The Efficacy of Students' Knowledge Construction Process in Computer-Supported Collaborative Learning (CSCL) Environment: A Malaysian View

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***Abstract*—The present educational system must be digitalised in light of the growth of communication technology and the current confined lifestyle caused by the pandemic's expansion. However, efforts to digitise education usually encounter two major issues: first, the applications developed are more likely to emphasise the qualities of graphics and animations; second, the multimedia presentation highlighted in the application is a stereotype that causes users to become bored. Thus, the purpose of this research was to look into the effects of Computer Supported Collaborative Learning (CSCL) as a medium for knowledge construction in the School Based Assessment (SBA) environment using the Collaborative Portfolio Assessment (CPA) learning system. The sample comprised 61 students from two Malaysian secondary schools partaking in the History teaching and learning (T&L) process utilising the CPA learning system. The value of Sig. (p-value) was 0.000, less than 0.05, based on the results of the pre and post-test evaluations for both groups of students. In essence, there is a substantial difference in the average test scores of the children before and after the intervention. According to the data, all selected students received an average grade of 80% or better on their 13 task question marks, indicating a good grade on the task questions. Finally, all students interviewed believed that the CPA learning system helped with their studies, especially in learning more about the History subject through quizzes, group projects, and discussion sessions.**

***Index Terms*—Computer supported collaborative learning (CSCL), knowledge construction process, school based assessment (SBA)**

I. Introduction

In the context of education, assessment is an inquiry method to determine the level of learning, a method to obtain and collect important feedback, a process of evaluating students in an educational context, a process of documenting teaching approach and technique, a cyclical process and knowledge, skills, attitudes, and beliefs, an important continuing to evaluate Teaching and Learning (T&L), a method to determine how T&L are best continuously and as a diagnostic and evaluative tool [1].

This assessment process impacts students because the goal is to motivate students to work hard based on the encouragement provided by the teacher or the environment [2]. Effective assessment assists teachers in determining the level of students' learning and the effectiveness of teachers' instructions. Teachers are given autonomy to carry out a formative assessment, which is an assessment carried out during the learning process, and a summative assessment, which is carried out at the end of a school-based learning unit.

Malaysia's assessment system is divided into two forms. First, the Malaysian Examinations Board manages a centralised assessment directly. Second, an internal assessment is conducted continuously in the classroom as part of the T&L process by the respective subject's teacher [3]. The two types of assessment practised are centralised assessment and internal assessment, as defined by Shepard [4].

School-Based Assessment (SBA) is an assessment system designed by the Ministry of Education (MoE) Malaysia that aims to shift the emphasis from public examinations to assessing student performance at the school level. This assessment system combines the current central examination system and school-based assessment, with teachers playing a significant role in assessing their students' T&L processes. It is hoped that this evaluation system will assist teachers in determining their students' performance through various informal methods and psychometric tests, such as diagnostics, general ability, and aptitude tests so that excellent students can progress faster and weak students can learn more interestingly and smoothly [5].

However, some issues and challenges have occurred in SBA, such as students' disinterest in learning, teachers' lack of time in planning assessment activities, and the continuation of the process of T&L often interrupted [6]. Moreover, only a few teachers are ready to implement SBA because they lack the opportunity to learn and practice the techniques. These have caused teachers to evaluate the product rather than the process of facilitating T&L [7].

SBA expects teachers to improve the quality of T&L and the assessment method [8]. SBA appraises students' achievement as high or low, increased or decreased, and determines whether students require enrichment or remediation. The assessment process should be carried out by gathering information to improve the quality and effectiveness of T&L.

Teachers must prepare individual student development files and showcase files in SBA management. The student's progress file is a document that contains complete evidence from all subjects completed by the student [9]. Each student is required to maintain an individual student development file, which is kept by the school. The showcase file contains the students' best evidence in all subjects, and each class will only have one showcase file. Therefore, teachers require a proper learning system to assist them in delivering their T&L

Manuscript received November 24, 2022; revised February 13, 2023; accepted March 10, 2023.

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process while recording all of the students' learning evidence.

On the other hand, Computer-Supported Collaborative Learning (CSCL) seeks to integrate collaborative learning into the classroom as a medium for more effective communication in collaborative learning, using technology to improve interaction with peers and cooperation within groups [10]. Most CSCL research aims to identify an effective method of interaction to assist students in groups in achieving their desired learning objectives, such as explanation, clarification, and conflict resolution. CSCL is a method or approach to learning science that emphasises how humans can learn and how to learn collaboratively with the assistance of computers [11].

For years, some research has focused on how CSCL strategy designs can assist learning, how students acquire knowledge through CSCL interaction, and what teachers or schools can learn from employing CSCL strategies to meet instructional goals [12]. According to Hmelo-Silver *et al.* [13], CSCL aims to foster knowledge-building and co-construction, necessitating careful structuring and guidance of learning and teaching activities. This is because CSCL typically provides tools that allow sharing of information and ideas and the distribution of knowledge among group members [14].

In fact, with the rapid advancement of learning technology, the CSCL application could be extended to function with various learning devices, such as tablet PCs and mobile phones. Moreover, CSCL can be implemented through synchronous and asynchronous, text-based, and video-based online collaborative learning, as well as other assortments of devices, besides taking place in campus-based classrooms (i.e., face-to-face). As such, CSCL connects learners in diverse locations by enabling them to interact and collaborate with individuals beyond the geographical and temporal range of their social interactions with the availability of a variety of technology [13].

According to Hmelo-Silver *et al.* [15], the three pillars of CSCL in education are the nature of collaboration, the technology used, and the pedagogical designs. This means that CSCL should be understood as a triptych that begins with learning and thus requires pedagogy and takes place through computers [16]. Hence, CSCL is about learners learning together with the support of computers connected via a computer network (e.g., the Internet, etc.).

However, using or not using a computer for collaborative learning is not an automatic way to achieve learning objectives. Knowledge construction could be aided by CSCL learning methods that engage students in collaborative learning through computer-mediated networks [17]. Thus, the purpose of this study is to examine the effects of the CSCL as a medium for students' knowledge-construction process in the SBA environment via the Collaborative Portfolio Assessment (CPA) learning system. The CPA learning system was created using the knowledge management process model and the CSCL strategy and e-portfolio management system approach implemented through Moodle.

The progression of this work will be articulated as follows: Section II begins with a review of previous works related to the objectives of the current work. Section III presents the methodological aspects, beginning with the development of the CPA learning system, the participants, and the procedure, and progressing to the statistical analysis of the acquired data, where the results are presented. Section IV describes the main study results, and Section V discusses the study's results. Finally, the conclusions are discussed in Section VI.

II. Related Work

Undeniably, computers and digital have always supported learning, but the recent proliferation of digital technologies and virulent diseases like the COVID-19 pandemic makes the role of those tools even more critical. With the increased adoption of digital learning systems during the health crisis, ensuring that the system design can increase students' motivation and engagement to obtain the required educational goals is critical. Accordingly, there should be an integration of socially oriented technology tools into the design of collaborative learning systems to boost the engagement and performance of the students during the T&L process [18]. Sustainable educational modes would allow academic institutions to thrive by adjusting learning tactics and implementing technological features used during the pandemic.

Collaborative learning with computer support, namely Computer Supported Collaborative Learning (CSCL), is an approach that has been increasingly used in education. However, research indicates that its application in an Information and Communication Technology (ICT) environment in primary schools is still challenging for teachers [19]. There are some prevailing arguments on the theory that CSCL can assist students in developing knowledge by utilising computer-mediated networks, and numerous studies have been conducted to support this assertion.

A study on the use of collaborative learning procedures, whether or not with a computer network, found that they had significant effects on students' cognitive and social development procedures; yet, it is not used in secondary schools due to a lack of pedagogical skills required to implement the collaborative learning process and a lack of teaching materials [20]. Additionally, Zheng *et al.* [21] revealed that the timing of socially shared monitoring influences the success of collaborative learning, which has implications for teaching practices and adaptive scaffolding group learners in CSCL.

As for now, the incorporation of the technical, instructional, and knowledge artefacts as Social Network Analysis (SNA) actors and relating SNA findings to cognitive, social, and motivational CSCL outcomes using statistical analysis should be focused on the future CSCL directions [22]. Changing pedagogies and evolving technologies have merged to create many new CSCL opportunities in classrooms. This assertion is similar to Zheng, Zhang, and Gyasi's [23], who claimed that new technologies are emerging that will expand the possibilities for collaboration and provide prospective learning opportunities in richer ways, such as providing flexible and immediate feedback.

Wongta, Grosseau, and Yachulawetkunakorn *et al.* [24] indicated that the orientation approach, which integrates the benefits of content topics and collaborative learning with applications and mobile devices through a series of training approaches, could promote students' creativity and process in different aspects. Teachers must also understand how to effectively implement strategies to provide the best learning experience for students by making learning fun. According to Fatimah *et al.* [25], it is challenging for many teachers to adopt CSCL as they must be familiar and conversant with the current online teaching platforms, fine-tune their syllabi and instructional approach, and adjust to the digital era.

Furthermore, Yilmaz and Yilmaz [26] highlighted that the use of the CSCL strategy has a significant impact on students' motivation, metacognitive awareness, and group processes toward their learning performance. This remark is congruent with the findings of Hashim *et al.* [27], who stated that the qualities of the CSCL strategy aid students in developing high-level knowledge during the teaching and learning process, resulting in more effective learning.

Likewise, CSCL enables students to contribute insight from their point of view or developmental zone into group work. This results in a feedback loop in which individual knowledge differences contribute to group meaning-making [28]. According to Fatimah *et al.* [25], student perception of CSCL via the digital platform is mandatory during the pandemic and positively associates with students' personalities and cultural beliefs. Furthermore, during the pandemic, teacher professionalism, such as features and intentions in implementing technology in teaching, plays an important role, forcing educators to transform their lessons into online versions in a short period [29].

The heart of the learning process, which determines the success of any learning endeavour, is known as knowledge construction. Knowledge construction is important to determine the learning process's effectiveness in the cognitive learning and constructivism traditions because it focuses on how humans process information and transform it into knowledge [30]. Rahman [31] discovered that critically examining other people's ideas during an online discussion could aid in the knowledge-construction process. One of the important aspects found in online environments that facilitate student engagement in knowledge building compared to face-to-face discussions is ways to overcome psychological barriers.

The CSCL learning process will be more appealing if it can be used as an interactive process in which students try to comprehend the information and integrate it into something they already know. The CSCL method is also expected to assist the process of assessment, which can increase students' motivation to learn better, help teachers to give more meaningful lessons, enhance the school system efficiency, and improve students' knowledge construction process more efficiently [32].

CSCL learning strategies often discuss perspectives on problems to build knowledge. Students should be encouraged to actively participate in their knowledge construction process, whether inside or outside the classroom, that is relevant to their daily lives and becomes part of the knowledge construction process that includes direct instruction from the teacher and individual study [33]. If the CSCL strategy can be applied, T&L will become more attractive, which could improve student performance.

Given the gaps revealed by the literature review, this work is guided by the following three research questions:

- Can students build their knowledge in CSCL environments through information provided by the Collaborative Portfolio Assessment (CPA) learning system?
- Can the CPA learning system adequately support student tasks in CSCL environments?
- Can the treatment provided by the CPA learning system help students understand more about the learning content?

The answers to the above research questions should assist in demonstrating the relevance of educational data from the CPA learning system to the academic community and assist institutions in implementing their strategies for sustainable digital transformation in education.

This study's research objective is not limited to assessing the CPA learning system as a medium for students' knowledge construction during T&L. It also seeks to provide feedback to teachers and suggest steps or actions implemented in their teaching to ensure students access to new knowledge while their engagement and satisfaction are being promoted, regardless of the learning environments, such as face-to-face, remotely, etc.

III. Methodology

This study is based on a randomised experimental design (also known as pre-experimental) study in which each respondent received a pre-test, treatment, and post-test. Furthermore, this research was conducted with the collaboration of two parties, namely teachers and students. The method is used to investigate the effectiveness of the Collaborative Portfolio Assessment (CPA) learning system in developing students' knowledge based on pre-test and post-test results. Students were given a brief explanation before being asked to use the provided system. Four meetings were held, each lasting approximately one hour and thirty minutes, to complete the planned learning activities. After four weeks of learning and teaching, all students were given a post-test and assignment questions.

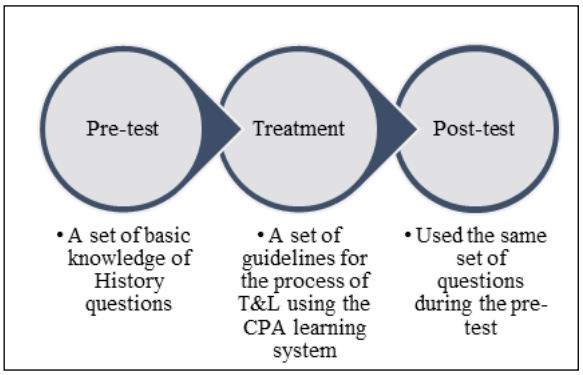

Fig. 1. Flow chart depicting the processing methodology used [34].

In addition, the assignments for the three students who

scored the highest improvement in the post-test compared to the pre-test were analysed in the form of scores, and an interview was conducted with them to support the statement that the CPA learning system is effective as a medium for the process of building knowledge in helping T&L. These students were selected based on the purposeful sampling strategies as its implementation in research can be used to identify cases from standardised questionnaires for in-depth follow-up [35]. Studying the knowledge-building process in this CPA learning system can help students and teachers carry out tasks that need to be completed as one of the School Based Assessment (SBA) elements. Furthermore, each term from the students' interview process was analysed through thematic analysis.

A. Participants

In all, 61 students and two teachers from a secondary school in Malaysia participated in this study, as shown in Table I. The pre- and post-tests for both of the study's student groups were examined for normalcy. The Shapiro-Wilk normality test data for the pre-test for group one's data has a significant value of 0.160. Because the value is higher than the chosen alpha threshold of 0.05, the null hypothesis is accepted. Therefore, it is possible to infer that the pre-test data is typical. Using the Collaborative Portfolio Assessment (CPA) learning system, respondents of this study went through the T&L process for the topic of History. The teachers and students in Malaysia were chosen for this study using a purposeful sample technique to include a wide spectrum of potentially pertinent social phenomena and viewpoints [36]. In order to meet the researchers' needs, this approach employs a few layers of sample selection by classification. The researcher divided the local schools with computer labs into groups before selecting those offering information and Communication Technology Literacy (ICTL) classes to first-grade students. Discussions with the authorities of each school are required to determine which classes will participate. Teachers and students from these two schools comprise the study sample chosen by the researchers.

TABLE I: RESPONDENTS' DISTRIBUTION OF STUDY BY SCHOOL

School	Sample
School A	A teacher and 28 students
School B	A teacher and 33 students
Total	2 teachers and 61 students

B. Procedures

The students were briefed before being requested to utilise the provided Collaborative Portfolio Assessment (CPA) learning system. For solving learning activities provided by the CPA learning system, which implements a Computer Supported Collaborative Learning (CSCL) learning environment, four meetings were held, each lasting approximately one hour and thirty minutes. The pre-test was given to both groups of students before they used the CPA learning system. In addition, the students were also required to complete the task assessment questions each time after they accomplished an activity in the CPA learning system. After carrying out the learning and teaching process for four weeks, all the students were given a post-test.

1) Pretest and posttest

This study used pre-test and post-test to determine the role of the CPA learning system as a medium for students' knowledge construction during the T&L process. The test questions are based on the T&L process for the History subject and were combined with encoding schemes for knowledge construction questions based on Saidin and Beacon [37], which consist of three levels of questions and three stages of knowledge construction. These questions are pre-checked by a qualified teacher with experience in teaching History subjects to ensure that each question is appropriate and based on the three levels of questions and knowledge construction. All students who participated in this study took a pre-test and a post-test online using the CPA learning system. The following are examples of objective and subjective questions for factual questions that restate knowledge:

"What must a historian do so that historical interpretation can make an event meaningful?" (Objective Question 2)
"What were the main tools used by Paleolithic humans?" (Subjective Question 1)

Next, below are examples of objective questions and subjective comprehension questions to express knowledge assimilation:

"Which of the following is a historic event in your life?" (Objective Question 11)
"State the types of stone tools in the Paleolithic Age in Malaysia?" (Subjective Question 4)

Finally, below are examples of objective and subjective questions and integration questions to express the integration of knowledge:

"Why is a reference to historical sources so important?" (Objective Question 5)
"Why did Metal Age society's beliefs differ from previous societies?" (Subjective Question 10)

Instrumentation issues can be detrimental to internal validity threats for both groups of students who take this pre and post-test. Instrumentation refers to a change in measurement, which is the difference between pre-test and post-test assessment [38]. This means that the item or question in both the pre-test and post-test must be fully reliable and valid, but it may be changed as long as the level of difficulty and contents remain the same. In order to avoid the instrumentation issue, the positions of the questions in the pre-test and post-test are changed.

This type of testing process, namely the test questions or tests to determine behaviour, is carried out to design and measure the achievement of the respondents during the process of T&L [39]. The tests were conducted at the level of 0.05 on the test questions, and the result of the correlation was 0.648. Schober and Boer *et al.* [40] show that a correlation coefficient between 0.10 to 0.29 is considered small, a correlation coefficient between 0.30 to 0.49 is considered moderate, and a correlation coefficient between 0.50 to 1.00 is considered high. Thus, according to Schober *et al.* [40], these test questions can be used during the actual survey as the correlation coefficient for the test questions is

high.

2) The average marks of task questions

In this study, every student received a task question as an assignment question set by the teacher as an instrument to measure their performance through this CPA learning system after completing the learning and teaching sessions. These task questions during the pre/post-test have also been prepared by the knowledge construction encoding scheme, comprising three levels of questions and three stages of knowledge construction based on Saidin and Beacon [37], as shown in Table II. Students attempted to complete all of the task questions assigned within the time limit set by the teacher. After completing all assignment questions, the CPA learning system saved all records of the student's completed work. For each task question, a balanced performance was used to evaluate the scores, which ranged from 0 to 10 and were then converted into a percentage.

TABLE II: DISTRIBUTION OF TASK QUESTIONS BASED ON THE LEVEL OF KNOWLEDGE CONSTRUCTION

Topics	Questions Levels	Items Subtopics
Prehistory	Fact question (Restate of knowledge)	- Expressing the sense of history - Declare the term/concept of time in history - Enlist the purpose of studying history
	Comprehension questions (Assimilation of knowledge)	- Describe the characteristics of history - Describe the historical sources - Describe the methods of history
	Integration question (Integration of knowledge)	- Provide examples of significant events in the history of the country - Using historical sources in studying history - Using the historical method in the study of history
Early State in Southeast East	Fact question (Restate of knowledge)	- Declare stage chronologically Prehistoric Period - Declare early form of government in Southeast Asia
	Comprehension questions (Assimilation of knowledge)	- Describe the characteristics of the community during the Prehistoric Period
	Integration question (Integration of knowledge)	- Describe the characteristics of the community during the Prehistoric Period

3) Thematic analysis for interview questions

In this study, interviews were used to collect qualitative data to assist the researchers in gathering additional data to support the findings in paired *t*-tests and average task question marks [41]. Three students were chosen and interviewed from each group of samples who received the highest increased scores in the post-test compared to the previous pre-test and received consistent average task question marks. Each term from these students' interview process was analysed using thematic analysis.

IV. RESULTS

A pre-test was given to both groups of students in the first week of the meeting. It aims to test students' basic topics knowledge of History subjects in their T&L process. After four weeks of treatment from the instructor via a set of guidelines for the process of T&L using the Collaborative Portfolio Assessment (CPA) learning system, the evaluation of the test was conducted on the students. Following that, these students were tested again with the same set of questions from the pre-test.

A. Analysis of Pretest and Posttest

Students' pre-test and post-test scores are reported individually, tabulated, and analysed. Students' pre and post-test scores were calculated using descriptive statistical methods. This approach used a paired *t*-test to compare the pre and post-test scores. In the early stages, researchers have outlined the results of pre and post-test scores of each student together with differences in their scores. The final marks of student achievement in the pre-test, post-test, and differences in scores full marks representing 100% of both groups are shown in Table III.

TABLE III: STUDENTS' MARKS IN THE PRE-TEST, POST-TEST, AND DIFFERENCES IN MARKS BY GROUP

School A			
Students	**Pre-test Marks**	**Post-test Marks**	**Differences**
1	27	53	26
2	27	47	20
3	30	47	17
4	43	50	7
5	57	50	−7
6	33	60	27
7	40	50	10
8	43	60	17
9	40	63	23
10	23	40	17
11	20	40	20
12	27	53	26
13	33	50	17
14	30	57	27
15	33	50	17
16	43	53	10
17	20	53	33
18	30	40	10
19	40	60	20
20	23	63	40
21	27	57	30
22	33	60	27
23	23	40	17
24	37	53	16
25	43	57	14
26	40	47	7
27	40	57	17
28	37	43	6
Mean	**33.64**	**51.89**	**18.25**
School B			
Students	**Pre-test Marks**	**Post-test Marks**	**Differences**
1	33	50	17
2	40	53	13
3	20	33	13
4	17	33	16

5	23	40	17
6	27	43	16
7	20	23	3
8	27	50	23
9	13	43	30
10	27	40	13
11	30	50	20
12	33	37	4
13	43	57	14
14	30	43	13
15	33	57	24
16	30	50	20
17	13	53	40
18	17	30	13
19	7	37	30
20	20	17	−3
21	20	50	30
22	23	40	17
23	10	30	20
24	30	47	17
25	30	27	−3
26	40	50	10
27	37	40	3
28	30	40	10
29	40	50	10
30	20	57	37
31	27	30	3
32	17	27	10
33	17	17	0
Mean	25.58	40.73	15.15

A total of 61 respondents from the two groups of students took part in the evaluation of the pre-test and post-test. The total percentage for both tests is 100%. For the first group (School A) of students, all students (N = 28) scored an average score of 33.64%, with a mark between 20% and 57% in the pre-test. Their post-test scores have an average score of 51.89%, with marks from 40% to 63%. For the second group (School B) of students, all students (N = 33) scored an average of 25.58%, with marks from 7% to 43% in the pre-test. For their post-test, the scores are within average marks of 40.73% and a range mark between 17% and 57%. The mean percentage difference between the two groups of students shows that student performance has improved after treatment given by the teachers' using the CPA learning system. After proving that the test scores are normally distributed, researchers continue to run the *t*-test analysis. The knowledge construction process through the CPA learning system during learning and teaching can be identified by comparing the scores between pre-test and post-test and testing the following hypothesis:

H0: There is no significant difference in the mean performance of students in the pre-test and post-test.

The purpose of this hypothesis is to determine whether or not there is a significant difference in the mean of student performance between the pre-test and post-test. Inferential statistics are used by researchers to answer this research question. Inferential statistics used in this study is the *t*-test, which is used to test the hypotheses. Tables IV and V show the results of the *t*-test analysis to assess the pre-test and post-test for both groups of samples.

TABLE IV: ANALYSIS OF THE T-TEST FOR PRE AND POST-TEST OF GROUP ONE

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Post test – Pre test	15.152	10.560	1.838	11.407	18.896	8.243	32	0.000

TABLE V: ANALYSIS OF THE T-TEST FOR PRE AND POST-TEST OF GROUP TWO

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Post test – Pre test	15.152	10.560	1.838	11.407	18.896	8.243	32	0.000

The analysis of the results shows that the value of Sig. (P-value) is 0.000, which is less than 0.05 for both groups of samples. This value indicates a statistically significant difference between the mean scores of pre-tests and post-test for both sample groups of students. Therefore, this result rejects the null hypothesis and concludes that the treatment provided through this CPA learning system is effective as a medium for the knowledge construction process in helping T&L.

B. Analysis of Student's Average Marks on Task Questions

In addition, the average marks for each student from each group were analysed to form a summary and conclusion of the current work. The main objective of analysing their average marks on task questions is to use them as supportive evidence besides the data from the pre-test and post-test to support the statement that the CPA learning system is effective as a medium for the knowledge construction process in helping the learning and teaching process. The average marks are taken from the 13 task question marks completed by all participating students during the four weeks of treatment. Three top students from each group that recorded the highest marks and had increased marks in the post-test compared to the pre-test were selected, and their data were analysed, as shown in Table VI.

If the students' marks progress consistently, it gives an overview that the process of knowledge construction has occurred during the T&L process. The researchers concluded that if the average marks of the three students from each group task questions scored are 80% and above, they signify support for the statement that the CPA learning system is effective as a medium for the knowledge construction process in helping the T&L process. Accordingly, the result shows that all selected students acquired an average score of 80% and above from their 13 task question marks; hence, the results support that the CPA learning system treatment is efficacious as a medium for knowledge construction.

TABLE VI: MEAN FOR TASK MARKS FOR SELECTED STUDENTS FROM EACH GROUP

Schools	Samples	Post Test Marks	Difference between Post-test and Pre test	Mean for task marks
A	S 1	53	26	81.64
	S 6	60	27	83.36
	S 20	63	40	94.43
B	S 17	53	40	85.36
	S 24	47	17	82.79
	S 30	57	37	90.86

C. Analysis of Student Interviews

To further support the findings in paired *t*-tests and the data from average marks of task questions of the three students in each group of samples, an interview was conducted with them, and these were some of the responses:

"In this system, there are challenging activities, and I like challenging activities." (Sample 1, Group One)
"It seems fun and helpful because there are quizzes and games in this system." (Samples 20, Group One)

"The discussions in the system allow me to ask the teacher." (Samples 24, Group Two)

Based on these interviews, the consistent theme that emerged was 'helpful'. All students interviewed agreed that the CPA learning system aided them in learning, especially in understanding the concepts in the History topic, which is related to the second interview question regarding what part of the CPA learning system helps them understand the concept in the History subject. Note part received the highest theme, as revealed by half of the interviewed students. Other themes obtained from the part in the CPA learning system are quizzes, collaborative activities, and discussion sessions. Based on the findings during this interview process, it can be concluded that the treatment offered by the CPA learning system is effective as a medium for the knowledge construction process in helping T&L.

V. DISCUSSION

The findings indicate that the study group's post-test scores are higher, demonstrating the effect of the Collaborative Portfolio Assessment (CPA) learning approach on students' learning. This study also demonstrates that, similar to the research by Mohammadyari and Singh [42], the CPA learning system may offer a supportive learning environment and flexibility in terms of place and time, as well as support the user. Tingoy [43] and Ouhrir *et al.* [44] found that Moodle increased student performance, with students receiving a score of at least 80% after using it in their learning.

A teacher's description or explanation of an issue will be easily understood when supported by various materials and technology that may communicate intents with a teacher's description, as claimed by Sandanayake and Bandara [45]. Utilising engaging visuals and tangible examples helps students learn the information better and has a lasting effect on them [46]. All student work completed and signed by a score as a gauge of performance throughout the student as a progress report will be recorded by the CPA learning system. According to the results of the interview procedure, every student interviewed shared the idea that Chapters 1 and 2 of the CPA learning system and a number of its portions help them understand the concept of the History subject. Students must have a solid broad understanding of the historical subject, and the information used must be reliable [47]. This result suggests that the CPA learning system approach to treating T&L is successful as a vehicle for the knowledge development process.

The majority of respondents thought that the online discussion process assisted the knowledge-building process through critical observation of other people's opinions in the discussion session, according to Ghazal and Al-Samarraie *et al.* [48]. This discovery is in line with findings by Saqr and Viberg [49] that student conversations in their study group in the Computer Supported Collaborative Learning (CSCL) learning environment are task-oriented and assist students in completing necessary tasks. Instead of only emphasising learning outcomes, teaching should focus on the process of acquiring knowledge. The presentation of authentic tasks and case-based learning environments, where students have a bigger say in the course of their education, should also be emphasised during the teaching process. The teaching method should also encourage learning-related reflection, support collaborative knowledge development, and enable knowledge construction based on context and content.

These results merely demonstrate the efficacy of CSCL learning methodologies in facilitating the learning process in this study, particularly in online discussion through social networking platforms [50]. Future teachers and the creators of instructional systems will receive immediate feedback thanks to the methods used in this study. The suggested recommendations and action plan are as follows:

- In order to boost students' interest in learning History, it is important to understand the needs of the learners. Restructure the job flow in accordance with the learning objectives, and use one newfound knowledge to pinpoint the crucial challenging spots.
- If necessary, learners should have direct access to particular system components. The access needs to be made clear to prevent misunderstandings.
- The system must be examined, judged, and rebuilt in light of the findings. This implies that the activities made should be scrutinised and, if unsuccessful, adjusted in accordance with the characteristics of the learning environment.

VI. CONCLUSION

In summary, this study demonstrates that the treatment provided by the Collaborative Portfolio Assessment (CPA) learning system is effective and useful as a medium for knowledge construction in assisting the T&L process. When the pre-test and post-test results are compared, students' average marks on the task questions increased by 17%–40%, indicating the CPA learning system's effectiveness as a medium for students' knowledge construction in the T&L process. This finding is similar to the findings on the portal-based collaborative learning method; it also supports

the constructivist theory in learning approaches, which emphasises that the construction of knowledge is better through experience and collaboration.

The use of the provided CPA learning system demonstrates that students' performance in answering questions and completing activities improved. Collaborative learning strategies employed by the CPA learning system are seen to address issues of location and time and provide benefits in terms of academic, social, and psychological impact. Besides, communication with other members of the community helps with socialisation. Thus, polarisations of behavioural patterns achieved through this method should be beneficial when applied in a real-world context.

The study's findings have practical implications for curriculum teams because they improve understanding of how the CPA learning system can be used as an effective e-portfolio tool to promote students' knowledge construction. It is especially critical for academic institutions that have made collaborative learning their primary instructional strategy in the classroom. This study demonstrates that Moodle is a promising tool for scaffolding students' knowledge building.

On another positive note, the result confirmed that students found the CPA learning system useful. Students must be explicitly communicated to perform the tasks using the CPA learning system medium for learning areas related to team selection of key information in the larger problem and subsequent reflection performed on feedback given by various stakeholders. Last but not least, this study demonstrates that the perceived value of learning derived from using the CPA learning system as an effective medium for students' knowledge construction is not solely dependent on examining learners' perceptions of their learning processes. To comprehensively assess the CPA learning system usage in promoting students' knowledge construction, it also necessitates careful orchestration of various domains, such as the technological, the learning process, and the affective aspects.

Nevertheless, the current study has some limitations, despite the three research questions listed in Section II have been duly answered. Although many academic institutions have begun adopting data and analytics, the system has a long way to go before fully demonstrating its potential for improving the learning experience. Further research is required to investigate the effects and patterns of interaction in the CPA learning system by implementing Computer Supported Collaborative Learning (CSCL) learning strategies that facilitate student learning via online discussions.

Because the current study is cross-sectional, future research could be skewed toward a longitudinal approach or mixed methods research on learners' perceptions of learning processes using the CPA learning system as an e-portfolio to support learning. This is important in drawing more firm conclusions about the stability of the research model under consideration. Second, because this study focused solely on the effectiveness of the technology used, the user acceptance of the technological aspects of Moodle could be thoroughly investigated.

While this study provided students' perceptions of Moodle as an effective pedagogical tool for promoting students' knowledge construction, it is also critical to explore teachers' perspectives on the use of the CPA learning system in facilitating learning and potentially investigating the various ways in which it could help in the area of formative or even summative assessment in terms of continuous assessment grading.

Third, this study is primarily quantitative. Qualitative research using a focus group discussion approach could provide more insights into the specific ways students use the CPA learning system in their learning and the challenges encountered when implementing this tool. Interviews with teachers should also be conducted to better understand the constraints that teams encounter when using the CPA learning system to facilitate discussion, sharing, and presentation. Undoubtedly, the learning benefits derived from using the CPA learning system are more important than the trendy implementation of the technological tool. To summarise, this study adds to the literature on learners' perceptions of the value of learning derived from an e-portfolio tool for knowledge building. It expands on the subsequent use of e-portfolios in other lessons as a formative evaluation of learners' learning.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Hashim, S. manages the whole research process from the main idea to the data collection process, discussion, and paper writing; Masek, S. is the mentor and manages all the instruments of the research; N. Z. M. Zahir. is the data analysis expert that manages all data and executes the validation of the whole instruments; Khamis, N. contributes in the literature review and analyses the whole problem background throughout need analysis. All authors had approved the final version.

Funding

Communication of this research is made possible through monetary assistance by Universiti Tun Hussein Onn Malaysia and the UTHM Publisher's Office via Publication Fund E15216, Ministry of Higher Education (MOHE) through Fundamental Research Grant Scheme (FRGS/1/2021/SSO/UTHM/03/3) and Universiti Tun Hussein Onn Malaysia (UTHM) through RE-GG (vot Q198).

References

[1] S. Chen, B. Mulgrew, and P. M. Grant, "A clustering technique for digital communications channel equalization using radial basis function networks," *IEEE Trans. on Neural Networks*, vol. 4, pp. 570–578, July 1993.

[2] H. A. Hornstein, "Student evaluations of teaching are an inadequate assessment tool for evaluating faculty performance," *Cogent Education*, vol. 4, no. 1, 1304016, 2017.

[3] N. H. C. M. Ghazali, "The implementation of School-Based Assessment System in Malaysia: A study of teacher perceptions," *Geografia*, vol. 12, no. 9, 2016.

[4] L. A. Shepard, "The role of assessment in a learning culture," *Educational Researcher*, vol. 29, no. 7, pp. 4–14, 2000.

[5] V. J. Shute and S. Rahimi, "Review of computer-based assessment for learning in elementary and secondary education," *Journal of Computer Assisted Learning*, vol. 33, no. 1, pp. 1–19, 2017.

[6] C. F. Yeap, N. Suhaimi, and M. K. M. Nasir, "Issues, challenges, and suggestions for empowering technical vocational education and training education during the COVID-19 Pandemic in Malaysia," *Creative Education*, vol. 12, no. 8, pp. 1818–1839, 2021.

[7] A. Helfaya, "Assessing the use of computer-based assessment-feedback in teaching digital accountants," *Accounting Education*, vol. 28, no. 1, pp. 69–99, 2019.

[8] W. M. Wan Yusoff, R. Hashim, M. Khalid, S. Hussein, and R. Kamalludeen, "The impact of Hikmah (Wisdom) pedagogy on 21st century skills of selected primary and secondary school students in Gombak District Selangor Malaysia," *Journal of Education and Learning*, vol. 7, no. 6, pp. 100–110, 2018.

[9] M. A. A. Malik, N. I. Madzuki, N. S. S. Hizam, N. H. S. Kamal, N. S. H. C. Yusof, M. F. Suhaimin, and S. N. Zulkifli, "Teachers' readiness and practices in school-based assessment implementation: Primary education in Malaysia," *International Journal of Advanced Research in Future Ready Learning and Education*, vol. 23, no. 1, pp. 1–9, 2021.

[10] J. W. Lin and H. C. K. Lin, "User acceptance in a computer-supported collaborative learning (CSCL) environment with social network awareness (SNA) support," *Australasian Journal of Educational Technology*, vol. 35, no. 1, 2019.

[11] S. Ludvigsen and H. C. Arnseth, "Computer-supported collaborative learning," in *Technology Enhanced Learning*, Springer, Cham, 2017, pp. 47–58.

[12] L. Ingulfsen, A. Furberg, and T. A. Strømme, "Students' engagement with real-time graphs in CSCL settings: Scrutinizing the role of teacher support," *International Journal of Computer-Supported Collaborative Learning*, vol. 13, no. 4, pp. 365–390, 2018, doi: https://doi.org/10.1007/s11412-018-9290-1

[13] H. Jeong, C. E. Hmelo-Silver, K. Jo, and M. Shin, "CSCL in STEM education: Preliminary findings from a meta-analysis," in *Proc. of the Annual Hawaii International Conference on System Sciences, 2016-March*, 2016, pp. 11–20, doi: https://doi.org/10.1109/HICSS.2016.11

[14] S. Charoenwet and I. Zurida, "Self-regulated learning behavior and perception of students participating in EU-SUPPORT social network," *Icaicte*, pp. 137–140, 2013, doi: https://doi.org/10.2991/icaicte.2013.26

[15] C. E. Hmelo-Silver, R. Jordan, C. Eberbach, and S. Sinha, "Systems learning with a conceptual representation: A quasi-experimental study," *Instructional Science*, vol. 45, no. 1, pp. 53–72, 2017.

[16] P. Kirschner, O. U. Nederland, and G. Erkens, "Toward a framework for CSCL research," *Taylor & Francis Online*, January 2013, doi: https://doi.org/10.1080/00461520.2012.750227

[17] A. Weinberger, F. Fischer, and K. Stegmann, "Computer-supported collaborative learning in higher education: Scripts for argumentative knowledge construction in distributed groups," in *Computer-supported Collaborative Learning 2005: The Next 10 Years!* Routledge, 2017, pp. 717–726.

[18] Z. Karnataka, C. Stergiou, G. Bekas, S. Jacques, C. Troussas, C. Sgouropoulou, and A. Ouahabi, "Acquiring, Analyzing and interpreting knowledge data for sustainable engineering education: an experimental study using YouTube," *Electronics*, vol. 11, no. 14, p. 2210, 2022.

[19] B. Tonui, E. Kerich, and R. Koross, "An investigation into implementation of ICT in primary schools, in Kenya, in the light of free laptops at primary one: A case study of teachers implementing ICT into their teaching practice," *Journal of Education and Practice*, vol. 7, no. 13, pp. 12–16, 2016.

[20] T. L. Good and A. L. Lavigne, *Looking in Classrooms*, Routledge, 2017.

[21] J. Zheng, W. Xing, and G. Zhu, "Examining sequential patterns of self-and socially shared regulation of STEM learning in a CSCL environment," *Computers & Education*, vol. 136, pp. 34–48, 2019.

[22] M. Dado and D. Bodemer, "A review of methodological applications of social network analysis in computer-supported collaborative learning," *Educational Research Review*, vol. 22, pp. 159–180, 2017.

[23] L. Zheng, X. Zhang, and J. F. Gyasi, "A literature review of features and trends of technology-supported collaborative learning in informal learning settings from 2007 to 2018" in *Journal of Computers in Education*, vol. 6, issue 4, Springer Berlin Heidelberg, 2019, doi: https://doi.org/10.1007/s40692-019-00148-2

[24] J. Wongta, C. Grosseau, C. Yachulawetkunakorn, C. Watthana, and C. Wongwatkit, "Effects of a collaborative STEM-based orientation approach on senior high-school students' creativity and operacy," *International Journal of Mobile Learning and Organisation*, vol. 15, no. 1, pp. 71–106, 2021.

[25] F. Fatimah, S. I. Rajiani, and E. W. Abbas, "Cultural and individual characteristics in adopting computer-supported collaborative learning during the covid-19 outbreak: Willingness or obligatory to accept technology?" *Management Science Letters*, vol. 11, pp. 373–378, 2021, https://doi.org/10.5267/j.msl.2020.9.03

[26] F. G. K. Yilmaz and R. Yilmaz, "Impact of pedagogic agent-mediated metacognitive support towards increasing task and group awareness in CSCL," *Computers & Education*, vol. 134, pp. 1–14, 2019.

[27] S. Hashim, P. Utami, M. H. A. Rahman, N. F. Jumaat, and D. N. E. Phon, "Knowledge construction process in an open learning system among Technical and Vocational Education and Training (TVET) Practitioners," *Journal of Technical Education and Training*, vol. 11, no. 1, 2019.

[28] S. B. Nolen, "A situative turn in the conversation on motivation theories," *Contemporary Educational Psychology*, vol. 61, 101866, 2020.

[29] I. Van der Spoel, O. Noroozi, E. Schuurink, and S. van Ginkel, Teachers' online teaching expectations and experiences during the Covid19-pandemic in the Netherlands," *European Journal of Teacher Education*, vol. 43, no. 4, pp. 623–638, 2020.

[30] D. E. Schrader, "Constructivism and learning in the age of social media: Changing minds and learning communities," *New Directions for Teaching and Learning*, vol. 2015, no. 144, pp. 23–35, 2015.

[31] S. Rahman, "Knowledge construction process in online learning," *Middle East Journal of Scientific Research*, vol. 8, no. 2, pp. 488–492, 2011.

[32] P. Tchounikine, "Learners' agency and CSCL technologies: Towards an emancipatory perspective," *International Journal of Computer-Supported Collaborative Learning*, vol. 14, no. 2, pp. 237–250, 2019.

[33] D. Adom, A. Yeboah, and A. K. Ankrah, "Constructivism philosophical paradigm: Implication for research, teaching, and learning," *Global Journal of Arts Humanities and Social Sciences*, vol. 4, no. 10, pp. 1–9, 2016.

[34] Z. Kanetaki, C. Stergiou, G. Bekas, S. Jacques, C. Troussas, C. Sgouropoulou, and A. Ouahabi, "Acquiring, analyzing and interpreting knowledge data for sustainable engineering education: An experimental study using YouTube" *Electronics*, vol. 11, no. 14, p. 2210, 2022.

[35] M. Q. Patton, "Qualitative research & evaluation methods," *Sage*, 2002.

[36] M. A. Azizi, "The accountability process of Public Account Committee (PAC) under different ruling parties: A case study Kedah State," Doctoral dissertation, Universiti Utara Malaysia, 2015.

[37] Z. Saidin and S. R. Beacon, "Web 2.0 in Teaching and Learning Malay Language," *in Proc. Malay Language Seminar 2011*, 2011.

[38] S. Jaba, R. Hamzah, A. R. Bakar, and A. M. Rashid, "Acceptance towards school-based assessment among agricultural integrated living skills teachers: Challenges in implementing a holistic assessment," *Journal of Technical Education and Training*, vol. 5, no. 1, 2013.

[39] E. Shafinaz and M. A. Zaharin, "Generic requirements model: School-based assessment and e-portfolio management system," Doctoral dissertation, Universiti Utara Malaysia, 2010.

[40] P. Schober, C. Boer, and L. A. Schwarte, "Correlation coefficients: appropriate use and interpretation," *Anesthesia & Analgesia*, vol. 126, no. 5, pp. 1763–1768, 2018.

[41] D. Barrett and A. Twycross, "Data collection in qualitative research," *Evidence-Based Nursing*, vol. 21, no. 3, pp. 63–64, 2018.

[42] S. Mohammadyari and H. Singh, "Understanding the effect of e-learning on individual performance: The role of digital literacy," *Computers & Education*, vol. 82, pp. 11–25, 2015.

[43] O. Tingoy, "A model for computer supported collaborative learning," in *Proc. INTED 2010, Marmara University (Turkey)*, 2010.

[44] S. Ouhrir, S. Lotfi, and M. Talbi, "Students' views on e-learning and knowledge of learning platforms: Case of a professional license at the higher normal school of Casablanca," *International Journal of Advanced Trends in Computer Science and Engineering*, vol. 8, no. 5, pp. 2282–2288. 2019.

[45] T. C. Sandanayake and A. M. Bandara, "Automated classroom lecture note generation using natural language processing and image processing techniques," *International Journal of Advanced Trends in Computer Science and Engineering*, vol. 8, no. 5, pp. 1920–1926. 2019.

[46] M. Pateșan, A. Balagiu, and C. Alibec, "Visual aids in language education," in *Proc. International Conference Knowledge-Based Organization*, vol. 24, no. 2, pp. 356–361, June 2018.

[47] S. Wineburg, *Why Learn History (When It's Already on Your Phone)?* University of Chicago Press, 2018.

[48] S. Ghazal, H. Al-Samarraie, and B. Wright, "A conceptualization of factors affecting collaborative knowledge building in online environments," *Online Information Review*, 2019.
[49] M. Saqr and O. Viberg, "Using diffusion network analytics to examine and support knowledge construction in CSCL settings," in *Proc. European Conference on Technology Enhanced Learning*, Springer, Cham., September 2020, pp. 158–172.
[50] G. A. Adanir, "Detecting topics of chat discussions in a computer-supported collaborative learning (CSCL) environment," *Turkish Online Journal of Distance Education*, vol. 20, no. 1, pp. 96–114, 2019.