



## Development of A Framework for an Asynchronous Discussion Forum through an E-Learning Platform

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### ABSTRACT

Throughout the last several decades, the digital era has expanded the process of information sharing in classroom instruction in novel and surprising ways with reference to a wide variety of complex challenges. As a result, effective interactive e-learning management is critical for removing barriers to "knowledge acquisition, exchange, and construction" in this global learning community. According to a review of the pertinent literature, digital and social learning platforms, such as learning management systems (LMS), are effective guides for accomplishing comprehensive online learning. Using a quantitative approach, this paper illustrates the authors' efforts to develop a social constructivist framework to facilitate formative assessment of an asynchronous discussion forum on various socio-scientific issues (SSI) among teenagers during the initial phase of the project. A learning management system (LMS) was utilised to collect data on project-based activities that encourage inquiry-based and problem-based learning (PBL) following the "Analyze, Design, Development, Implementation, and Evaluation" (ADDIE) model. Different methods of evaluation were implemented to determine the effectiveness of this approach in facilitating the discussions as well as to observe how students' participation in an asynchronous discussion forum improves their overall level of knowledge construction, interaction, and social network analysis (SNA). The important benefits of sharing information are looked at, and future research, innovative projects, and recommendations are shown and predicted.

**Keywords:** Social Network Analysis (SNA), Socio-scientific Issue, Framework, e-Learning, Knowledge Construction (KC)

## INTRODUCTION

### Background and Overview

As pandemic challenges occur on a regional and international scale, information and communication technologies (ICT) will become essential in all institutions, including early childhood education. Throughout this pandemic, the majority of the world's educational institutions rely on web-based teaching and learning. It's been an excellent opportunity for all of us to recognise our memorandum of understanding that online-based education is beneficial and, in fact, may provide us with a promising educational approach.

## Rationale and Problem Statement

Unprecedented levels of effective teaching and learning have been achieved through the use of web-based technology. To do so effectively, we must remove all obstacles to information transmission and maximise opportunities for collaborative learning in all forms and at all times within the global learning community. To play an active role, educators must possess a specific and comprehensive understanding of the theories, as well as the power to enhance current ICT benefits in addressing contextual problems and socio-scientific issues (SSI).

## Methods

In this article, the author described the initial phase of existing literature into developing an interactive online learning environment through the use of a learning management system (LMS). Additionally, through the use of an asynchronous discussion forum with scaffolded questions and tasks, this study demonstrates the ADDIE Model's instructional design model. The tasks extend to project-based programmes that emphasise inquiry-based learning (IBL) and problem-based learning (PBL). The following are research objectives identified:

1. To propose a conceptual framework that can be built for an asynchronous discussion forum to be operated by a learning management system based on social constructivist theory.
2. To propose a comprehensive analysis method (content analysis, cluster analysis, and social network analysis) that will be used to evaluate the outcome of an asynchronous discussion forum in terms of knowledge construction and participation
3. To identify a suitable platform for knowledge construction through collective and collaborative learning or capacity-building activities with the objective of minimising barriers towards EFA in SEAMEO member countries.

The following are the research questions formulated to guide this study:

1. What is the conceptual framework that can be developed for an asynchronous discussion forum to be operated by a learning management system anchored on social constructivist theory?
2. How could a more productive level of knowledge construction be facilitated with the numerous values-based research data collected?
3. What is the suitable platform for knowledge construction through collective and collaborative learning or capacity-building activities, with the aim of reducing barriers towards EFA in SEAMEO member countries.

## Literature Review

### **Social Constructivism, Theory of Online Learning and Connectivism Theory Involving Knowledge Construction (KC) in E-Learning for All**

Social constructivism supports learning via discussion. Social interaction among learners is key to cognitive and social development. This idea explains how a learner learns through

actively engaging with a knowledgeable person. The notion of a Zone of Proximal Development (ZPD), which is the space between actual and potential development that may be reached with adult direction or with a more knowledgeable peer was proposed by Vygotsky as cited by [1] This ZPD may be done by encouraging, guiding, or reminding pupils to finish a task. Students' participation in group discussion allows them to generalise, transfer information, synthesise ideas, and create understanding to promote learning. This philosophy emphasises feedback to assist in building knowledge.

This study was grounded in the social constructivist theory proposed by Vygotsky as cited by [2]. Students are expected to actively participate in "acquiring" knowledge through meaningful learning and "sharing and applying" their knowledge in daily life as part of the Knowledge Construction (KC) process that promotes deep, rich, and open communication as advocated by [3]. Students will learn via feedback, interaction, and scaffolding. In this research, students are asked to actively construct meaning via online forum conversations. From a social constructivist approach, learning entails building shared knowledge. Numerous studies were also conducted by researchers in line with the concept of KC as proposed by [3], with an integrated approach to capture, evaluate, identify, retrieve, and share the information assets (e.g. databases, documents, policies, and procedures) of an institution. For example, [4] developed an on-line learning hub as a one-stop information dissemination centre in SEARCH for youth science and mathematics researchers. [5] also developed a framework for managing technology-enhanced innovation programmes with exemplars illustrated.

Through interaction, the Theory of Online Learning prepares students for online learning. According to [6], a good learning environment should include student, instructor, and content interaction. This interaction will enhance individual knowledge construction [6]. According to [6], deep and meaningful connections will develop if one of the three modes of interaction (students to instructors, student-to-student, or student-to-content) is high. This study looks at asynchronous communication in a blended learning context. [7] suggested six different kinds of asynchronous forum engagement. Through information sharing, multilateral involvement encourages collaborative learning. The three most common interactions in asynchronous discussion forums are student-instructor (conversation and feedback), student-student (collaborative exchange of ideas, information, and discourse), and student-content (i.e., learning content, course materials). All interactions, including those with content, students, and instructors, take place via the interface (in this case, the computer). For meaningful learning, this online learning theory emphasises collaborative, interactive learning. Asynchronous discussion forums can provide opportunities for students to interact with content (simulation of cognitive), instructors (support and enhance learning), and other students (social interaction) in achieving learning outcomes.

The asynchronous online discussion as advocated in this study will also incorporate connectivism theory and inclusive pedagogical approaches towards blended-mode "Education for All" (EFA). Connectivism was established by George Siemens as a digital learning paradigm for networked learning (Siemens, 2004). Learning, according to this theory, has both cognitive and emotional components. Connectivism emphasises the discovery and curation of fresh knowledge. This philosophy also emphasises information

sharing. Nodes must find reputable resources and identify relevant information in order to participate in critical thinking. In addition, precision and validity may vary. This technique promotes active learning by challenging students to investigate, present, analyse, evaluate, and understand relevant content. Students affect learning, interaction, and communication. Students must be able to identify connections among disciplines, ideas, and concepts (Siemens, 2008). The forum activity enables students to share their expertise while doing research, obtaining reliable new information, and building active learning connections. Connectivism makes it possible for students and teachers to get the most up-to-date information and to learn quickly.

Researchers in the Basic Education Research Unit (BERU), Penang [8] conducted nationwide research studies and revealed that basic education to reach out to all is important to prevent school dropouts at an early stage. Slower learners should be guided by a peer or expert in the Zone of Proximal Development (ZPD) proposed by Vygotsky as cited by [1], and interactive online discussions among students of various academic achievement levels could facilitate better learning outcomes. Connectivism theorists advocate that technology plays a major role in learning and knowledge construction. In fact, constant connectedness gives people opportunities to rethink their choices in learning. The Malaysian educators [9] also stressed the importance of 6 inclusive pedagogical approaches in STEM learning for better inclusive education programmes as one of the targeted missions of the Malaysian Minister of Education to enable equity education for all (EFA). Among the strategies related to the focus of this paper's discussion were flexible methods, group/individualized/peer coaching teaching and learning methods, as well as contextual teaching and learning methods. Efforts to promote lifelong learning among rural youths were also initiated by researchers to transform public libraries into digital knowledge dissemination centres [10].

### **Social Network Analysis (SNA), Knowledge Construction (KC), and Values-Based Research Data Interaction Level in Learning Management Systems**

As a matter of fact, educators should investigate the level of interaction among students as well as the relationship between knowledge construction (KC) and the level of interaction in an online discussion. The levels of students' knowledge construction were observed using a content analysis method which comprises the Interaction Analysis Model or IAM rubric [1] [6], involving five phases extending from the lower level of knowledge construction to higher levels of knowledge construction.

The second method of analysis, is cluster analysis as proposed by [11]. It is a model for assessing students' interaction levels and is used in this research to categorise students' levels of engagement and involvement in an online forum. Opening or reading and responding to postings submitted by other participants is an example of a listening behaviour activity. Four domains involving temporality, breadth, depth, and speaking were determined. Temporality is comprised of four variables: average session length; percentage of sessions with posting actions; average number of sessions per discussion; and average number of reads prior to contributing a post. The depth consists of one variable, namely the average length of time spent reading a post. For the breath domain, it comprises of two variables, namely the percentage of posts viewed at least once and the average number of views per discussion. Speaking involves three variables: the average

number of posts per discussion, the average number of words per post, and the average amount of time spent on making a post.

This research also includes Social Network Analysis (SNA) [12], which investigates connections, interactions, and messages in the forum. The social network study also showed density (the overall level of interaction in the forums). According to [12], network participants may become significant or prominent if they have more direct interaction with other participants (degree centrality), are closer to other participants (closeness centrality), or are in a better position than other participants (betweenness centrality). Centrality in networks measures who's powerful or isolated. In-degree centrality measures the quantity of messages received from others, whereas out-degree centrality measures messages given to others. Closeness centrality measures how well-connected a person is [13]. The closer someone is to others, the lower their closeness value, which means information may be provided directly to them in the network/forum. A greater closeness number indicates that information must transit via additional participants. Betweenness centrality is the degree to which a node is located between other nodes in a network [13]. This participant has the ability to control the flow of information among classmates. High-betweenness nodes have a significant impact on network information flow. Eigenvector centrality measures a participant's interaction with other highly interactive individuals or communication with less active members. The Eigenvector value shows how participants interact and develop strong links with significant or active members. Based on these studies, isolated, at-risk, leaders of information and bridge-building people can be identified.

Finally, a relationship between the level of KC and the social networking built can be detected. Furthermore, any significant relationship between KC level and in-degree and betweenness centrality can be detected. In their studies, [13] found that there were strong and significant relationships between SNA measures (in-degree centrality and out-degree centrality) and the level of knowledge construction.

In addition, educators require a platform such as Moodle to prepare students for 21st century learning as well as to assist them in developing their creativity and their own learning strategies through the integration of technologies [14] to discuss socio-scientific issues (SSI) such as environmental conservation affecting the sustainability of "life below water" (SDG No.14) and "life on earth" (SDG No.15).

From the literature search, the researchers also found that MOODLE is an online learning platform that permits educators to create online courses and also consists of various features of a Learning Management System (LMS) (e.g. quizzes, glossaries, forums, assignments, to name a few) that facilitate students' learning in a safe online learning environment with self-paced/accessed/directed learning achievable by individual students. It is also freely accessible as open source software (under the GNU General Public License). MOODLE is also connected with learning analytics, enabling educators to track their students' progress. For example, activity or resource views, readings, activity resource uploads, postings, and student interactions (Social Network Analysis) (forum posts vs views) and others.

Hence, such tools could facilitate more productive levels of knowledge construction in the focused discussion themes related to values-based sustainable education (VaBSE), such as 'Climate Awareness and Disaster Risk Reduction Education' (CADRRED) and Health and Environmental Education in line with Sustainable Development Goals (SDGs). Some selected SDGs include goals No.3 (Good health and well-being), No.4 (Quality education), No.12 (Responsible consumption and production), No.13 (Climate action), No.14 (Life below water), No.15 (Life on land), and No.17 (Partnerships for the goals) [15]. Addressing SSI, especially in science education, has been the concern of researchers on moral ethics and VaBSE. For example, [16] conducted a study on wildlife ethics and awareness of wildlife conservation in Malaysia. Whereas with VaBSE, integrating cross-curricular teaching and technology-enhanced learning was advocated by reflective practitioners such as [17], [18], and with assessment/evaluation techniques as reported by researchers such as [19] and [20].

Students will be greatly assisted in their participation in an asynchronous discussion forum on SSI issues as global citizens by the use of MOODLE. Three types of analysis will be used to determine the level of knowledge construction, interaction, and participation, which include content analysis, cluster analysis, and social network analysis. Thus, this analysis revealed the effectiveness of an online learning platform that integrates activities from major web-based learning portals in order to address SSI issues through highly interactive digital learning environments. The development of LMS of training is hoped to enable more effective management of web-based learning experiences, thereby promoting international collaboration for ongoing online sharing, capacity-building activities, and innovation management.

## MATERIAL AND METHODS

### Quantitative Research Design and Data Collection

This study used a quantitative research design [21] with three distinct methodologies to examine the levels of knowledge construction, levels of interaction, and interaction patterns in asynchronous discussion forums [22]. The first technique uses content analysis to analyse knowledge construction levels in relation to a student's post or message [23]. The second method uses cluster analysis to look at levels of interaction, or "listening behavior," and then social network analysis to look at how the students interact with each other. For instance, content analysis can provide student cognitive information [6], cluster analysis [24] is able to classify students based on their behaviour patterns [25], and social network analysis describes the pattern of interaction and exchange of information in student circles [26]. All three methods can be used to obtain information that is thorough, in-depth, and comprehensive about student participation in asynchronous discussion forums overall. The topics of discussion that addressed socio-scientific issues (SSI) included climate change (floods, haze), environmental health and disease, conservation, as well as wise use of resources. Scaffolded questions as instruments to collect data were prepared, and during the pilot study, these questions were read by experts to ensure content validity.

The conceptual framework (Figure 1) is grounded in social constructivist learning

theory and supported by online learning and connectivism to assist with this study. Meaningful discussion requires dynamic interaction in a constructivist learning environment. This study presents an asynchronous discussion forum using the Learning Management System (MOODLE). The computer interface in online learning makes it easier for classmates, the teacher, and the course material to communicate and share information. The principles of connectivism are applied by the students in order to produce meaningful learning. Additionally, this study presents three techniques to analyse students' engagement and knowledge construction using three different methods, consisting of content analysis; listening behaviour (categorising students by participation); and social network analysis (SNA). Besides that, this study analyses the links between knowledge construction and social networking, such as centrality and knowledge. [6] claim interaction generates new knowledge.

### **Sampling Techniques and Research Activities**

Secondary students from two schools in Penang and a few schools from the Southeast Asia region were selected as participants of this study. During the workshop and knowledge sharing on the Learning Management System (MOODLE), applications on pedagogies like Inquiry-based Learning (IBL), Project-based Activities (PBA), and Problem-Based Learning (PBL) will be added to each of the above discussion topics. The online platform is intended to facilitate students' participation in the discussion by providing scaffolded questions with time-bound assigned tasks or assignments incorporating IBL, PBA, and PBL and the use of information and communication technology (ICT). Each topic will be carried out for one week of discussion and followed by a formative assessment.

In order to facilitate fruitful discussions with a better learning outcome, various scaffolded questions were designed based on literature review, document analysis, and interviews with practitioners. These questions were also read by experts for content validation during a pilot study conducted over the past 3 months. The following Table 1 summarises the consolidated scaffolded questions with the expectation that numerous values-based research data could be collected in the subsequent phases of study.

**Table 1.** Scaffolded questions designed and validated by content experts in line with SDGs

No.	Topic and sub-theme to promote e-discussions	Scaffolded questions content validated by experts	Reflection on SDGs
<b>Floods</b>			
1	Floods: Causes and their consequences	What is a flood? What factors contribute to floods? What are the consequences of floods?	SDGs No. 4, 13, 15
2	Flood forecasts and warnings	How do we forecast floods? How do we communicate and give warning to each other about floods? How do we estimate the chance of a flood occurring?	SDGs No. 4, 13, 15, 17
3	Managing floods	How do we manage flood risks? How can we reduce the impact of flooding? Where can we get help when we face floods?	SDGs No. 4, 13, 15, 17
<b>Environmental Health and Diseases</b>			
4	Definition	What is environmental health?	SDGs No. 3, 4, 14, 15
5	Importance	Why is environmental health important?	SDGs No. 3, 4, 14, 15
6	Benefits	What are the benefits of optimising environmental health?	SDGs No. 3, 4, 14, 15
7	Impact on health	How can environmental factors impact personal health?	SDGs No. 3, 4, 14, 15
8	Pollution	List (a) two environmental factors that have an impact on your health and (b) how to protect yourself.	SDGs No. 3, 4, 14, 15
9	Ultraviolet (UV) rays	List (a) two environmental factors that have an impact on your health and (b) how to protect yourself.	SDGs No. 3, 4, 15
10	Noise	List (a) two environmental factors that have an impact on your health and (b) how to protect yourself.	SDGs No. 3, 4, 15
<b>Global Climate Change</b>			
11	Definition	What is climate change?	SDGs No. 4, 13
12	Measurement	How is Climate Change Measured Over Time?	SDGs No. 4, 13
13	Causes	What causes climate change?	SDGs No. 4, 13
14	Effects	What are the effects of global climate change?	SDGs No. 4, 13
15	Health threat	List down the biggest health threat facing humanity as a result of climate change	SDGs No. 3, 4, 13
<b>Natural Resources</b>			
16	Negative impact	What impact do people have on not conserving natural resources?	SDGs No. 4, 12, 15
17	How to conserve	How can we conserve and protect our natural resources?	SDGs No. 4, 12, 15, 17
18	The importance	Why is it important to conserve natural resources?	SDGs No. 4, 12, 15
19	Consequences	What will happen if we are successful or not successful in conservation of our natural resources?	SDGs No. 4, 12, 15
20	Traditional method	How were natural resources conserved and protected traditionally?	SDGs No. 4, 12, 15
21	Community responsibility	What responsibilities did the community have as a whole to conserve natural resources?	SDGs No. 4, 12, 15, 17
22	Individual responsibility	What responsibilities does the individual have as a whole to conserve natural resources?	SDGs No. 4, 12, 15

## Conceptual Framework for an Asynchronous Discussion Forum

The thorough review of pertinent literature anchored on social constructivist and connectivist theories enabled the researchers with the development of a conceptual framework as illustrated in Figure 1.

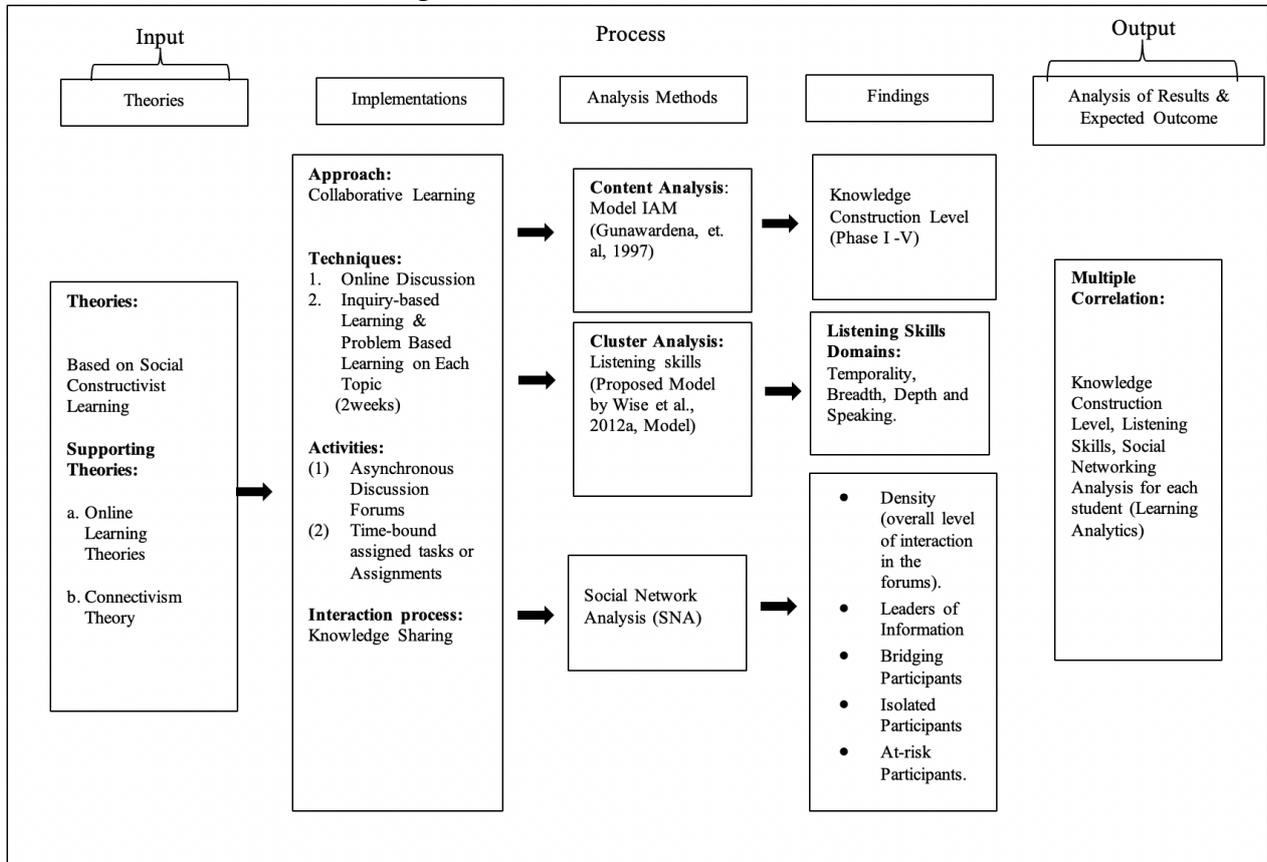


Figure. 1. An extended framework that integrates knowledge construction level, listening skills and social networking [12][21][24]

## CONCLUSION

### Summary, Significance and Implications

This article outlines the authors' preliminary initiative in developing a platform with a scaffolded framework and monitoring tools to assist students in online discussion associated with global citizenship in line with SDGs, particularly in the area of socio-scientific issue (SSI)-based problem-solving activities.

The findings of this study have implications for the LMS platform's efficacy in fostering knowledge construction in lower secondary science students via asynchronous online discussion. This conceptual framework may greatly aid and contribute to instructors using a collaborative approach in monitoring students' participation and social interaction levels. Additionally, the analysis incorporates three different methods in order to provide the most detailed information on knowledge construction, interaction, and participation as a whole.

The combination of methodology or approach enables the analysis of the subject in the comprehension of the values of different types of analysis in obtaining data from multiple sources in order to gain a more complete understanding of the investigation. As such, in asynchronous forums, content analysis, cluster analysis, and social network analysis approaches may offer even more comprehensive insights on student engagement levels. When a combination of content analysis tools is used with social networking, it is possible to get information that covers both the cognitive and social components of an online environment.

### Limitation and Suggestions for the Way Forward

However, each of the abovementioned analyses has its own limitations, which can be compensated for by applying a more comprehensive research methodology for data collection. Thus, this is a necessary first step toward establishing a platform with a scaffolded framework and monitoring tools that will prepare students to overcome constraints associated with global citizenship, particularly in the area of socio-scientific issue-based problem-solving activities.

As a matter of fact, the particular example made in this study was limited to reporting research findings of a study conducted with secondary students in a couple of ASEAN countries, given the constraints faced by limited access to research samples, time, and Internet access. Interactive internet links can be created to include necessary information, such as "Special design-build project promoting education for sustainable development, Educational Partners with International Institutional Links." It is hoped that by developing an LMS focused on SSI issues in order to accomplish the aspirational goal of EFA, more global networking activities can be enhanced further with possible research evidence to report on, for instance, the impact of online learning on increased students' motivation and thinking skills in science or mathematics learning among broad groups of students in South East Asia and beyond.

Additional research activities could be conducted too, for example, by networking with any site that offers enrichment opportunities for interest groups in order to obtain mentorship for developing additional research ideas. Additionally, research studies based on the findings could be conducted to examine gender differences in the discussion, the effect of PBL on students' motivation and thinking skills, and academic achievement levels.

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