CHAPTER II

LITERATURE REVIEW

The focus of the literature review is based on the findings from several studies that are divided into four parts: (1) Synchronous online collaborative argumentation learning, (2) Cognitive load, (3) User Interface (UI) & User Experience (UX) (4) Reflective, Recursive Design and Development Model (R2D2).

2-1 Synchronous Online Collaborative Argumentation Learning

The characteristics of synchronous communication is that the conversations are conducted in real-time, and people are communicating together at the same time. The pedagogical assumption that motivates communicating in synchronously way is that participation is critical to the learning process (Leidner & Jarvenpaa, 1995). Synchronous communication is richer than asynchronous communication because of the immediate feedback that the people could receive so that that interpretation can be checked immediately (Daft & Lengel 1986, p. 560) so it would be excellent to be used on online learning activity. Leidner and Jarvenpaa (1995) proved that if all members of a class contributed in a computer-mediated synchronous discussions and they communicated with each other rather than on a one-to-one basis with the teacher like in the traditional classroom, got a better result on developing their skill on problem-solving. A synchronous live sessions could help the students to feel like participants rather than isolates or listeners. Isolation can be overcome by continuing the contact to each other, synchronously, and by becoming aware of themselves as members of a community rather than as isolated individuals communicating with the computer (Haythornthwaite & Kazmer, 2002, p. 459). According to Kearsley (1995), classes that communicate synchronously will increase a sense of excitement and spontaneity that is not present with delayed interaction (Hrastinski, 2007a,

p. 47). A synchronous communication will be better to support personal participation because it involves the following key elements such as: (1) it would increase the psychological arousal, (2) it will increase the motivation, and (3) it will increase convergence on the meaning of the activity. This is useful for less complicated information exchanges, such as task support and social support exchanges (Hrastinski, 2007b, p. 109).

Collaborative learning based on the literature (Dillenbourg 1999; Underwood & Underwood 1999) is a concept that used loosely and interchangeably. The first concept about it is when the members of a group may choose to take responsibility for sub-tasks while the second describes groups that work together on all parts to solve a problem (Littleton & Häkkinen 1999; Underwood & Underwood 1999, p. 12). Students that work collaboratively and share the decision-making need to communicate frequently. It depends on the students to choose to work cooperatively or collaboratively, and it depends on the task and characteristics of the students in the group (Underwood & Underwood 1999).

Synchronous Online collaborative argumentation learning system is a system that facilitates collaborative learning activity through the online real-time method. Students would experience learning activity through a system and would share their ideas and arguments to build a new knowledge. The environment of this system is online, which means it can be accessed anywhere anytime with internet support.

2-2 Cognitive Load

Cognitive load on psychology refers to the used amount of the working memory resources that will affect human being or learner in learning something. The cognitive load theory differentiates cognitive load into three types: intrinsic, extraneous, and germane. The explanation of each type also includes, like the Intrinsic cognitive load is the effort associated with a specific topic, extraneous cognitive load refers to the way information or

tasks are presented to a learner, and germane cognitive load refers to the work put into creating a permanent store of knowledge, or a schema into the human brain.

2-2-1 Intrinsic Cognitive Load

Intrinsic cognitive load refers to the demand made of a student or learner by the intrinsic quality of the information or knowledge that he learned. The load on a student depends on the complexity of the task, set, or concept that being presented, and the student's ability to understand the information, and process it to their brain.

This intrinsic aspect and nature of cognitive load will make it challenging to eliminate, and the developer will always find difficulty in designing new activity with complicated things. This cognitive load can be reduced by breaking the activity into easier or simpler steps that can be done by the student individually.

2-2-2 Extraneous Cognitive Load

Extraneous cognitive load refers to the cognitive load that is in the control of the teacher or instructional designers. This cognitive load is extraneous to the activity, learning task, and unnecessary information giving by the teacher or instructor. This can be increased by the ineffective teaching method, which will unintentionally misdirect the students with distracting information and complicated task. This cognitive load is the type that makes the student does not achieve the learning goal and get misinterpretation of knowledge and information.

This cognitive load can be decreased by the design of an effective presentation method that can help to reduce this cognitive load on the student. Design an effective interface if it is related to a system is also will help to decrease this cognitive load. For example, the designer can use a picture, diagram, and an icon to help the student understand

the function or a system rather than using too many explanations that will only confuse the student.

2-2-3 Germane Cognitive Load

Germane cognitive load is the type of cognitive load that is produced as the student observe and learns about the experience to help them to anticipate and understand the effect of what will happen when the student does some action. This cognitive load is processing, construction, and automation of the schemas. The instructional designer can design a system that will direct the student's attention to the relevant construction of the schemas of learning design.

The developer or designer can design a system that has clear flows and steps that would direct the student to the purpose of the learning activity and learning system, and the student will be able to predict what will they get when they use the system by "reduce extraneous cognitive load and redirect learners' attention to cognitive processes that are directly relevant to the construction of schemas" (Sweller et al., 1998. p.265).

2-2-4 Individual Differences in Processing Capability

Some researchers like Scandura and Joseph M (1971) have found that human as each individual had differences in processing capacities. Murphy, Gregory L.; Wright, Jack C. (1984) divided the type of individual into two types, they are novices and experts. Expert type of individual or student is having more knowledge and experience with regard of some specific task that is giving by the teacher or instructor, while novice individual or student do not have as much knowledge and experience than the experts, and thus what makes the cognitive load might be heavier on novice student than on expert student, because they have to process the order, steps and information harder.

Based on the research done by Hackman, Daniel A.; Farah, Martha J. (February 2009), proved that the environment also affects the cognitive load, for example, the poverty or the place the person lives, their educational background and many more. This also proved that impoverished learning environment could contribute to cognitive load.

Considering the individual difference, it would be better for an instructional designer to know and understand more about the participant educational background and experience on a specific matter, for example, in using a computer or a system. As a designer of the system, it would be better to consider this aspect, so the final product or system will give the best result and suitable for the user. For the expert user, the designer could make the system a little bit more complicated, and for the novice user, the designer could make the system a little easier to operate with clear steps and not too complicated, and also provide some help feature to help the novice user use the system.

Table 1. User Treatment (Novice & Expert)

Type Of User	**Novice**	**Expert**
Treatment	• Less complexity • Need more help • Need repetition for information • Need more guide • Need to be checked frequently by the teacher or instructor • Cannot do progress without a clear guide	• Okay with complexity • Need less help • No need too many repetitions of information • No need too many guides • No need to be checked frequently by the teacher or instructor • Can figure it out by himself how to progress without a

	from a teacher or instructor	guide from teacher or instructor

2-2-5 The Effect of Heavy Cognitive Load

The effect of heavy cognitive load on a student of a learner would increase the error or interference in doing a specific task giving by the teacher or instructor. Moreno, R. & Mayer, R. (1999) had stated that it would create more errors and interference in the task. Biernat (2003) proved that a heavy cognitive load on an individual could also increase stereotyping, that would lead to misconception and misinterpreting knowledge, task and the central concept of learning material and that will be generalized to all the related concept of the material. This will be dangerous because it can affect a learner in an extended period.

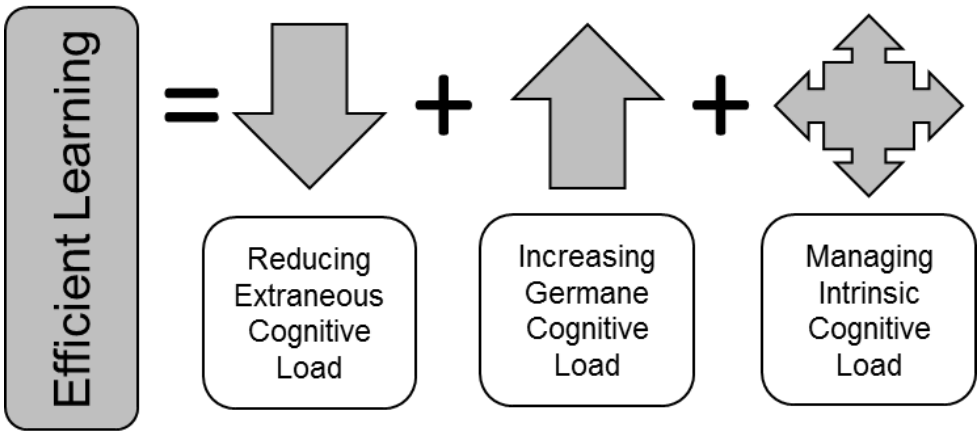
The cognitive load theory was developed around the late 1980s out of a study of problem-solving by John Sweller. Sweller argued that instructional design could be used to reduce the cognitive load in learners (Sweller, J (June 1988). After that, the following study by Paas, Fred G. W. C (1993) and Skulmowski (2017) developed a way to measure perceived mental effort that is indicative of cognitive load. Then another researcher, Granholm, E et al. (July 1996) stated that a task-invoked pupillary response is a reliable and sensitive measurement of cognitive load that is directly related to human working memory.

A human could process information, and it may only be stored in long term memory after first being attended to and processed by the working memory. Human working memory is extremely limited in both capacity and duration, depends on the person's capability on processing the information. It also depends on the situation and the environment when the situation is happening. These limitations will, under some conditions and will affect learning. If a student gets a heavy cognitive load, it will have adverse effects

on task completion, thinking, and any other learning activities. It is also important to note that the experience of cognitive load is not the same in every one since every learner has their own preference and style in learning. Like on the elderly, or students, and children, the learning experience will be different on each person and more often higher, amounts of the cognitive load will depend on the age and educational background.

Figure 1. Efficient Learning to Manage Cognitive Load

(Source: Sweller 2010)



The figure above is about efficient learning; the efficient learning is to reduce the extraneous cognitive load, increase germane cognitive load, and manage the intrinsic cognitive load.

The quality of instructional design will be raised if the fundamental principle of cognitive load theory get consideration giving to the role and limitations of working memory. To design a system that would decrease the Cognitive Load on students and increase the usability aspect of the system or prototype.

2-3 User Interface (UI) & User Experience (UX)

The User Interface is the specific name for a visual appearance on a system. The User Interface is connecting the system to the user on using the system like a particular machine, device, computer program, or another complex tool. The User Interface is connected to the user by receives instructions from a terminal user to run a program or a system. In computer science and HCI (Human-Computer Interaction), The User Interface refers to the graphical, textual, and auditory information the program resents to the user and the control sequences, such as keystrokes with the touchscreen, movements of the computer mouse, and selections with the touchscreen which allows the user control the system (Sodiya et al., 2009, p.19).

User interface design in this research is for an online system that resembles website chatting page with the focus on the user's experience and interaction. The purpose of user interface design in this research is to make the user's interaction as simple and efficient as possible, and user-centered design in terms of accomplishing user goals on collaborative argumentation activity.

The User Experience is the activity and experience that the user will do on using and interact with a system. The User Experience is also connected to the user's behavior on using the system, based on the user ability, user-based knowledge, and user needs. The User Experience design is connected with The User Interface, because this will affect the usability aspect on the system, so the interface should support the user needs and consider about the user behavior on using the system based on their purpose on using the system.

In this research, The User Experience is based on the user's background, which is high school students, and the activity that will be supported by the system, which is a collaborative argumentation activity.

2-3-1 User Interface Components

A system that operated on a computer and displaying the user interface to the student or user have main components that have a function that connected to each other in order to make the user interface works. Each component has function and purpose but connected to one another. The main components for the user interface are; colors, icons, buttons, contents, and navigation.

(1) Colors

Colors for the user interface is an essential component because color could communicate the meaning and also could affect human perception, interpretation, and feeling. Color is being used in several cultures like Egyptians and Chinese, to practice chronotherapy on human (Azeemi ST, Raza SM. 2005). Based on Azeemi ST and Raza SM (2005) study, they used several colors for the chronotherapy, for example; Red used to stimulate the human body and mind and could increase the blood circulation. Yellow used to stimulate the human nerves and purify the human body. Orange used to heal the human lungs and to increase the energy. Blue to soothe the illnesses and treat patients with pain. Indigo to alleviate skin problems. The other study also has shown that colors could impact performance. A study by Elliot AJ et al. (2007) about the effect of red on performance attainment shows that the color red could impact the test performance, and it shows that exposing the students to the red color before the test would give a negative impact on their test performance.

According to the effect of color on human behavior and performance impact, the color has a significant role in communicating with a human, especially if it used on the user interface. The color that could be used in a system user interface should show the main purpose of the system, should be unique, communicative but appropriate, and please the eye of the user.

For the system that the researcher develops, the colors that used as a component in the synchronous argumentation system are carefully chosen. The main color for the system is purple, white, and gray. Purple is a color that is intermediate between blue and red color (Oxford English Dictionary). In China, the purple color represents spiritual awareness, mental healing, abundance, and strength, while the Chinese word for purple is zi or zi Wei (紫色) in Chinese. In the design aspect, purple could give a sense of soft, calm, and also imaginative. Purple is also associated with a peaceful state of mind because of it soothing. This color has a variety effect on the human mind, it could be uplifting spirits, and calming mind and nerves and encouraging imagination and creativity. This means that while using the system, the user could feel calm but also could be creative with their mind and ideas. The color white and gray are neutral color, that could help the user to feel at ease on seeing these colors many times and won't make their eye tired, because this system also uses other colors but now as the main colors, like blue, green, and soft dark orange that would be still representable for the functions and still eye-pleasing for the user.

(2) Icons

An icon is a picture on a computer screen representing a particular computer function. If the user wants to use it, he had to move the cursor onto the icon using a mouse (Collin English Dictionary). Good icons have to foremost communicate meaning in a graphical user interface and a visual representation of an action, object, or idea and must be apparent to the user. The good icons will not mislead and confuse the user because it has the function to communicate with the user on using the system. The benefit of using icons are; because sometimes the text or information of the function is not always convenient to be presented because it is too much, an icon can be readily displayed on the screen and save space. Icon also compact to be placed in toolbars and palettes on the display interface. Icons are visually pleasing and enhance the aesthetic appeal of a designed system.

The effective way of using icons is to use the icons that are familiar with the user. Because the user will remember the familiar icons, they usually see and also remember the function of each icon.

(3) Buttons

The button is an interactive element of the user interface and could create stable interactions with the user on using the system. Button enable the expected interactive feedback from the system to the user using a particular command. Button has control and allows the user to directly communicate with the system, for example, to send an email, then the user will click “send” and to close a program, the user will click “x.” The button usually clearly visible and in geometric shape and often supported with icon or text to make it more explicit about the button function. The designer has to consider practical and noticeable buttons that will naturally be integrated into a general concept but still stand out in the screen layout.

(4) Contents

The content is one of the important features for user experience in using a system. The content in a system should communicate well with the user, not too much but not too little either. The content should be in the right place and at the right time. For example, when the user wants to see the content, then the user could access the content quickly and the content will be visible clearly and effectively for the user to read.

The content in a system should be placed and organized well, so the communication between the user with the system will be much more efficient. The misplaced the content will lead to confusion and lack of aesthetical and function aspect in a system.

(5) Navigation

The navigation is one of the essential features for usability in a system. The navigation is important to keep user know the main purpose of using the system and to keep them guided correctly to their goals. The underlying meaning of navigation is to help the user to control and support the process while using the system.

In user experience design, the concept of navigation could be generally defined as the set of several actions and techniques that will guide the user throughout the system and enabling the user to fulfill their goal and interact with the system. The efficient navigation component has a significant impact on positive user experience, so it is best to set the best and easiest steps to solving the user's problem. In the user interface, the navigation should be in the early stage, and the designer should use effective and efficient elements on the layout. The placement of each button, tabs, menu, bars, and transition should guide the user to their goal.

2-3-2 Existed UI Principles

There are User Interface Principles that already developed by the previous researchers;

(1) Ten Usability Heuristics for User Interface Design by Jakob Nielsen (1994)

a. Visibility of system status

The system should always keep the users informed about what is going on through appropriate feedback within a reasonable time or real time.

b. Match between system and the real world

The system should speak according to the users' language, with words and concepts that are familiar to the user; it should be user-oriented rather than system-oriented terms. Follow real-world conventions, making the information appear in a natural and logical order.

c. User control and freedom

If the user does a mistake or users often choose system functions by mistake, then the system will inform the user with emergency exit to leave the unwanted state or problematic situation without having to go through a lengthy and extended dialogue. Support the system with undo and redo.

d. Consistency and standards

The words, situations, or actions in the system mean the same thing. Follow platform conventions.

e. Error prevention

In a system, a suitable error message is a careful design which prevents a problem from occurring. The solution could be either eliminate error-prone conditions or check for them and present users with a confirmation option before the system process an action.

f. Recognition rather than recall

Minimize and reduce the user's memory load by making objects, actions, and options visible. The user should not have to remember too much information from one part of the dialogue to another. Instructions for the use of the system should be visible.

g. Flexibility and efficiency of use

Accelerators unseen by the novice user may often speed up the interaction for the expert user so that the system could be used by both inexperienced and experienced users.

h. Aesthetic and minimalist design

Dialogues should not contain information which is irrelevant or rarely needed. No extra unnecessary information or design in the interface of a system.

i. Help users recognize, diagnose, and recover from errors

Error messages should be expressed in plain language with no codes and easy to understand, precisely indicate the problem, and constructively suggest a solution for the occurring problem.

j. Help and documentation

It stated that it is better if the system can be used without documentation; this documentation is might be necessary to provide help and documentation. Any such information should be accessible to search, focused on the user's task, list concrete steps to be carried out, to the point, and accurate.

(2) *The Eight Golden Rules of Interface Design by Shneiderman, B., Plaisant, C., Cohen, M., Jacobs, S., and Elmqvist, N. (2016)*

a. Strive for consistency.

Consistent sequences of actions should be required in similar situations such as identical terminology should be used in menus, prompts, and help screens then use consistent colors, layout, capitalization, fonts.

b. Seek universal usability.

Recognize the needs of diverse users and design and facilitating the transformation of content. Novice to expert differences, disabilities, age ranges, international variations, and technological diversity each enrich the spectrum of requirements that guides design. Adding features for novice user such as explanations and help function and features for experts, such as shortcuts and faster pacing, enrich the interface design.

c. Offer informative feedback.

There should be interface feedback for every user action, and the response can be modest for frequent and minor actions, the response should be more substantial, whereas for infrequent and significant actions.

d. Design dialogs to yield closure.

The sequences of each action should be organized into groups with an opening or beginning, middle, and end or the finish. Informative feedback at the completion of a group of actions will give users a sense of relief, the satisfaction of accomplishment, and an indicator to prepare for the next group of actions.

e. Prevent errors.

Design the interface so that users cannot make serious errors ss much as possible. Example, blur out menu items that are not appropriate and do not allow alphabetic characters in numeric entry fields. If users make an error, the interface should offer simple, effective, and more specific instructions for the recovery. Example, if the users should not have to retype an entire name or address form, they enter an invalid zip code but rather should be guided to repair only the faulty part not start from the beginning and re-type all of the information they already input. “Erroneous actions should leave the interface state unchanged, or the interface should give instructions about restoring the state.”

f. Permit easy reversal of actions.

All actions should be reversible in the system. This feature will relieve user anxiety because the users know that errors can be undone and encourages the user to do an exploration of other unfamiliar options. “The units of reversibility may be a single

action, a data-entry task, or a complete group of actions, such as entry of a name-address block."

g. Keep users in control.

The user will strongly desire the sense that they are in charge of the interface and that the interface responds to their actions as the excellent user experience. Avoid to surprise or changes in familiar function or action; keep the user in the control of their own output.

h. Reduce short-term memory load.

Humans have limited capacity for information processing in short-term memory, and this is related to cognitive load theory. This is required for designers to avoid interfaces in which users must remember too much information from one display and then use that information on another display. This means that to reduce the load of the user memory, the designer should design the interface that uses familiar component and will not force the user to remember.

In this research, the researcher developed 9 (nine) design principles adapted from the previous principles developed by those researchers above and based on cognitive load and user interface design theory that applied on the User Interface (UI) design elements such as; colors, icons, buttons, contents, and navigation.

The Principles (P);

(1) The screen design is aesthetically pleasing,

(2) The arrangement of options/menus is appropriate,

(3) The screen layout is easy to understand,

(4) Flexible and efficient to use (for novice and expert user),

(5) Provide help option for the user,

(6) Visibility of system status.

Users should always know where they are and what is going on,

(7) Consistency and standards. Use objects and phrases consistently,

(8) Error prevention and make user able to delete or undo, and

(9) Responsive.

These principles are the principle adapted from 10 Usability Heuristics for User Interface Design by Jakob Nielsen (1994) and The Eight Golden Rules of Interface Design by Shneiderman, B., Plaisant, C., Cohen, M., Jacobs, S., and Elmqvist, N. (2016), with more integrated and applicable design principle that could be easier to apply in a system design on the user interface design components.

Table 2. UI & UX Design Principles based on Cognitive Load and UI Theory

Principle	**UI Design Component**					**UX Design Application**
	Colors	**Icons**	**Buttons**	**Contents**	**Navigation**	
P1	√	√	√	√	√	The color that is used is not more than two main colors, and the other colors are to define some actions. The Icons that being used represent the purpose of the icon. The buttons function is represented on the good visual way with the right functions. The contents composition and place is eye-pleasing and not make eye tired from using too many varieties of colors. The navigation is clear.
P2	√	√	√		√	The color, icons, buttons, and navigation are placed nicely on the right side. The name and function of

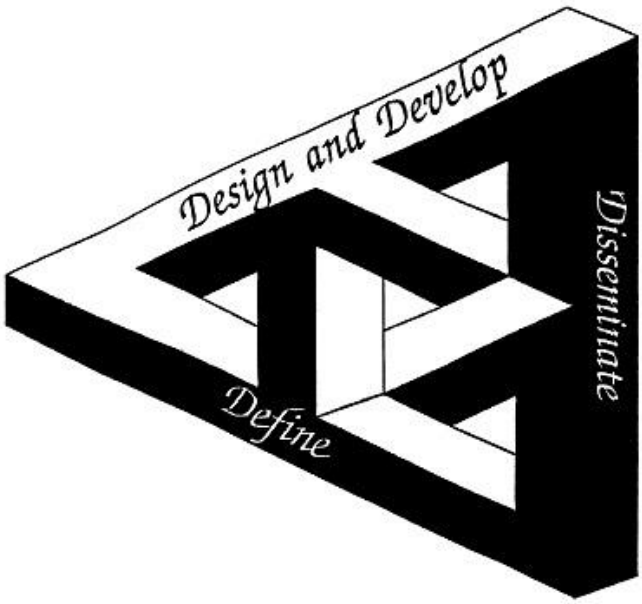
						the button are on the right side of the icon, and with a specific color.
P3	√	√	√	√	√	The Colors, Icons, Buttons, Contents, and Navigation are representing the whole system. No ambiguity of each button and functions, so the user would understand how to use the system.
P4	√	√	√	√	√	The user had different needs, so the system has to provide settings for novice and expert user. The system could show the option before the user enters the system after login, or provide a helping button to set the setting. All of the design elements have to combine well for each type of user.
P5		√	√	√	√	There are a novice and expert users, and each user has different needs when it comes to "help option." The novice user needs more explicit information about how to use the system, while the expert user will be able to use the system with ease, but they still need help especially when they find trouble in using the system. So it is important to include the "help option" on the right corner of the screen into a small icon or "help?" word.
P6	√	√		√	√	Visibility of system status means that the users will know what activity is going on in a system. For

						synchronous system, the user will be able to see the activity happen in real time. Moreover, also, they can choose whether to see other online users status or not.
P7	√	√	√	√	√	All of the elements should represent the system. So it has to be unique but consistent and has a clear standard. Such as the colors, the typography, icons, place settings, and sizes.
P8		√	√	√	√	Give the user scaffold and prompt so it will be easier for the user to use the system in the right and efficient way. We can use AI to prevent the user make some errors, but when they do, we have to provide the option for the user to delete or undo.
P9				√	√	Give the user the maximum function and satisfaction by make the responsive system. The responsive system is related to the connection if it is online and also the fast action right after the user decides to click on specific buttons or post a comment or do other activities in the system. Provide some information that the user could read when they want.

2-4 Reflective, Recursive Design and Development Model (R2D2)

R2D2 Model, as presented by Lebow (1993), is a C-ID Model. This model reflects the values of constructivism through collaboration, personal autonomy, generativity, reflectivity, active engagement, personal relevance, and pluralism. The R2D2 acronym represents Recursive, Reflective Design, and Development. Willis makes it clear that he is not proposing hard and fast rules or procedures in the spirit of true constructivism (Willis, 2009, p. 283).

Figure 2. R2D2 Instructional Design Process (source: Dick, 1996)



The figure above is known as basic procedures graphically as or an impossible triangle that presented by Willis (2009). With this triangle aspect will ensure the non-linearity of the model and also allows entry to the procedures from any positions. The developer and designer group would work on these three aspects intermittently and recursively. The aspects are defined as below;

(1) Define (this aspect involves three activities)

a. Creating and supporting the team as a participant. This activity involves in selecting the group member that would be involved in the Instructional Design process. Each

team member had to develop a sense of empowerment and realize they have equal input. Each team member needs a full awareness of all aspects of the design and makes contributions in all decisions. The team is working collaboratively together.

b. Progressive problem solution. This means that all of the aspects of the design process will be addressed in a general way at the same time when each aspect will affect another aspect. This progressive problem solution will lead to the emergence of more explicit objectives and specific solutions in a continuous spiral.

c. Developing Contextual Understanding. This will lead to solutions that are direct to the focus of the analyzed and implemented context of the design. It will lead to a better understanding of the applicable solutions for the design focus.

(2) Design and Development (In this process, will allow constant feedbacks and have three main activity);

a. Selection of a Development Environment. In this activity, the researcher has to decide design tools like software and hardware. Then after that on the process of design, the designer combines together all of the components into a single prototype. The designer could revise and modify the prototype and allows for recursion and revision of previous steps.

b. Cooperative Inquiry. In this activity, the design team will do constant and cooperative research and reflection among all team members through formative evaluation to improve their work and final prototype product. In this activity, there is no quantitative goals are set, and the quantitative goals will be set and measured through subjective data collections, interviews, etc. That will require feedbacks from each member and revision.

c. Product Design and Development. In this activity, involves the planning and development process of overall instructional techniques that will be used on the

Instructional Design process for the product. It can be students or user-centered to make it easier to conduct a practical instructional approach.

(3) Dissemination. In this last step, the design team members focus on planning the methods for distributing the final product, and also provide and developing the guidelines to make the product meet the customer or user's needs.

Botturi et al. then summarize the R2D2 principles according to the theory as follows;

(1) Recursion: is the steps/elements that are revisited at different times, and decisions can be made anew after that.

(2) Reflection based on feedback and ideas from many sources from literature research or discussion, which is contrasted with the linear design rationality of linear models.

(3) Non-linearity, focal points instead of steps (e.g., a bit like the Kemp design model).

(4) Participatory design: the whole idea behind this model is that the ID process is not only the designer's job but more teamwork, in which different people collaborate to make a better prototype.

In this research, the researcher used this R2D2 model to develop and enhanced the previous version/the first prototype to the second version. With this model, the designer and the observant are working together to develop the prototype as a design team. The design team works collaboratively in developing the second version of the synchronous argumentation system, and the user's opinion will help the developers to enhance the prototype. This model is suitable to provide the correlation about Synchronous Online, Cognitive Load, and R2D2 Model, UI UX theory in terms of developing the framework because it provides the precise steps and purposes through all of the activity. The steps are practical and efficient to be applied to this kind of research that only has limited time to develop the product.

CHAPTER III
RESEARCH METHOD

This chapter aims to present the research method and implementation that consist of eight sections; (1) Research subjects, (2) research instrument, (3) Data collection and analysis, (4) Research design framework, (5) User Experiment Activities, (6) R2D2 design process, (7) Implementation of 9 design principles, and (8) Final design of the system.

3-1 Research Subjects

Research subject or research participant is a person who participates in human subject kind of research by being the subject and target of observation by the researcher. In this study, the research subject has to meet the requirements to be a human research subject. The requirements are;

(1) Familiar with a computer, internet, and online learning tools.

The system is a synchronous online argumentation system, so it will require someone who has knowledge and experience of using a computer, internet, and online learning tools.

(2) At the age of 16 to 18 years old (High School students)

According to educational psychology theory and principles, students at this age are developing their critical thinking, mindset, and goal setting. If they developed their creativity and social skill at a younger age, then at the age of 16 to 18, they will define their perspective of more complex and abstract subjects, which means they need to learn how to process new ideas, how to improve their performance and how to deal with a problem. The developed system is a synchronous argumentation system, so students at this age meet the criteria to use the system, according to their ability, psychology, and their learning activity at school.