Collaborative Mobile Seamless Learning (CMSL) based on Android Apps to Improving Critical Thinking in Higher Education in the Post-Covid-19 Era

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Abstract--- Pandemic COVID 19 made a change implementation of the higher education system from traditional learning to online learning. The problem is online learning was still conservative, so it has an impact on the lack of social interaction and critical thinking skills of students. Thus, this paper focused on the design and development of mobile seamless learning (MSL) based on android apps that integrated with collaborative learning. The type of research is research and development aimed at developing collaborative mobile seamless learning (CMSL), testing the validity, and effectiveness of those products. The app was tested by 3 expert judgment and one group students to find its effect on critical thinking skills and student performance. The findings showed that the application CMSL had good validation from learning media experts have scored 87%, validation from subject matter experts have score 89%, and validation from Instructional designers expert have scored 89%. It is included in the validity level criteria which are very valid and suitable to be implemented. Affectivity testing showed that the application had a positive effect on critical thinking skills and students' performance. Analysis of the paired sample t-test from critical thinking skill found a significant difference (p = 0.000, t (30) = 15.570, α < 0.05) between the pretest score (mean = 61.40, SD = 10.36) and the posttest score (M = 80.27, SD = 7.80). The findings also showed that 6 Critical Thinking Elements (Interpretation, Analyzing, Evaluating, Inference, Explanation, and Self-Regulation) have significant differences (p = 0.000) between the pre-test. This study contributes to how to integrate collaborative learning and mobile seamless learning critical thinking framework in courses higher education "Play and Game in Early Childhood Education".

Keywords--- Collaborative Mobile Seamless Learning, Critical Thinking Skill, Mobile Apps.

I. Introduction

COVID phenomenon has changed the education system from traditional to online (eLearning). Online education or referred to as e-learning allows learning to be done from a distance away to take advantage of the digital platform. Research shows that learning online has been proven to increase retention of information and take over a bit of time in Post-COVID-19 Era (Zaharah et al, 2020). The use of the eLearning function in educational practices has the aim of increasing effectiveness and efficiency (Bolstad, 2004). Learning that is fast, effective, and efficient is the purpose of learning that it focuses the mastery of the material as quickly and thoroughly. Learning that emphasizes the processes of determining students participate actively so that independence and productivity learn more and increase the time to learn efficiently (Setyosari, 2006: 4). This can be implemented with a mobile android based seamless learning model. Seamless learning is learning without limits, a learning approach that is characterized by continuity experience learning through a series combination of location, time, technology, or the background behind the social, the device is a mobile personal (smartphone) as a mediator (Wong, 2015). Chan et al, (2011) explained that seamless learning is all learning activities that are characterized by the continuity of learning experiences through the context of the study were different by using the technology of mobile.

The use of mobile seamless learning as a distance learning solution is the right solution in the COVID era 19. But in practice, there are still some shortcomings in the use of e-learning that lack of involves interaction or social aspects and critical thinking skills especially in higher education (El-Seoud et al, 2014). The purpose of arrange of

higher education is to produce graduates who have higher-order thinking skills (HOTS) so they can solve problems in their lives (Bridgstock, 2009).

Critical thinking skills, is a skill that brings accuracy in making consideration and making the best decision because it's based on productively, logically, reflectively, and systematically appeared thinking. Critical thinking skills are beneficial in improving the creativity, analysis skill, ability to make ideas, and self-reflection (Cottrell, 2005: 4). In Indonesia, students' critical thinking skills are still low due to the lack of variation in teaching strategies using critical thinking. Some elements of critical thinking skills such as making assumptions, making inferences, drawing implications, and constructing concepts are still relatively low (Junining, 2016). Considering the importance of social interaction and critical thinking skills, there are need to design mobile app based on the principles of collaborative learning is required by carrying out the Seamless Learning approach.

II.   Background of Problem

2.1 Collaborative Mobile Seamless Learning (CMSL)

Adoption of the technology of mobile and models of learning allows the participant students to learn anytime else they want either as individuals, with students other, a group of small, or a community online that is large (Wong, 2015). Essentially in seamless learning, learners are allowed to collaborate and interact in various ways with friends, colleagues, a source of learning, and the world, the real physical world, and the (virtual worlds). Seamless learning-based mobile android can build understanding repeated in more depth on a material (Milrad, Wong, Sharples, and Hwang, 2013). Seamless learning can only occur if the participant students are willing to be active, productive, and creative in the search for an understanding of the material that is learned in a variety of settings and contexts (Chan et al, 2011: 10).

Designing mobile applications that can accommodate the implementation of collaborative learning must pay attention to the principles of collaborative learning and the tools to be used. The principle of collaborative learning transfer is 1) Students learn in a group and have a sense of relying on the learning process, 2) Relationships between students, 3) Intensive relationships between group members, 4) Sense of personal responsibility for tasks that have been assigned 5) There are knowledge sharing and discussion (Kohen-Vacs, 2016). Based on these principles the design of cellular collaborative learning must have interactive video features, discussion forums, synchronous systems, and video streaming (Håklev, Faucon, Hadzilacos, & Dillenbourg, 2017; Roschelle, Dimitriadis, & Hoppe, 2013).

The use of the model study seamless learning can be done by individuals, groups of small, or a community online that large proven able to increase motivation and ability to improve the outcomes of learning so that seamless learning's since had to be considered as a solution best for various problems of learning (Sharples, 2015). Model study seamless learning can be used to study the nature of academic and non- academic as well as to establish an intact understanding and the process of learning that is sustainable (Kuh, 2011). The use of seamless learning has also proven to be more successful and effective Ozdamli (2013) and more productive (Looi and Wong, 2013) if using a seamless learning model because students can learn according to their respective speeds.

Technology mobile has the potential to mediate seamless learning, which is to create the experience of learning that is connected (Looi et al. 2010). Participants learners can use smartphones - her to record the data, take pictures, upload the data to the online portal and reference them, the device mobile and online portals be a cognitive tool through which they can dismantle tasks, remember information from time to time, and modify their initial thoughts (Milrad et al, 2013). Excellence in seamless learning is, supporting learners to optimize the experience of learning and concern for them to experience the abstract and the concrete (Kuh, 1996). Mobile seamless learning has an impact positively on the development of technology that is changing the paradigm in education, learning develops already outside the context of traditional learning in general. Learning can be used in mobile, without any limitation (Wong, 2015). Students can use various mobile media to support the learning process (Shuler et al., 2013). Students can use a variety of tools such as cloud computing to save the extent to which the material is studied and can continue it at home analysis explanation (Barden & Bygroves, 2017: 6).

2.2 Critical Thinking Skills

Pandemic Covid 19 today has a lot to bring changes to the way of thinking and human behavior, especially in the field of education. Based on data from UNESCO 188 countries around the world have imposed closure (United Nations, 2020). Therefore, it needs the right strategy in the field of education. According to John Moravec (2020) critique of education today is to produce human beings who can think creatively to survive without waiting for

orders or directions from others, learning is now outdated does not correspond to the needs of students in the field, educators cannot measure the ability of student thinking.

The importance of learning critical thinking in students will support the ability and skills to survive students after graduation. Critical thinking is an effective and reliable mental process to get relevant knowledge about the material we are learning (Jensen, 2011). According to Santrock (2011) critical thinking is a process of reflective and productive thinking involving evaluation results that are in accordance with reality. Through learning that hones the ability to think critically students can easily solve their problems in the field. In fact, the ability to think critically will help someone to survive when facing a competition with superior quality, this is supported by the opinion of researchers who claim that success in learning, working, and living in the 21st century will succeed if you have critical thinking skills 21 (Zare & Othman, 2015; Kivunja, 2015; Bermingham, 2015). Students who have the ability and good communication will easily adjust in any circumstances in the context of academic and work environments (Mason, 2007; Rudd, 2007; Kosciulek and Wheaton, 2003). In instill skills that one must truly understand the critical thinking component.

Components or criteria that must be owned by a person in critical thinking by Enis (1991) are abbreviated by the term FRISCO (Focus, Reason, Inference, Situation, Clarity, and Overview). Focus is defined as the main concern or identification of focus, namely students understand the problems given. Reason deals with the identification and assessment of the acceptability of the reasons that students can give reasons based on the experience that happened based on the relevant facts. Inference which is interpreted as an assessment of the quality of conclusions or assumptions that can be accepted reasoning that students can deduce precisely according to the reasons given in support of conclusions. Situation which means the actual situation as students make use of any situation or information appropriate to the problem. Clarity means clarity that students can examine and clarify the language easily understood in solving the problem. Overview, which means checking back, that is, students checking back from the beginning to the end as a whole.

Some research indicates that critical thinking skills are very helpful for students with a variety of approaches, models, as well as different methods. According to Dwijananti and Yulianti (2010) the development of students' critical thinking skills can be increased through problem-based learning in physics courses. In addition to learning is developed through the material to stimulate critical thinking in students (Setyowati, Sari, And Habibah, 2018). Besides that, critical thinking skills can also be developed through problem-based learning by using a mobile app (Ismail, Harun, Zakariat, Mazm., And Salleh, 2018). The use of technology in this Covid Era is needed primarily to assist the learning activities that keep running even if there is no face-to-face in the classroom. Therefore, in this study the authors used Collaborative Seamless Mobile Learning as a solution.

2.3 Mobile Application for Distance Learning

Study on use of applications and mobile devices increasingly rapid progress with lately. The use of smart phones with various features that can be utilized in a variety of learning by each student who has different characteristics, the material can be used specifically by each individual, and the results of the evaluation of student development can be tracked, motivated, and measured at any time (Martinez, 2013) . On the other hand, the use of mobile devices has become part of the activities and experiences every day (Robson, 2013; Traxler, 2013). The study concluded that the use of smart phones has been instrumental in helping the lesson is good for each person or group (Traxler, 2013). In addition, there is an investigation of 400 users of this technology can help information search experts and the overall material required in the field to strengthen their confidence so that the maximum service makes users more satisfied (Ahmad & Orton, 2010). It is getting stronger impact and extent of the use of this technology. In addition, this smart phone technology has also been adapted through a traditional approach by adjusting environmental needs as the main material and location of its use (Godwin-Jones, 2011; Robson, 2013; Traxler, 2010).

The last few years the development of mobile technology in the fields of education, health, and psychology is quite rapidly. Mobile applications are able to overcome the challenges that exist in conventional learning. Williams et al (2007) explain that mobile applications provide a means for parents to gain knowledge and competence in the parenting field. Incorporating smartphones into parent training programs shows a high level of satisfaction, because they can access material anytime and anywhere (Collins, Kashdan, & Gollnisch, 2003). In terms of the cost of conducting training programs, mobile applications have been proven to be able to minimize costs because they can access limited information (Cason, 2009; Harper, 2006; Karp et al., 2000; Luxton et al., 2011; Robinson, Seale, Tiernan, & Berg, 2003). Soares and Langkamp (2012) some weaknesses of mobile applications are the length of response and consultation activities outside the schedule which causes a small number of consultants. Jones et al. (2014) the application of cellular technology in distance learning must consider the characteristics of users

associated with initial knowledge and skills currently possessed. By understanding the characteristics of the user it can discuss instructional design appropriately so that learning has high effectiveness (Salas et al., 2012). But the most important thing besides instructional design and user characteristics is the implementation and controlled learning process so that it can be learned (Luxton et al. 2011).

III.   Design and Development of CMSL

This research uses Ghirardini (2011) design and development model. It is selected because it has structural and systematic steps in developing e-learning and mobile learning. Ghirardini model is a modification of ADDIE that has the same main phase analysis, design, development, implementation, and evaluation.

3.1 Analysis

3.1.1 Need Analysis

At this stage, the extent of application user mastery and knowledge about courses "Play and Game in Early Childhood Education" will be identified. This identification can be done by distributing questionnaires to users. From the results of this analysis of needs, it can be seen that the need for this application is very high.

Table 1: Question Need Analysis

No	Item	Mean
1	Student's level of knowledge about the course "Play and Game in Early Childhood Education"	1.37
2	The availability of reference sources for the course "Play and Game in Early Childhood Education"	1.40
3	The student ability in operation android applications	1.43
4	Support from the department to facilitate the implementation of CMSL	1.47
5	Availability of learning media	1.30
6	Availability study groups that support distance learning activities	1.50
Mean Total		1.41

Overall the value of the level of need analysis is at an average of 1.41 and is in the category of very need. Based on the six indicators item number 5 "availability of learning media to learn course games in early childhood" is the main factor in developing collaborative mobile seamless learning (CMSL) based on android apps.

Table 2: Results of Needs Analysis of Each Individual

No	Range of Marks	Category	Number of Students	Percentage
1	3.25-4	No Need	0	0%
2	2.5-3.24	Less Need	0	0%
3	1.75-2.49	Need	1	3%
4	1-1.74	Really Need	29	97%
Total			30	100%

Based on the need analysis it can be seen that the majority of respondents have categories needed with 29 students or 97% and needed 3% or 1 person. So it can be concluded that potential users need this application.

3.1.2 Analyzing the Target Audience

In analyzing the target audience, it is necessary to identify various factors that can be used as a reference for the design and implementation of a mobile android based CMSL. Target audience analysis

Table 3: Question Target Audience Analysis

No	Item	Mean
1	Suitability of the CMSL application with the students need/problem	3.50
2	Students interested in the CMSL application	3.47
3	User skills in operating android mobile	3.37
4	Appropriate CMSL application with the course and student schedules	3.17
5	Internet network availability	3.40
6	User hardware (smartphone) ownership	3.43
7	Understanding of users about similar applications	3.57
Mean Total		3.41

Table 3 shows that from 7 (seven) questions related to the target user analysis, 6 of them included the "very capable of implementation" category and one question in the "capable of implementation" category. Overall the value of the level of need is at an average of 3.41 and is categorized as "very capable of implementation".

Table 4: Results of Target Audience Analysis of Each Individual

No	Range of Marks	Category	Number of Students	Percentage
1	3.25-4	Very capable of implementation	27	90%
2	2.5-3.24	Capable of implementation	2	7%
3	1.75-2.49	Less capable of implementation	1	3%
4	1-1.74	No capable of implementation	0	0%
Total			30	100%

Based on the analysis of the target audience it can be seen that it is very capable of implementation which means users can implement CMSL applications as learning media.

3.1.3 Task and Topic Analysis

1. Identifying Tasks,

CMSL was developed based on the latest references and credible research or journal. Credible information is the responsibility of the developer to provide lecture material that can be accounted for. These activities include:

- Identifying theoretical reference, empirical reference, and juridical reference sourced from clear, and up to date sources, and credible. The reference includes: 1) Books on the psychological of child development, 2) Books about early childhood education games, 3) Book about stimulation and development phase, 4) Books about playing psychology, 5) Laws and government regulations early childhood education.
- Gathering sources, classifying and classifying them into a neatly arranged material framework

2. Classifying Tasks

The developer makes information and instructions on how to use the product. This information contains learning objectives from the material that has been compiled. This stage describes Classifying content elements helps to further recognize connections between them thus contributing to the refinement of the draft course outline.

- Explain the advantages of the delivery strategy and technology of the developed material product
- Develop a basic guideline for the use of developed material

3. Breaking up the tasks

In this section the developer make a design that has effective reports for decision-makers, providing them with recommendations based on analysis results and design guide assessing student performance.

4. Identifying Required Knowledge

Design effective reports for decision-makers, providing them with recommendations based on analysis results, such as a) Define the communication purpose, b) Identify users' information requirements, c) Construct a message logically and persuasively, d) Choose a report format according to the context, e) Write the report clearly and concisely.

3.1.4 Design

1. Learning Objectives

In the analysis section, the general objectives and main focus of the CMSL application were determined. Furthermore, these general objectives are spelled out the specific objectives of the material so that it can then be developed into a more complete Android Mobile Based CMSL material. Special learning objectives are operated in the form of verbs ranging from knowing, understanding, applying, analyzing, evaluating, to creating an idea or ideas.

2. Defining the Course Sequence

In this section, the developer will rank general learning goals and specific learning objectives based on a hierarchy or prerequisite material that must be mastered first. Certain material will be placed in the first position and must be mastered first because it becomes a prerequisite for mastery of further material. Sorting criteria and material developed based on the following Chapters:

Chapter 1 Basic concepts of play and game

Chapter 2 Theory of play and game in early childhood education

Chapter 3 The development of play and game in early childhood education

Chapter 4 Various of play and games in early childhood education

Chapter 5 Educational game tools

Chapter 6 Source and learning media in early childhood education

3. Instructional Strategy

The design of learning strategies in this research development is focused on how to apply appropriate learning strategies so that the effectiveness of learning activities can be achieved. In this research development, learning design is implemented in the form of training designs that contain material, methods, media, time allocation, assessment strategies. The learning methods used in utilizing and mastering material from the CMSL application use a combination of several learning methods which include: Collaborative learning.

4. Defining the Delivery Strategy

The delivery strategy is ways that are used to convey learning to users, as well as to receive and respond to user input. Thus, this strategy can also be called a strategy for implementing the learning process. In the delivery strategy for learning activities based on CMSL, there are several factors to consider, namely:

A. User-Related Factors
- Availability of resources, tools, and comfort factors in accepting student material.
- User Skill Level, if a user has difficulty learning video streaming, alternative alternatives can be found such as the availability of the material download menu.
- Time available, different time availability and timeliness for educators and users is one obstacle in learning activities so that it can replace it with asynchronous activities.

B. Technological Aspects

The capabilities, infrastructure, and connectivity possessed by each user need to be considered before making the technology system used. Developers need to understand whether users have easy access to network systems, but some users who do not have a good internet connection must have available material that can be stored offline such as eBooks so that they can be opened anywhere.

C. Organizational Aspects

Various factors originating from the organization can also hamper developers in developing and implementing products including issues of policy, licensing, availability of time and budget, personnel, and availability of available facilities and infrastructure.

5. Defining the Evaluation Strategy

One important aspect that must be considered in developing the CMSL application is determining the strategy and type of evaluation. In contrast to conventional classes, the characteristics of asynchronous learning activities that can be done anywhere and anytime allow users to give assignments or evaluations at any time.

3.1.5 Development

A. Content Development

CMSL activities are very different from conventional learning activities based on face to face. Interaction limitations require that the material developed must have specific criteria. The main criteria that must be considered by developers in developing CMSL applications include:

- The material must have a detailed description contained in the general objectives and special objectives
- Material Contains specific and detailed information due to the limited number of face-to-face meetings with the user to explain the material
- The material presents accurate, quality and credible source information
- There is material or supporting information from the main material in the form of links or other sources that are loaded on the website
- Equipped with various illustrations/images, animations/videos so that the material is not abstract.
- Clear content classification and material structure
- System for developing evaluation tools

B. Storyboard Development

There are two Storyboards in the CMSL application divided into two parts, namely the storyboard material and the navigation system storyboard. Storyboards help researchers to determine work steps in developing CMSL.
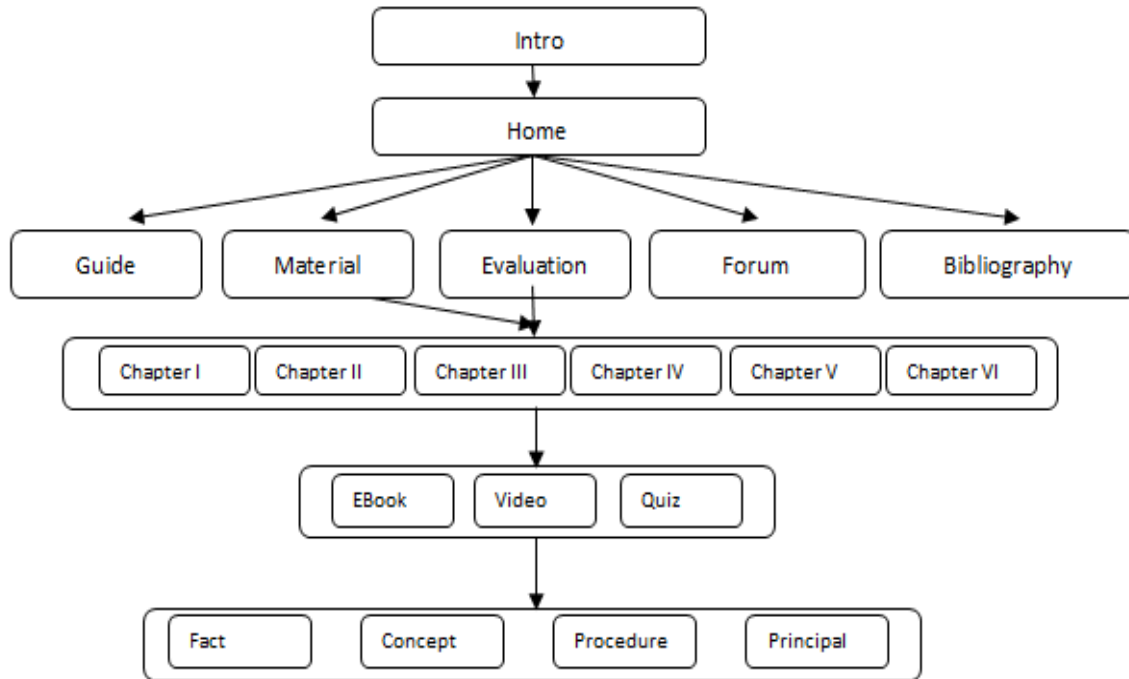
Figure 1: CMSL Application Storyboard

C. Courseware Development

Develop CMSL applications that require various types of software such as data processing to the development software.

- Text data: Microsoft office word and excel
- Graphics: Corel draw and Adobe Photoshop
- Animation: Flash
- Application CMSL: eclipse

1. Results of CMSL Product Development Based on Android Mobile

- Opening intro scene, intro contains information about the name of the program, contains a description of the material.
- Main menu, at the scene of the main menu (home), there is a nine buttons menu, where the buttons will deliver users navigate through the application CMSL.
- Material menu, the material consists of three menus, namely eBook material, video material, and practice questions.
- Evaluation menu, then after the user chooses one of the menus, questions will come out of the six chapters. Questions are divided based on the chapters in the book chapters.

Figure 2: Result CMSL Product Development

3.1.6 Implementation

At the implementation stage there are two main activities namely Installation and distribution and Managing Learner's Activities. The first activity aims to share applications with users through the Google Play Store. while the second activity accommodates students downloading and doing learning activities through the application.

3.1.7 Evaluation

A. Validation Expert Judgment

1. Review from Learning Media Experts

To determine the appropriateness of an application, an assessment was carried out by media experts who were qualified as users of Educational Technology who taught the CMSL application at the State University of Malang and was carried out on 28-30 June 2020. The instrument developed in the media expert category was divided into 54 items.

Table 5: Results of Learning Media Expert Validation

Dimension	Element	Item	Percentage
1. Learner	a. Motivation	1, 2, 3, 4, 5	85%
	b. Technology skills	6, 7	75%
	c. Time issue	8, 9	75%
	d. Experience with CMSL	10, 11	88%
	e. Accessibility	12, 13, 14	92%
	f. Written Communication	15	100%
2. Content	a. Accuracy	16, 17	88%
	b. Update	18	50%
	c. Relevancy	19	75%
	d. Content presentation	20	50%
	e. The format of text	21, 22, 23	100%
3. Delivery Mode	a. Navigation	24, 25, 26	67%
4. Technology	a. Technology requirements	27, 28, 29	100%
	b. Time zone issues	30	100%
	c. Security	31, 32	100%
5. Design	a. Size and composition	33, 34	75%
	b. Graphic Quality and illustration	35, 36, 37,38, 39, 40, 41, 42, 43	94%
	c. Layout	44, 45, 46, 47, 48, 49	96%
	d. Typography	50, 51, 52, 53, 54	95%
Total Average			**87%**

Based on the results of the assessment, the application is in the Very good category (can be used without revision) 86% - 100%.

2. Review from Subject Matter Experts

Material expert validation serves to assess the level of validity of the material contained in the CMSL application Based on Android Mobile. The instruments developed in the material expert category are divided into 29 item.

Table 6: Results of Subject Matter Experts Validation

Dimension	Element	Item	Percentage
1. Content Feasibility	a. The suitability of the contents with the goals or targets	1, 2, 3	83%
	b. Material Accuracy	4, 5, 6, 7, 8, 9, 10	89%
	c. Material Updates	11, 12, 13, 14, 15	85%
	d. Encourage curiosity	16, 17	88%
2. Feasibility of presentation	a. Presentation technique	18, 19	75%
	b. Supporting the presentation	20, 21	100%
	c. presentation of learning	22	100%
3. Linguistic quality	a. Simple	23, 24, 25	100%
	b. Conformity with Language Rules	26, 27	100%
	c. Use of terms, symbols or icons	28, 29	75%
Total Average			**89%**

Based on the results of the assessment, the application is in the Very good category (can be used without revision) 86% - 100%.

3. Review of Instructional Design Expert

Validation of instructional design serves to assess how much the degree of validity and suitability of the instructional design with the psychological aspects contained in the CMSL application. The instruments developed in the learning expert category are divided into 14 item.

Table 7: Results of Instructional Design Expert Validation

Dimension	Element	Item	Percentage
1. Aspects of visual psychology	a. Display	1, 2	75%
2. Communication Design	a. Communicative	3	100%
	b. Dialogical and Interactive	4, 5	100%
	c. Conformity with User Development	6, 7	75%
3. Context assessment	a. Contextual Nature	8, 9	100%
	b. Contextual Components	10, 11, 12, 13, 14	85%
Total Average			**89%**

Based on the results of the assessment, the application is in the Very good category (can be used without revision) 86% - 100%.

IV.   Methodology

4.1 Objective and Type of Research

This study uses a Pre-experimental design with a type of One-Group Pretest-Posttest design by giving a pretest before being treated. The main objective of this study was to answer the following three research questions:

- How to design and develop collaborative mobile seamless learning (CMSL) based on android apps in higher education?
- How to validate collaborative mobile seamless learning (CMSL) based on android apps with learning media experts, subject matter experts, and instructional designers expert?
- What are the effects of collaborative mobile seamless learning apps on students' critical thinking?

4.2 Samples and Instruments

The CMSL application was tested with 30 students in Malang State University, Indonesia, using purposive sampling with criteria for students taking Play and Game in Early Childhood Education courses.

The achievement-test was developed according to the Syllabus from the department early childhood education at Malang State University with 6 chapters and the Critical Thinking elements based on the cognitive level by Facione (1990).

Table 8: Number of Question

Construct	Cognitive Level	Chapter	Item No.	Total of Item
Critical Thinking Elements (Facione, 1990)	Interpretation	I, II, III, IV	1, 2, 3, 4	4
	Analyzing	I, II, III, IV	5, 6, 7, 8	4
	Evaluating	I, II, III, VI	9, 10, 11, 12	4
	Inference	I, II, V, VI	13, 14, 15, 16	4
	Explanation	III, IV, V, VI	17, 18, 19, 20	4
	Self-Regulation	II, III, IV,V,VI	21, 22, 23, 24, 25	5
Total of Questions				25

Explanation: I: Basic concepts of play and game, II: Theory of play and game in early childhood education, III:

The development of play and game in early childhood education IV: Various of play and games in early childhood education, V: Educational game tools, VI: Source and learning media in early childhood education

Table 9: Result of Validity and Reliability Test

Cognitive Level	Item No.	Item Total Correlation	Cronbach's Alpha
Interpretation	1, 2, 3, 4	0.716-0.887	0.895
Analyzing	5, 6, 7, 8	0.664-0.853	0.864
Evaluating	9, 10, 11, 12	0.775-0.811	0.889
Inference	13, 14, 15, 16	0.725-0.918	0.932
Explanation	17, 18, 19, 20	0.689-0.735	0.811
Self-Regulation	21, 22, 23, 24, 25	0.756-0.834	0.867

4.3 Data Analysis

1. Normality Test

A normality test is done to test whether the research sample is a type of normal distribution or not. The way to detect whether residuals are normally distributed or not is to use graph analysis. Data normality test in this study used the Kolmogorov Smirnov test and was tested using SPSS.

$P < 0.05$ there is not normal

$P > 0.05$ there was normal

2. Paired sample t-test

Hypothesis testing in this study uses a paired sample t-test. A paired sample t-test is used if the data is normally distributed. Independent sample t-test is one of the testing methods used to assess the effectiveness of the treatment by pretest and posttest. The basis for the decision to accept or reject Ho in the paired sample t-test is as follows:

If the probability (Sig) <0.05 then Ho is rejected and Ha is accepted. If the probability (Sig) > 0.05, then Ho is accepted and Ha is rejected.

V. Findings and Discussion

Table 10: Results of the Pretest and Posttest

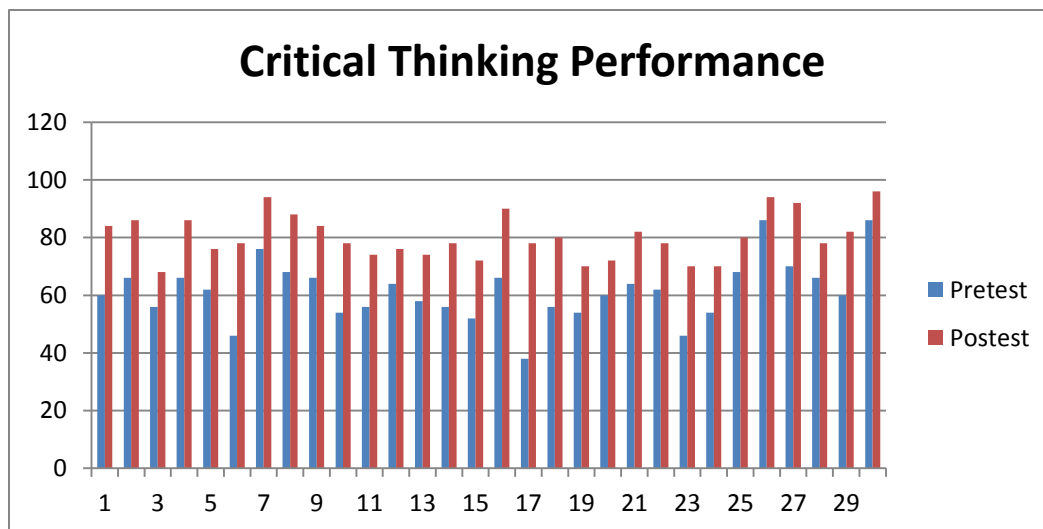| Level	Range of Marks (%)	Number of Students	
		Pretest	Posttest
Excellent	80–100	2	14
Good	60–79	16	16
Moderate	40–59	11	0
Weak	20–39	1	0
Very Weak	0–19	0	0
Average		61.4	80.27
Minimum		38	68
Maximum		86	96
Standard Deviation		10.36	7.805

Figure 3: Critical Thinking Performances

Based on table 10 show the lowest pretest score is 40, the highest score is 86, with an average score 61.4. Post-test data obtained from the learning outcomes after all the learning material is delivered. Post-test scores with the number of 30 students can be seen with the lowest score is 68; the highest score is 96, with an average score is 80.27.

Table 11: Normality Test

One-Sample Kolmogorov-Smirnov Test	Pretest	Postest
N	30	30
Mean	61.40	80.27
Std. Deviation	10.36	7.80
Test Statistic	0.129	0.148
Asymp. Sig. (2-tailed)	0.200	0.094

After learning is done using the CMSL application on "play and game in early childhood education" subjects. Then the next step is to test the hypothesis whether there is a difference between the pretest and posttest. The paired sample t-test was analyzed through the SPSS 24.0 for Windows program using paired sample t-test with a significance level of 0.05.

Table 12: Test Hypotheses with the T-Test

Cognitive Level	t	Sig. (2-tailed)	Explanation
Interpretation	5.120	0.000	Significant
Analyzing	4.564	0.000	Significant
Evaluating	4.173	0.000	Significant
Inference	2.981	0.000	Significant
Explanation	2.344	0.000	Significant
Self-Regulation	2.489	0.000	Significant
Critical Thinking Performances	**15.570**	**0.000**	**Significant**

Analysis of the paired sample t-test from critical thinking skill found a significant difference (p = 0.000, t (30) = 15.570, α < 0.05) between the pretest score (mean = 61.40, SD = 10.36) and the posttest score (M = 80.27, SD = 7.80). The findings also showed that 6 Critical Thinking Elements (Interpretation, Analyzing, Evaluating, Inference, Explanation, and Self-Regulation) have significant differences (p = 0.000) between the pre-test. This study contributes to how to integrate collaborative learning and mobile seamless learning critical thinking framework in courses higher education "Play and Game in Early Childhood Education".

CMSL has an interactive component like video features, discussion forums, synchronous systems, and video streaming yang memungkinkan terjadinya proses collaborative learning Peer learning (Toping & Ehly, 2001), since it addresses the potential of knowledge production through social communication and interaction especially knowledge sharing and discussion dapat meningkatkan kemamapuan berpikir kritis siswa (Håklev, Faucon, Hadzilacos, & Dillenbourg, 2017; Roschelle, Dimitriadis, & Hoppe, 2013). Learning that utilizes e-learning and other information technologies has features to develop collaborative learning models of learning activities in distance learning (Jara et al., 2009). The features available at CMSL can facilitate the interaction of students to be active in learning activities through the chat and discussion forum features (Macdonald, 2003). In addition, teaching and learning activities that involve students to develop their own way of learning, become active students (Amhag & Jakobsson, 2009; Hew & Cheung, 2008). Anderson and Simpson (2004) show that discussion activities in cyberspace can be more productive because students are more free and have the same time and opportunity in renewal.

VI. Conclusion

In summary, the results show that the positive effects of CMSL on student critical thinking skills. That is because CMSL has features such as interactive video features, discussion forums, synchronous systems, and video streaming that allow students to carry out discussions and share knowledge. Of the six aspects of cognitive level in critical thinking all increase significantly. But the highest increase in Interpretation while the higher the Cognitive Level, the lower the increase. This shows that there are still weaknesses of CMSL in improving critical thinking. This can be the basis for further research to add other features that allow students to interact freely in virtual learning.

Conflict of Interest

The author would like to declare that there is no conflict of interest in this study.

References

[1]   Ahmad, N., & Orton, P. (2010). Smartphones make IBM smarter, but not as expected. *Train Dev,* 64(1), 46-50.

[2]   Amhag, L., & Jakobsson, A. (2009). Collaborative learning as a collective competence when students use the potential of meaning in asynchronous dialogues. *Computers & Education,* 52(3), 656–667.

[3]   Anderson, B., & Simpson, M. (2004). Group and class contexts for learning and support online: learning and affective support online in small group and class contexts. *The International Review of Research in Open and Distance Learning,* 5(3).

[4]   Barden, O., & Bygroves, M. (2017). "I wouldn't be able to graduate if it wasn't for my mobile phone." The affordances of mobile devices in the construction of complex academic texts. *Innovations in Education and Teaching International,* 1–11.

[5]   Bermingham, M. (2015).Clearing up "Critical Thinking": *Its Four Formidable Features. Creative Education,* 2015, 6, 421-427.

[6]   Bostald, 2004. The role and potential of ICT in early childhood education A review of New Zealand and international literature. *Wellington : Council For Educational Research Te Rūnanga O Aotearoa Mō Te Rangahau I Te Mātauranga*

[7]   Bridgstock, R. (2009). The Gradutae Attributes We've Overlooked: Enhancing Graduate Emplybility Through Career Management Skills. *Higher Education Research & Development,* 28(1), 31-44.

[8]   Cason, J. (2009). A pilot telerehabilitation program: Delivering early intervention services to rural families. *International Journal of Telerehabilitation,* 1, 29-38.

[9]   Chan, Tak-Wai dkk. 2011. One-To-One Technology-Enhanced Learning: An Opportunity For Global Research Collaboration. *Research and Practice in Technology Enhanced Learning.* Vol 01, no 01 pp3-29

[10]   Collins RL, Kashdan TB, Gollnisch G. The feasibility of using cellular phones to collect ecological momentary assessment data: Application to alcohol consumption. *Experimental & Clinical Psychopharmacology.* 2003;11:73–78.

[11]   Dwijananti, P., & Yulianti, D. (2010). Development of students' critical thinking skills through learning problem based instruction in environmental physics courses. *Indonesian Physics Education Journal, 6(2).*

[12]   El-Seoud M., Taj-Eddin I., Seddiek N., El-Khouly, N., Nosseir, A. 2014. E-Learning and Students' Motivation: A Research Study on the Effect of E-Learning on Higher Education. *International Journal of Emerging Technologies in Learning (iJET).* Vol 9, No 4 (2014)

[13]   Ennis, R.H. (1996). A Critical Thinking. *New York: Freeman*

[14]   Ghirardini, B. 2011. E-learning methodologies A guide for designing and developing e-learning courses. *Government of Germany and implemented by FAO (Food and Agriculture Organization of the United Nations)*

[15]   Godwin-Jones, R. (2011). Emerging technologies: mobile apps for language learning. *Language Learning & Technology,* 15(2), 2-11.

[16]   Håklev, S., Faucon, L., Hadzilacos, T., & Dillenbourg, P. (2017). Orchestration graphs: Enabling rich social pedagogical scenarios in MOOCs. *In Proceedings of the Fourth (2017) ACM Conference on Learning@ Scale (pp. 261–264). ACM.*

[17]   Harper, D. C. (2006). Telemedicine for children with disabilities. *Children's Health Care,* 35, 11-27.

[18]   Hew, K. F., & Cheung, W. S. (2008). Attracting student participation in asynchronous online discussions: a case study of peer facilitation. *Computers & Education,* 51(3), 1111–1124

[19]   Ismail, N. S., Harun, J., Zakaria, M. A. Z. M., & Salleh, S. M. (2018). The effect of mobile problem-based learning application DicScience PBL on students' critical thinking. *Thinking Skills and Creativity,* 28, 177-195.

[20]   Jara, C. A., Candelas, F. A., Torres, F., Dormido, S., Esquembre, F., & Reinoso, O. (2009). Real-time collaboration of virtual laboratories through the Internet. *Computers & Education,* 52(1), 126–140.

[21]   Jensen, E. (2011). Brain-Based Learning. New Teaching Paradigm. *Jakarta: PT Index.*

[22]   Jones DJ, Forehand R, McKee LG, Cuellar J, and Kincaid C. (2010). Behavioral Parent Training: Is There an "App" for That? *Journal Behav Ther (N Y N Y).* 2010 Apr; 33(4): 72–77.

[23]   Junining, E. 2016. Developing Critical Thinking Skills in Language Teaching: *Oral Interpretation Class. PROSIDING ICTTE* Vol 1, Nomor 1, January 2016

[24] Karp, W. B., Grigsby, R. K., McSwiggan-Hardin, M., Pursley-Crotteau, S., Adams, L. N., Bell, W., Kanto, W. P. (2000). *Use of telemedicine for children with special health care needs. Pediatrics,* 105, 843-847.

[25] Kivunja, C. (2015). Using De Bono's Six Thinking Hats Model to Teach Critical Thinking and Problem Solving Skills Essential for Success in the 21st Century Economy. *Creative Education,* 2015, 6, 380-391.

[26] Kohen-Vacs, D. (2016). A design and development approach for deploying web and mobile applications to support collaborative seamless learning activities. *Doctoral dissertation, Linnaeus University Press.*

[27] Kosciulek, J. F., & Wheaton, J. E. (2003). *On critical thinking.*

[28] Kuh, George D. 1996. Guiding Principles for Creating Seamless Learning Environments for Undergraduates. *Journal of College Student Development, v37 n2 p135-48 Mar 1996 Learning? A Crtical Review of The literature. Computers & Education.* 57.4.2364-2381

[29] Looi, C.-K., Seow, P., Zhang, B., So, H.-J., Chen, W., & Wong, L.-H. 2010. Leveraging mobile technology for sustainable seamless learning: A research agenda. *British Journal of Educational Technology,* 41, 154–169.

[30] Looi, Chee-Kit dan Wong, Lung-Hsiang. 2011. What Seams Do We Remove in Mobile-Assisted Seamless Learning? *A Critical Review of the Literature.* Vol 57. 2364-2381.

[31] Luxton, D. D., McCann, R. A., Bush, N. E., Mishkind, M. C., & Reger, G. M. (2011). Mhealth for mental health: Integrating smartphone technology in behavioral healthcare. *Journal Professional Psychology: Research and Practice,* 42, 505-512.

[32] Macdonald, J. (2003). Assessing online collaborative learning: process and product. *Computers & Education,* 40(4), 377–391.

[33] Martinez, M. (2013). Adapting for a Personalized Learning Experience. In R. Huang, Kinshuk & J. M. Spector (Eds.), Reshaping Learning: *Frontiers of Learning Technology in a Global Context (pp. 137-174). London: Springer Science+Business Media*

[34] Mason, Mark. (2007). Critical Thinking and Learning. *Journal Compilation Philosophy of Education Society of Australasia* (Nomor 343 tahun 2007). Hlm. 339-349.

[35] Milrad, M., Wong, L., Sharples, M., & Hwang, G. (2013). Seamless Learning: An International Perspective on Next Generation Technology Enhanced Learning. In Z. Berge & L. Muilenburg (Eds.), Handbook of Mobile Learning (pp. 95–108). *New York: Routledge. Models Volume III, Building a Common Knowledge Base.*

[36] Moravec, J. W. (2020). International education in the era of COVID-19: Making learning visible. *Sociální pedagogika Social Education,* 8(1), 38-42.

[37] Otero, N., Milrad, M., Rogers, Y., Santos, A.J., Veríssimo, M. and Torres, N. 2011.'Challenges in designing seamless-learning scenarios: affective and emotional effects on external representations', *Int. J. Mobile Learning and Organisation,* Vol. 5, No. 1, pp.15–27.

[38] Ozdamli, F. dan Cavus, N., .2013. Basic Elements and characteristic of Mobile Learning, *WCETR,* 1, 28, 937 – 94

[39] Robinson, S. S., Seale, D. E., Tiernan, K. M., & Berg, B. (2003). Use of telemedicine to follow special needs children. *Telemedicine Journal and e-Health,* 9, 57-61.

[40] Robson, R. (2013). The Changing Nature of E-Learning Content. In R. Huang, Kinshuk & J. M. Spector (Eds.), Reshaping Learning: Frontiers of Learning Technology in a Global Context (pp. 177-196). *London: Springer Science+Business Media*

[41] Rogers, Y. and Price, S. (2009) 'How mobile technologies are changing the way children learn', in A. Druin (Ed.), Mobile Technology for Children. *Morgan Kaufmann,* pp.3–22.

[42] Roschelle, J., Dimitriadis, Y., & Hoppe, U. (2013). Classroom orchestration: Synthesis. *Computers & Education,* 69, 523–526.

[43] Rudd, R., Baker, M., Hover, T. (2000). Undergraduate Agriculture Student Learning Styles And Critical Thinking Abilities: Is There A Relationship? .*Journal of Agricultural Education.* Vol. 41 Issue 3, 2000

[44] Salas, E., Tannenbaum, S. I., Kraiger, K., & Smith-Jentsch, K. A. (2012). The science of training and development in organizations. *Psychological Science in the Public Interest,* 13, 74-101.

[45] Santrock, John W. (2011). Child Development 7th Edition Volume 2. (Translation: Sarah Genis B) Jakarta: Erlangga. Seow, P., Zhang, B.H., So, H.,J., Looi, C.-K., Chen, E. 2008. Towards A Framework for Seamless Learning Environments. *Proceeding*

[46] Setyosari, Punadji. 2006. Theory and Application: On Line Learning Systems in Learning. *Faculty of Education, State University of Malang.*

[47] Setyowati, R. N., Sari, M. M. K., & Habibah, S. M. (2018, October). Improving Critical Thinking Skills of Students through the Development of Teaching Materials. *In 1st International Conference on Social Sciences (ICSS 2018).* Atlantis Press.

[48] Sharples, M et al 2015 Mobile and Accessible Learning for MOOCs. *Journal of Interactive Media in Education,* 2015(1): 4, pp. 1-8.

[49] Shuler, C., Winters, N., & West, M. (2013). The Future of Mobile Learning: Implications for policy makers and planners. *Paris: UNESCO.*
Retrieved from http://www.unesco.org/new/en/unesco/themes/icts/m4ed/mobile-learning-resources/unescomobilelearningseries/

[50] Soares, N. S., & Langkamp, D. L. (2012). Telehealth in developmental-behavioral pediatrics. *Journal of Developmental and Behavioral Pediatrics,* 33, 656-665.

[51] Traxler, J. (2013). Mobile Learning: Shaping the Frontiers of Learning Technologies in Global Context. In R. Huang, Kinshuk & J. M. Spector (Eds.), Reshaping Learning: *Frontiers of Learning Technology in a Global Context (pp. 237-251). London: Springer Science+Business Media*

[52] United Nation. (2020). Policy Brief: *The Impact of COVID-19 on children.*

[53] Williams GC, Lynch M, Glasgow RE. Computer-assisted intervention improves patient-centered diabetes care by increasing autonomy support. *Health Psychology.* 2007;26:728–734.

[54] Wong, L.-H. 2015. A brief history of mobile seamless learning. In L.-H. Wong, M. Milrad, & M. Specht (Eds.), *Seamless Learning in the Age of Mobile Connectivity (pp. 3–40). Singapore: Springer.*

[55] Zaharah, Kirilova, G., Windarti, A. (2020) Impact of Corona Virus Outbreak Towards Teaching and Learning Activities in Indonesia. *Journal of Social & Culture Syar-i FSH UIN Syarif Hidayatullah Jakarta* Vol. 7 No. 3 (2020), pp.269-282

[56] Zare, P. & Othman, M. (2015). Students' Perceptions toward Using Classroom Debate to Develop Critical Thinking and Oral Communication Ability. *Asian Social Science;* Vol. 11, No. 9; 2015.