ESFJ, ENFJ
Learning Approach	Theory-Application-Application-Problem Solving (T-A-PS)
	Prefers simulations and case studies in groups Using values for conclusions
Preference Learning Characteristics	Working harmoniously Rewarded feeling when the needs of others are met Involvement seeker Sociable
Electronic Media	Chat function, - E-mail function, Forum pages, Animations, Online learning availability, Podcast, Internet search, Web blogs, Wikis

The chatbot was created using an intent-response dialogue wherein possible responses are matched to possible intents that the user might query or ask the chatbot. Afterwards the chatbot is trained to an acceptable accuracy of 95% which is the possibility of the chatbot correctly identifying the intent and giving the response [14]. In this case the intents are concepts in the cybersecurity materials while the appropriate response would be the definition or examples of said concepts. The chatbot can be accessed on any part of the website except for during assessments.

### C. Testing

This study tested the effectiveness of the Web Application and the chatbot in teaching cybersecurity using the t-test formula between the results of the Assessments and the Pre and Post-test assessments. The study also tests technical elements regarding the Web Application such as Cross Browser Testing to assess the compatibility of the Web Application to different browsers, Load testing using LocustIO to test the user count limits and speed of loading of the website, Vulnerability testing using OWASP Zed Attack Protocol (ZAP) to assess its security and Usability Testing using the System Usability Scale (SUS) to check for the respondent’s feedback in using the Web Application.

Purposive sampling was used to pick the respondents. Only forty cybersecurity college students will participate, with twenty students in the Control Group and twenty students in the Experimental Group. After two weeks of using the Web Application, the responses will be collected in the form of the assessment results and the Pre-test and Post-test results. There is also a Null Hypothesis of  $\mu_A = \mu_B$  where the results of the Pre-test and Post-test is not significant is and the alternative hypothesis  $\mu_A > \mu_B$  where the Post-test results show improvement for the respondents regarding learning cybersecurity.

## IV. RESULTS AND DISCUSSIONS

### A. Pre-test and Post-test Comparison

The scores of the students in the Control Group and the

scores of the students in the Experimental group on the pre-test, as well as the scores of the Control Group and the scores of the students in the Experimental group on the post-test and the scores of the Control Group and Experimental group in the weekly assessments, will be used for statistical treatment. It’s worth noting that the two groups have no effect on one another and are thus regarded separate entities. The Experimental Group has a lower total score of 259 while the Control Group has a higher total score of 330. As a result, the average score of the Experimental Group is 12.95 while the Control Group’s average score is 16.5. It should be noted that the Standard Deviation for the Experimental Group which is 7.06 is higher than that of the Control Group which is 4.58 as shown in Table II.

TABLE II: PRE-TEST COMPARISON

Groups	Pre-test Total	Pre-test Average ( $\bar{x}$ )	Pre-test Standard Deviation (s)
Experimental	259	12.95	7.06
Controlled	330	16.5	4.58

Both groups take the post-test exam after two weeks of studying their Learning Paths for the Experimental Group and the traditional learning materials for the Control Group. With an average of 25.6 and a standard deviation of 2.66, the Experimental Group received a score of 521. The Control Group received a score of 448 out of a possible 500, with an average of 22.4 and a standard deviation of 4.32 as shown in Table III.

TABLE III: POST-TEST COMPARISON

Groups	Post-test Total	Post-test Average ( $\bar{x}$ )	Post-test Standard Deviation (s)
Experimental	521	25.6	2.66
Controlled	448	22.4	4.32

### B. T-test Results

A two-tailed t-test with a 95% confidence interval is used to calculate the t-value. The pre-test comparison between the Experimental and Control Groups yielded a t-value of  $-1.89$  and a resulting p-value of 0.66197, which is not significant at  $p < 0.05$ . The t-test on the Control group’s post-test and pre-test produced a t-value of 3.19 and a p-value of 0.002868, which was significant at  $p < 0.05$ . The t-test on the Experimental group’s pre- and post-tests produced a t-value of  $-10.67$  and a p-value of less than 0.00001, which is significant at  $p < 0.05$  as shown in Table IV. Therefore, the null hypothesis of  $\mu_A = \mu_B$  is rejected, and the alternative hypothesis  $A > \mu_B$  is accepted.

As indicated in the same table, Table IV, the Control Group’s post-test scores were higher than their pre-test scores, and the Experimental Group’s post-test scores were also higher than their pre-test scores. The Experimental Group, on the other hand, scored much higher in the post-test than the Control group, which could indicate that the Learning Paths’ learning materials are superior to the standard learning materials supplied to the Control group. Furthermore, the Experimental group scored more consistently, as seen by their reduced standard deviation of 2.66 compared to the control group’s standard deviation of

4.32. This shows that students can study and learn more effectively because of the personality-based learning tools [3].

TABLE IV: T-TEST RESULTS

	T-value	P-value
Pre-test Comparison (Experimental and Control Group)	-1.89	0.66197
Pre-test and Post-test Comparison (Control Group)	3.19	0.002868
Pre-test and Post-test Comparison (Experimental Group)	-10.67	0.0001
Post-test Comparison (Experimental and Control Group)	-2.82	0.007606

### C. Cross Browser Testing Results

Google Chrome, Mozilla Firefox, and Safari all had no problems loading the website. This is most likely due to the use of Bootstrap 4, which is a blend of standardized Cascading Style Sheets (CSS) and JavaScript for animations and event handling; some components, such as the progress bar, also have special CSS attributes for different browsers as shown in Table V.

TABLE V: CROSS BROWSER TESTING RESULTS

Browsers	JavaScript	CSS
Google Chrome	Passed	Passed
Mozilla Firefox	Passed	Passed
Safari	Passed	Passed
Safari	Passed	Passed

### D. Load Testing Results

The number of users and the growth rate of users per second were both reduced, which had a significant influence on the website's performance. The first load test had unacceptable failure rates, with most requests being dropped; the second performed much better but still had a success rate of less than 95% due to the 8.15% failure rate; and the third load test performed the best, with a 0% failure rate and faster loading times as shown in Table VI.

TABLE VI: LOAD TESTING RESULTS

Total Number of Users	User Growth Rate Per Second	Average Response Time (ms)	Failure Rate (%)
500	50	7393.94	76.19
250	25	15132.21	8.15
125	10	8036.32	0

### E. Vulnerability Test Results

Because vulnerability assessment tools are prone to false positives, another test was run OWASP ZAP to see if the results will vary. After using OWASP ZAP, the site underwent a vulnerability test using web application scanning by Tenable. After thorough testing, there are six vulnerabilities found in total shown in Table VII, which were analyzed with concern with the Web Application and the usual cases regarding the found vulnerability to calculate the correct Common Vulnerability Scoring System (CVSS) Base Score. The results of vulnerability testing are shown in Table VII.

TABLE VII: VULNERABILITY TESTING RESULTS

Vulnerability	CWE ID	Severity	CVSS Base Score
X-Frame-Options Header Not Set	1021	Low	3.1
Cookie No HttpOnly Flag	1004	Low	3.1
Cookie without SameSite Attribute	1275	Low	3.5
Cookie Without Secure Flag	614	Low	3.1
Incomplete or No Cache-Control Header Set	525	Low	3.7

### F. Usability Test

The website and the overall system's usability were assessed using the System Usability Scale (SUS) [15]. The SUS consists of ten items that are answered on a 5-point scale), with 1-strongly disagree, being the lowest and 5-strongly agree, being the highest. The middle values are 2-disagree, 3-neutral, 4-agree, and 5-strongly agree. For each odd-numbered question, remove one from the score when grading the site's usability. Then, from five, remove the value of each of the even-numbered questions (5). Finally, total up all the results and add them to the overall score. You now have your score on a scale of one to one hundred. The website's usability is great if the score is 80.3 or higher. If the score falls between 68 and 80.2, the usability of the site is acceptable. If the score is 51 or less, the site's usability is poor and must be upgraded immediately. The overall average score for using *Cybele* across all users is 83.875, showing that the experimental group users are satisfied with using the Web Application. The results of usability testing are shown in Table VIII. The SUS survey questions or statements are the following:

- 1) I think I would like to use this system frequently.
- 2) I found the system unnecessarily complex.
- 3) I thought that the system was easy to use.
- 4) I think that I would need the support of a technical person to be able to use this system.
- 5) I found the various functions in this system were well integrated.
- 6) I thought there was too much inconsistency in the system.
- 7) I would imagine that most people would learn to use this system very quickly.
- 8) I found the system very cumbersome to use.
- 9) I felt very confident using the system.
- 10) I needed to learn a lot of things before I could get going with this system

TABLE VIII: USABILITY TESTING RESULTS

Survey #	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	0%	0%	5%	35%	60%
2	45%	40%	5%	0	10%
3	0%	0%	0%	20%	80%
4	65%	15%	0%	5%	15%
5	0%	0%	5%	30%	65%
6	25%	45%	15%	5%	10%
7	0%	0%	0%	15%	85%
8	35%	55%	0%	0%	10%
9	0%	0%	0%	35%	65%
10	60%	25%	0%	0%	15%

## V. CONCLUSIONS AND RECOMMENDATIONS

Upon the development of *Cybele*, the effectiveness was tested on forty Mapua University students. The population was divided into 2 groups that contains the equal number of students with their consent. They have started in taking a pre-test that consists of 30 questions adopted from the CompTIA Security+ Get Certified Get Ahead: SY0-501 Study Guide. The pre-test results consist of: 1) the control group having higher collective points with an average of 16.5; and 2) the experimental group average score of 12.95. The experiment then is continued with the control group consisting of 20 students using the traditional method of learning, that only uses pdf of chapters as the learning material, and the experimental group of twenty students that will be using *Cybele*. The study has successfully identified the personality types of the twenty students, using 16personalities.com, that belong in the experimental group as it was required to do since it was the first step in the experiment process of the group.

The experimental group of students who used *Cybele* that whose personality classification was identified from 16personalities.com as a key factor in determining their learning path. Also, the study had successfully integrated a chatbot using Rasa 2.0 that holds terms and definitions relevant and related to the two chapters used in the system. The usability test for the research had scored a satisfactory high rating of 83.875.

The last step of the experiment was after the controlled and experimental group finish studying by using the pdf material and *Cybele* respectively. It will be conducted through a post-test, and the results of the post tests of the 2 groups leaned more positively towards the experimental group, that of which had collectively scored an average of 25.6 points than the control group score in the post-test, which averaged 22.4 points. According to these results, the researchers have concluded that with the use of a system that adapts to certain particularities of a person, like *Cybele*, which adapts its learning method and design depending on the users' personality type, is a much more effective way of learning for students than traditional and not adaptive learning methods.

The findings of this research can revolutionize the environment of e-learning or can be treated as a reference for aspiring researchers whose goal is aligned with improving the e-learning environment. One of the limitations in the study is the population and can be improved further by future researchers. More data can be collected for a more structured adaptive system for all 16 MBTI personality types. Future researchers can consider other aspects to use for their personalized e-learning system rather than using the personality types alone. Other longer-term evaluation with additional individuals and a larger range of learning tools can be considered for future study. Various factors can largely impact the student-system interaction such as students' satisfaction and/or motivation.

Lastly, for the future researchers to investigate the relationship between the social area of learning and technology, the implications of good and sensible usability principles in developing instructional content, and the impact these factors may have on student achievement and learning

as personalized learning becomes more widespread in the e-learning environment and the education system in general.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## AUTHOR CONTRIBUTIONS

Ms. Samonte supervised the whole research development and took the lead in writing the manuscript. Mr. Miraflores developed the theoretical formalism and wrote the manuscript with support from Mr. Alvarez and Mr. Acuña. All authors provided critical feedback and helped shape the research, analysis, and manuscript.

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