Sustainability in the Development of Learning Management Systems with Modularisation and Reusable Learning Objects

Chong Yen Nee,
Curriculum Development Division,
Ministry of Education Malaysia
chongyennee@moe.gov.my

Fazlinah Said
Curriculum Development Division,
Ministry of Education Malaysia
fazlinahsaid@moe.gov.my

Abstract:

This article aims to propose a conceptual framework that outlines a strategic learning management system (LMS) using Google Classroom (GC) that relates to designing modular content and digitalizing learning objects. The framework is built based on the adaptation of Cognitive Load Theory in digitalizing smaller discrete modules or units that can help to reduce long hours of online classes. Due to the COVID-19 pandemic, many teachers have faced difficulties and challenges in developing teaching materials. Besides, students have constraints in online lessons which have led to severe learning losses and burnout after long hours of lessons. Therefore, the objective of the study is to investigate the feasibility of the proposed LMS model. The feasibility of the proposed framework was tested by conducting a pilot study involving 50 higher secondary students who were randomly selected. Two teachers from different schools were conducting online classes for three weeks using the modules uploaded in Google Classroom. Data were collected from the teachers and students through questionnaires. The results obtained from the pilot study illustrated that the proposed LMS model can assist teachers to reduce hours of online classes effectively. Students find it helpful as the application is easily accessible and learning objects are always available even without access to the Internet. This model can assist teachers in sustaining students' participation through the long-term accessibility of many kinds of learning objects during or after virtual or online classes.

Keywords: modularisation, reusable learning objects, learning management system, instructional design

1. Introduction

The main effect of school closures due to the COVID-19 pandemic has caused a rapid paradigm shift in the mode of delivery, particularly in how teaching and learning take place. Conventional face-to-face learning was disrupted and many of us were compelled to look at other alternatives to learning mode. The transition to remote learning in Malaysian schools throughout the COVID-19 pandemic since 2020 has provided some challenges for both students and teachers to remain connected and engaged while teaching and learning (T&L) take place from home. However, the efficiency of the transition depends on the preparedness of students and teachers to stay connected with the support of technology tools and infrastructure during the pandemic. This rapid paradigm shift had brought us into serious contention to meet the requirements of replacing traditional classroom environments with the remote learning environment.

Unfortunately, some teachers struggle in designing remote teaching plans and delivering lessons using an affordable digital platform which can be an extremely time-consuming process. On the other hand, students needed to discipline themselves in following continual lessons digitally with technological gadgets and Internet access. Indeed, some students were marginalized from remote learning due to severe learning losses caused by tiredness after long hours of remote lessons, and poorer households who could not afford to purchase technological devices or pay for Internet subscriptions. Teachers and students were facing great challenges attending long hours of virtual classes which caused learning burnout and learning loss. Digitalizing the existing learning objects posed another challenge for teachers to adopt the use of technology in their learning environment. These were the challenges faced by many teachers and students throughout the implementation of remote learning during the school closures. Therefore, long hours of remote learning may cause distraction and cognitive overload due to extraneous or ineffective load imposed by information and learning activities that do not contribute to the process of knowledge construction (Paas et al., 2004).

The rapid change in performing remote learning structure needed required immense effort from teachers in designing a well-defined instructional structure whereby the elements of time, communication, technology tools and lesson design needed to be taken into consideration. In conjunction, the Ministry of Education (MOE) of Malaysia provided guidelines or manual for the implementation of remote learning from home such as Home Teaching and Learning Manual Version 2 (Curriculum Development Division, 2021) and a digital repository in the Digital Educational Learning Initiative Malaysia (DELIMa) portal. The remote learning lesson guidebook was provided to assist teachers in preparing well-structured lesson protocols. DELIMa provides various technology software for developing and delivering reusable learning objects. With the provision of guidebooks and digital learning platforms, teachers were given some support to develop or transform non-digital to digital materials despite the differences in the technological level of competency among them.

Remote learning is different from virtual learning programs that have gone through the process of adopting an online curriculum and creating a system of learning management structure to support students who are enrolled in schools, colleges, and universities. Therefore, it is pertinent to acknowledge that in remote learning environments, students and teachers are not accustomed to adopting distance learning as implemented by virtual learning programs or online classrooms that adopted a learning management system (LMS) in providing effective curriculum delivery. LMS is a platform that facilitates students' learning in carrying out e-learning-related tasks. LMS or e-learning is a kind of learning method that shares and distributes information, and it can be used as an alternative mode of learning environment for students, who may not be able to attend the traditional classroom environment (Khan et al., 2019). Hence, remote learning can be extended by adopting the structure of developing strategic LMS that will continually assist teachers to create an interactive system of instruction and learning with specific goals, contents, strategies, assessments, and resources during the pandemic and post-pandemic period in Malaysian schools.

DELIMa is one of the MOE's e-learning portals which has been enhanced from time to time to accommodate teachers' and students' needs. This platform has created rooms for repositories of learning objects and learning applications as well as software that are accessible to all teachers and students in Malaysian national schools. After the paradigm shift in 2020, teachers and students struggled during the transitional process of adapting to remote learning skills. From the adoption of remote learning, the emergence of e-learning in schools is seen as a possible learning mode for connecting students after school hours. However, the effort of training teachers to plan and develop sustainable learning objects

and managing LMS needs continuous support. Teachers will need to be fully committed to digitalizing learning objects.

This study proposes a conceptual framework that outlines a strategic LMS using the open-source Google Classroom (GC) that relates to designing a student-centered learning environment and digitalizing reusable learning objects (RLOs). The framework integrates modular curriculum design and RLO strategy adapted from the cognitive load theory (CLT). This study aims to help teachers to digitalize smaller discrete modules or units that can help to reduce the long hours of virtual classes. In addition, the proposed strategic LMS model illustrates a sustainable lifelong learning ability to encourage students to achieve learning goals through self-regulated learning methods for both face-to-face and online learning environments. Besides, this framework is tested to make the use of GC more effective, utilizing the free software applications and mitigating the learning gap or learning loss. The research questions of this study are:

i. How feasible is the proposed LMS model in reducing long hours of online classes?
ii. How feasible is the LMS model in sustaining students' participation after reducing hours of online lessons?

2. Literature Review Theoretical Framework

2.1 Learning Management System

The adoption of remote learning during the COVID-19 pandemic has brought about the adoption of LMS to the forefront and enhanced its role in delivering and managing learning resources, materials, and content to students via online or web platforms. LMS provides educators the opportunities to create, deliver, supervise dan monitor the participation of students as well as to assess their performance. Indeed, LMS provides a platform for learning and obtaining knowledge at any time regardless of the geographic location of the users (Başaran & Mohammed, 2020). Moreover, the additional features of accessing the learning progress of students, students' registration, tracking and delivering of educational resources, materials, and contents which are provided in LMS will enable teachers to monitor and mitigate learning loss. LMS is implemented using different Internet technologies such as open source, cloud computing and mobile-based. The most widely used technology when it comes to LMS is open source such as Moodle which is one of the highly preferred LMS (Başaran & Mohammed, 2020; Santiago et al., 2020). As for Malaysia, the MOE has widely advocated the use of repositories that included free software and learning materials through the DELIMa portal. The open-source LMS is provided and available for free to all teachers and students in the national schools in Google Classroom (GC).

According to Santiago and his team (2020), GC is one of the LMSs that has high reliability in the performance of evaluation indicators. Therefore, GC is recommended to help mitigate learning loss during the pandemic but the main barrier to overcoming the implementation of LMS as indicated by Santiago and team (2020) is the behavioral intention, attitude towards using perceived usefulness and perceived ease-of-use. Another barrier faced by Malaysians is the Internet connection and the sufficiency of technology gadgets to access online classes either through online applications or LMS. Through a study by Santiago and his team (2020), it is acknowledged that GC can increase academic efficiency with the integration of virtual libraries such as IEEE browsers and Google Academic. The Malaysian MOE embarks on an effort to develop repositories of learning materials in a platform known as SumberKU, a virtual repository accessible to all teachers and students registered as users of the DELIMa portal. Hence, the integration of learning tools such as social networks, chat rooms and video tutorials in the LMS enables the virtual transmission of academic resources through mobile devices that

substantially ease the interaction between students and teachers. With the virtual library, learning tools and mobile use in the LMS, a two-way virtual interaction will help in performing activities and discussions between students and teachers. Besides that, teachers can follow up and monitor students' progress such as in homework submission, giving feedback and providing advice. E-learning and mobile learning applications on their mobile phones perceive ease-of-use with the use of software browsers such as Google Chrome or online URL, https://classroom.google.com for free. Therefore, LMS is as sustainable as they are affordable and secure since teachers and students only need a Gmail account which is provided and help them to use the software applications for free (Khan et al., 2019; Santiago et al., 2020). Consequently, reduced learning hours will help to overcome learning burnout after long hours of teaching remotely, minimizing attrition with the fewer online learning hours but perceiving the usefulness of converting digital to non-digital materials during self-managed offline learning hours.

2.2 Academic Resources

Academic resources are learning objects reposited in the LMS to be used in electronic learning (e-learning) or mobile learning (m-learning) that could ease accessibility and be shared through weblinks or websites.

2.2.1 Learning Objects

According to Wiley (2002), learning objects are digital entities deliverable over the Internet that allows high accessibility and usability. Jonassen (2004) indicated that learning objects are digital or non-digital entities. These objects can be used, reused, or referenced during technology-supported learning. Learning objects include multimedia and instructional content with learning objectives which are developed through instructional software and software tools by persons and organizations. Nevertheless, it will be considered as imperfection if the learning objects are not well designed and developed digitally, substantially allowing conversion to non-digital forms, able to stand alone and to be reusable relevantly before sharing on the website or any teaching-learning system. Therefore, the RLO strategy will be integrated into this framework to ensure the learning objects are digitally and appropriately located in the LMS.

The Reusable Learning Object Strategy of Cisco (CISCO System, Inc., 1999) defined a two-level hierarchy of objects consisting of five types of reusable information objects that are the concept, fact, principle, process, and procedure elements. These elements were used to build a larger structure based on a single terminal objective called the reusable learning object (Barritt & Alderman Jr., 2004). Based on the CISCO Model, small information chunks namely the reusable information objects (RIOs) were created. Then these RIOs will be combined and arranged appropriately to form a larger structure as reusable learning objects (RLOs) which is illustrated in Figure 1. An RIO can be developed once and delivered in multiple delivery mediums. Each RIO can stand alone as a collection of content items, practice items and assessment items that are combined based on a single learning objective as illustrated in Figure 2. These developed RLOs were digital resources available to be adapted, reused and delivered effectively through a digital platform such as uploaded into the learning management system (LMS) or in different file types such as text, images, video, and audio in different formats (TIFF, DOC, GIF, JPEG, PDF, MP3, and MP4). The purpose of developing these reusable RIOs into simple informative and interactive items is to reduce the complexity of deliverable items, then to ensure the reduction of cognitive load.

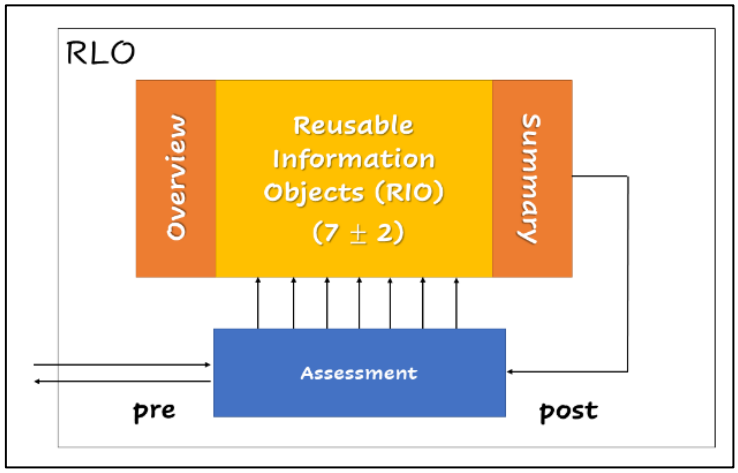

Figure 1 The Reusable Learning Object Strategy
(Adopted from Cisco System, Inc., 1999)

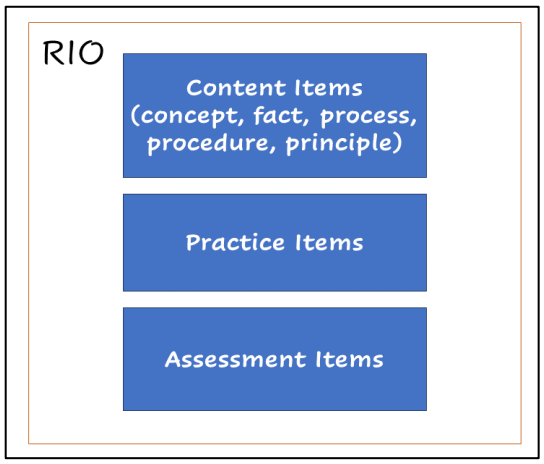

Figure 2 Content, Practice and Assessment items in A Reusable Information Object
(Adopted from Cisco System, Inc., 1999; 2003)

2.3 Theoretical Framework

The adoption of the RLO strategy in the development of instructional LMS visualizes the large numbers of RLOs developed and stored as repositories in the LMS. However, these RLOs will not be efficiently assisting students if proper and exact guidance to locate the RLOs for retrieval of appropriate objects is not provided. At the same time, students may be distracted while exposed to overloaded learning content and materials. To overcome this drawback, the RLO strategy should be integrated with a modular approach to create an interactive learning environment and reduce excessive cognitive load through the adaptation of CLT. Kanimozhi and Cyrilraj (2016) indicated that adaptive RLO for e-learning needs raising external stimuli related to learning materials in the form of presentation, audio clips, video clips, questionnaires, and diagrammatical representation of learning content to retain the student in a focused listening mood using an appropriate cognitive architecture. For this study, a development model of a strategic LMS is proposed with the integration of the RLO strategy to accommodate the appropriate number of learning materials that can be retrieved and reused by adopting the CLT. Hence, the modular

curriculum design is also integrated into the model to ensure the learning activities are well distributed and structured to avoid cognitive overload and sustain students' attention for the completion of every unit or module.

Technically, students interact with the learning object to acquire new knowledge. The content elements of the RLO define similarity to cognitive architecture. As illustrated in the CLT, human cognitive architecture is held to consist of a limited-capacity working memory and an unlimited-capacity long-term memory (Gog & Paas, 2008). Elements of RLO are the elements of information absorbed into the working memory system. The storage of elements could approximately last for at least 20 seconds in the working memory unless the information is refreshed by rehearsal (Merrinboer & Sweller, 2005). Working memory can store up to seven elements at a time but operationally process only two to four elements simultaneously. Resources kept in the repositories and working memory system are vulnerably meaningless if there is no generative step taken to manipulate these rich resources. The interactivity of the elements in RLO and working memory need a further cognitive process to construct new knowledge through the accomplishment of learning tasks arranged in modular curriculum design. This interactivity of information chunks in RLO helps to release the cognitive load of the working memory when schema construction of new knowledge and automation which creates familiarisation takes place in the long-term memory. The limitation of five to nine RIOs structured in an RLO is strategized to avoid excessive load in the working memory capacity. To foster thinking skills, students need to utilize the content cognitively and then adapt schema automation to locate prior knowledge stored in the long-term memory which leads to the schema construction process. Therefore, rich resources which consist of multiple RLOs in the repository system without an appropriate instructional strategy and learning theory will not benefit students (Kanimozhi & Cyrilraj, 2016). Besides, the interactivity between the stand-alone RIOs should be stimulated by self-learning skills guided by curriculum and instruction to assist the formation of new knowledge. Figure 3 depicts the similar functionality of the working memory and learning object repositories associating the CLT to stimulate the cognitive process.

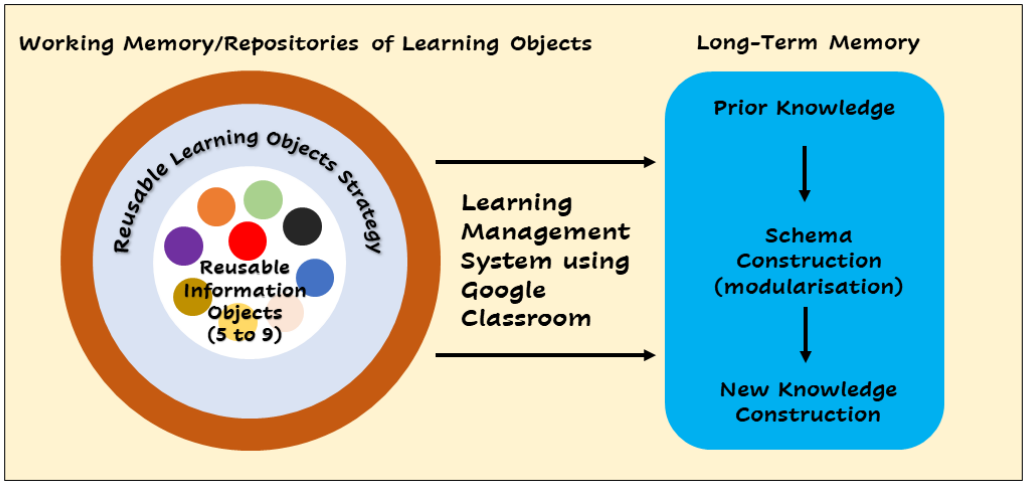

Figure 3 The Similar Functionality of the Working Memory System and Repositories of the Learning Objects Developed from the Study (Chong, 2012)

CLT provides evidence-informed principles that can be applied to the design of instructional messages or relatively short instructional units, such as lessons, written materials consisting of text and pictures, and educational multimedia (instructional animations, videos, simulations, games) as illustrated by Sweller et al. (2019). This indication supports the development of the proposed model where the

developed learning objects are distributed into different smaller modules in short and tentatively focus on short videos that must be considered for the hardware capacity and minimum Internet speed on smooth transmission amongst students' mobile devices. Modularisation integrated into the LMS breaks down learning subgoals into smaller achievements within the units in each module. The accomplishment of each learning task in the learning system enables schema construction in the process of new knowledge formation.

A modular curriculum delivers curriculum in the form of division or unit. The curriculum division or unit is named a module (Curriculum Development Division, 2018). Modularisation is the process of dividing the curriculum into smaller units or modules that stand independently for a shorter duration (Dejene, 2019; French, 2015). Modularisation is the process of dividing learning sessions or teaching-learning materials into smaller tasks to achieve specific goals. Modularisation is preferred to develop materials used in small units of the module for better understanding, supervisory, quality control, reusable and reduce redundancy.

In line with the virtual learning environment, modularisation could help teachers to manage and digitalize bite-sized items of teaching materials that are suitable to be integrated into the online learning system. Tentatively, teachers can diversify instructional strategies with the role of facilitators, providing module usage guides with videos, demonstrations, and stimulation as well as related links for additional support materials that students can explore (Tate et al., 2014). A teacher who integrates constructivism such as problem-based learning and experimental learning can also attract the attention and interest of students. A modular approach can create a more student-centered and multidirectional individualistic learning situation where students can be assisted by parents, peers, teachers, and experts in related fields while they are out of the classroom or school (Dejene, 2019).
Extensively, modularisation includes formative assessment units that can be used to measure the level of mastery of specific knowledge and skills. These assessments can be designed with a scoring system that teachers and students can adopt to keep a tab of the score credit points for self-assessment. Teachers set the number of credit points that will be referred to by students as self-achievement in mastering each unit that has been successfully logged in. Students' achievement is measurable by accumulating credit points after the accomplishing learning activities of the modules (Dejene, 2019; French, 2015). Generally, the modular learning approach is a better mechanism for the delivery of key skills, transferable skills, and disciplined-based knowledge such as vocational-oriented courses (French, 2015; Hennessy et al.,, 2010). In addition, modules of the management and finance courses have given some intrinsic motivation to students after realizing the benefits of independent tasks and engagement with materials. Besides, students who score high grades, enjoy extrinsic motivations (Hedges et al., 2013). Therefore, a group of secondary students who registered for the Business elective subject was selected to be involved in the pilot study. However, this study did not investigate the motivation level but mainly focused on the feasibility of the concept framework depicts in Figure 4.

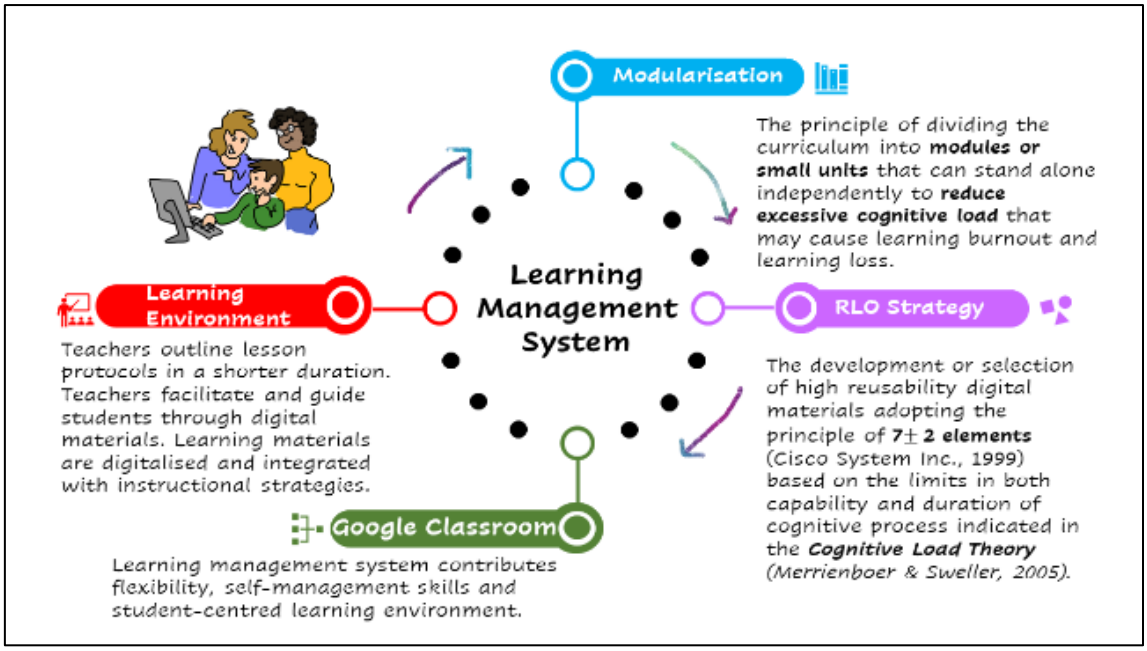

Figure 4 The Conceptual Framework for the Development of a Strategic Learning Management System

2.4 The Development of A Strategic Learning Management System

The development of the strategic LMS is based on the adoption and adaptation of Alessi & Trollip Theory (2001) and the Cisco Model (2003). The development starts with the process of modularisation by dividing a large topic into smaller units after selecting and reorganizing the structure of learning materials for easy access by students in the LMS using Google Classroom. The process of modularisation includes six stages of development namely analysis, design, development, dissemination, coordination, and evaluation. Figure 5 shows the six stages of LMS development.

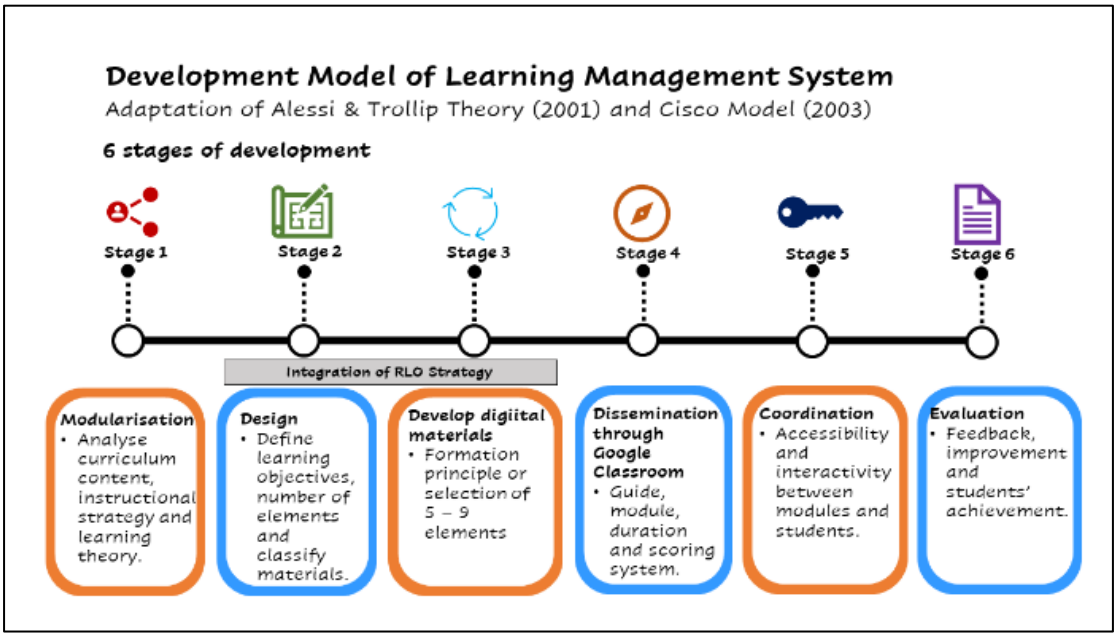

Figure 5 The Six Stages of the Learning Management System

At Stage 1, teachers analyze the target group following students' cognitive ability or the number of modules integrating the proposed instructional design.

Stage 2 is to outline the instructional design to define learning objectives, numbering, and classify the existing learning materials.

Stage 3 is the development or mix-and-match of the selection of reusable information objects (RIOs) for the formation of RLOs. Each RLO is a module that holds the principle of 7 ± 2 elements. RIOs can be in the form of text documents, audio, graphic, media merging and resource links.

Following Stage 4, teachers prepare lesson plans and integrate RIOs into the specific modules to be disseminated through Google Classroom. Each module consists of smaller units. Each unit is equivalent to one RIO. The RIO includes a learning content, practice item and assessment item respectively with learning objectives that needed to be accomplished by students. Guides, manuals, or instructions can be posted as the announcement in Google Classroom. The duration of each unit or module helps students to manage assignments flexibly. In addition, the scoring system is needed to measure students' achievement in every assessment or assignment.

Next, teachers can coordinate with students through a forum, chatroom, Google Meet and scoring remarks. Students' accessibility within the LMS and interactivity between the modules can be monitored in the scoring system to indicate the learning gap and learning loss at Stage 5.
Lastly, students' achievements can be evaluated after completing all units in each module. The scoring system helps to identify attrition with the number of assignments and assessments completed by students. Teachers can give immediate feedback and trace the limitations of the system at the same time.

3. Methodology

3.1 Pilot Study

A pilot study was carried out to investigate the feasibility of the LMS model. A total of 50 Form Five upper secondary school students from two different schools participated in this study. The samples were selected conveniently. Two teachers taught their lessons according to the model presented for three weeks via online classes. Student participants completed one of the three modules related to the preparedness of business start-ups for the Business subject.

Both teachers were guided to select suitable existing teaching materials to be transformed into RIO and RLO as shown in Figure 1 and Figure 2. The preparation of lesson plans was carried out referring to the development stages shown in Figure 5. In conjunction, the teachers arranged the learning objects according to the lesson plans. Consequently, Figure 6 depicts the units that are in the modules and the digital material developed. The teachers were involved in the development by providing content, worksheets, and test items. Each module consists of a pre-test and post-test, three sets of content items, 3 sets of worksheets and the evaluation item. The online classes were conducted through online applications such as GC, WhatsApp and Google Meet. This combination of these applications will help teachers to reduce teaching hours, but students will be guided to perform the learning process using the learning objects after class.

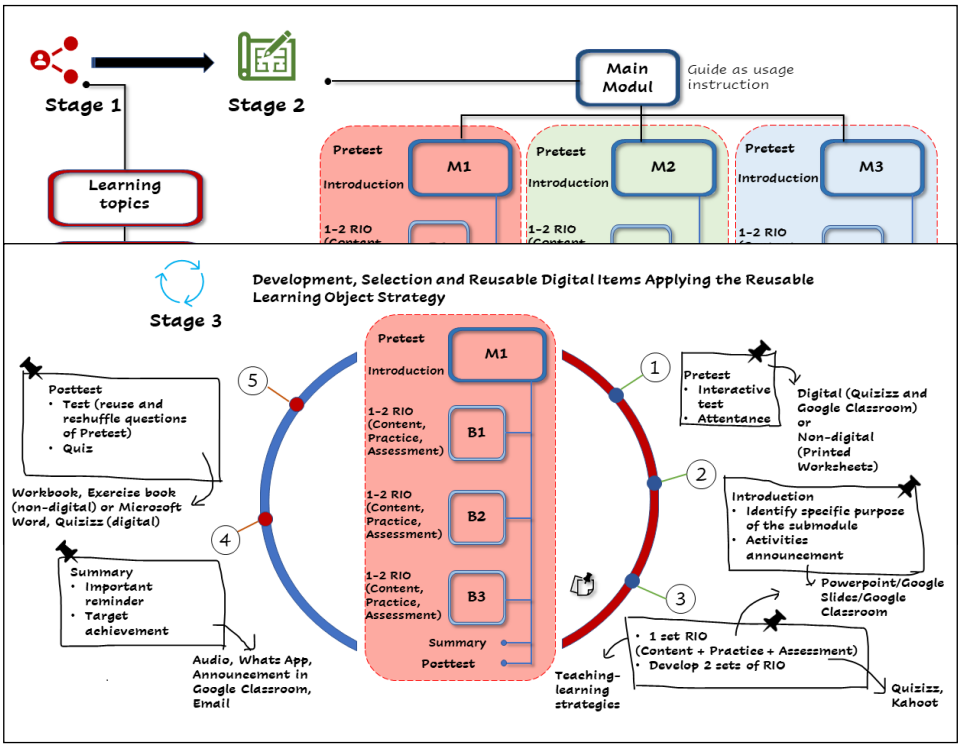

Figure 6 Adaptation of Reusable Learning Object Strategy in the Development, Selection and Placement of Digital and Non-Digital Modular Items

However, there were some limitations in this study. Within three weeks, teachers were able to complete only one of the modules. Therefore, the effectiveness of the online classes using GC was not able to be tested but the study was more focused on the feasibility of the model. Besides GC, teachers communicated with students using Google Meet and other chat applications such as WhatsApp and Telegram. Students and teachers participated in the online survey after completing Module 1 (M1).

3.2 Instruments

There were two sets of survey forms each for teachers and students to be filled out online at the end of the pilot study. The survey consists of questionnaires for teachers regarding teachers' preferences upon adopting the LMS model into their lesson plans, the usability of technological devices and applications, Internet accessibility and the feasibility of LMS (using GC) during the learning process. For students, the questionnaires investigated the availability level of Internet access and technological devices, preferred learning hours, usability level of the units and modules in the LMS, accessibility level to all kinds of learning objects uploaded in the LMS, and preferences using the LMS as a learning medium. Data were analyzed descriptively.

4. Findings and Discussion

Two different sets of questionnaires survey were administered to both teachers and students which were related to the feasibility of adopting modularisation, RLO strategy and the LMS model using GC in this study. From this survey, the teachers stated that GC makes good coordination in planning and implementing lessons in smaller units, assessing students' mastery level and tracking evidence of

learning items that can be easily accessed at any time. However, this finding is not able to make a generalization representing other teachers. One of the teachers was a beginner in conducting online classes using GC which he had never used before or during the pandemic due to slow Internet coverage in school. After this study, he found that GC was user-friendly and can be easily used on a mobile phone or laptop. He was able to start digitalizing existing materials and breaking down bigger elements into smaller units using the development framework. This model can guide him in preparing lessons at a faster pace, then conducting online and offline classes. It is proven that this LMS model can help the teacher in reducing long hours of online classes. This finding is supported by the modularisation illustrated by Dejene (2019) and French (2015).

For the students' participants, 32 out of the 50 students responded to the survey. The study shows students' engagement was at the rate of 40% retrieval from the record of work task submission. The percentage was not able to prove the increase in the student's participation but was able to illustrate students' commitment to the learning process. GC managed to detect students' commitment via the submission of learning activities uploaded in the said LMS. Therefore, the LMS model used in this study has shown positive outcomes in sustaining students' participation in accessing learning objects during offline classes through managing their own learning path.

The survey showed that 96.9% of students owned personal mobile phones which indicated that ownership of technology tools was not a barrier for online classes. In conjunction, 75% of the students had moderate and good Internet connection at home. 87.5% of the students prefer using WhatsApp, Telegram and GC. 71.9% of them preferred using WhatsApp, Telegram and Google Meet as virtual classroom platforms compared to only 12.5% on GC. The data illustrated that GC was used with other mobile applications such as WhatsApp and Telegram for responsive interaction. The result indicated that mobile devices and Internet access were not the cause of attrition and learning loss when students were well-equipped with technological devices and applications. With the availability of devices and Internet access, the implementation of the proposed LMS model can sustain students' participation in retrieving digital objects and involving in learning activities or evaluation items set by the teachers.

In addition, it appeared that 50% of the students preferred GC as it was able to shorten online learning hours and 37.5% of them were able to manage their learning process flexibly. This result indicated that the delivery model proposed in the LMS (GC) was feasible to reduce online learning hours instead of long hours of video conferencing. Modularisation and the RLOs help to increase the flexibility of students' self-management during the learning process (French, 2015). 34.3% of them agreed GC enables immediate response and 28.1% found that scoring systems were easily referred. Immediate feedback posted after the evaluation of assessments can help sustain students' participation and engagement in the LMS (Dejene, 2019). 25% of the students stated that learning with GC helps in narrowing the learning gap or learning loss due to unattended learning sessions. However, 37.5% found that GC was complicated and 18.8% stated that the instructions were not clearly written. Therefore, clear instructions and announcements to facilitate students' direction are important to sustain students' attention and engagement throughout the learning process.

Practically, 50% of the students attended more than 3 hours of online classes in a day, while 18.8% of them attended classes less than 3 hours but 28.1% of them were not aware of the learning hours. From this study, 50% of them stated that the reason for not attending online classes was due to long hours surfing the Internet or using technology devices which caused exhaustion. Moreover, 46.2% of students preferred face-to-face classroom sessions and 38.5% were not able to manage self-learning without teachers in schools. Therefore, the dependency on teachers was still high among the secondary students

who needed guidance and face-to-face classroom instruction. Teachers play important roles in organizing alternative platforms to ease students accessing multiple digital objects.

On the other hand, 50% to 60% of the students agreed that modularisation has perceived ease-to-use and usefulness from online learning through GC as it was able to shorten their learning hours. Modules developed consist of the smaller size of RIOs and RLOs that ease students through the discovery of sequential content items. Students gained exploratory experience adopting and reusing the digital items that helped to guide them in managing the learning process. Students believed that the digital items integrated were reusable and easily extracted from the learning system. The results obtained from the study indicated that students preferred GC as a repository and reference centre to retrieve teachers' announcements and instructions, coordinate teachers' feedback and monitor test scores. In addition, 71.9% of the students downloaded various learning objects which were then used for revision repeatedly. 59.4% illustrated that replaying videos and reusing the learning objects help students in understanding the lessons' content. Therefore, this study has shown that GC can increase students' interaction and accessibility with learning objects and modules which can sustain students' participation even after school or online sessions.

Generally, 75% of the students enjoy using GC after this study. More than 60% of them would continue using GC substantially even after the pandemic when schools reopen. They believe that GC with its modular structure and various learning objects was a better mechanism for the delivery of knowledge and skills sustainably. The proposed framework is found to be suitable for teachers to adapt for preparing lesson plans and organizing learning objects or evaluation items without burdening students cognitively to mitigate learning burnout. GC has the potential to sustain students' participation during or after conducting online classes which can assist teachers to close the learning gap.

5. Conclusion and Recommendations

In conclusion, the results obtained indicate that teachers and students do not face difficulties in accessing GC. GC as proposed to be used in this LMS model are free application and can be a potentially substantial learning platform after the pandemic. Teachers who are adopting this LMS model can distribute lessons into smaller units in each module. They do not need such advanced technical skills in developing RLO because GC allows them to simplify the process of creating, distributing, and grading assignments and engaging students. Teachers can easily integrate simple digital materials using Microsoft Office, Google products and other interactive applications from DELIMa platform. They iterate that LMS can be used as a repository of learning materials and learning tasks shared among students, storage of feedback records and assessment scores. Therefore, GC is highly feasible to be integrated into the daily learning process for extensive lessons, worksheets, quizzes and assessments to close the learning gap after the pandemic. The engagement rate among the students is still low which is at 40% and this is reflected in their lack of interest, behavioural patterns and attitude toward using LMS for online learning (Santiago et al., 2020). Indeed, they preferred virtual video calls using Google Meet and documents shared through WhatsApp and Telegram communication applications. However, this communication instruction is feasibly posted in the GC to facilitate students' learning process. Therefore, this study finds that the feasibility level is high for teachers to plan and implement lessons with the LMS model. In contrast, students' participation is viably found at a moderate level based on the result of 40% retrieval from the record of work task submission that shows students' commitment to task completion.

Consequently, teachers are found to be motivated in using GC with the integration of modularisation in dividing long hours of lessons into smaller modules and fully attaining the exact curriculum standards. The reusable learning objects strategy helps teachers in selecting, developing and digitalizing learning materials using simple software applications. However, the scoring system in the modularisation needs further refinement. A modular curriculum is found to be popular at the tertiary level. In colleges and universities, students select their favourite courses and modules. Therefore, they are motivated to accomplish the modular courses to achieve higher scores (Hennessy et al., 2010). In contrast, modules in the proposed model are designed and developed by teachers. Students must complete the modules under the directive of teachers' instruction. Hence, students will not be too motivated to complete the assigned modules. However, further investigation can be implemented to study the effectiveness of the model in increasing motivation and students' achievement.

In addition, it is recommended that more appropriate assessment rubrics can be designed to evaluate students' achievement and acknowledge students' success according to their mastery level. The acknowledgment of success can motivate and increase students' engagement to complete learning tasks and attain goals in the LMS. Consequently, the learning contents are presented using video presentation in a non-interactive mode. Therefore, the one-size-fits-all video version does not take into consideration the different cognitive levels among students. Higher cognitive level students ended up the boredom and the lower cognitive level ones may face difficulties in adopting a self-learning approach (Dejene, 2019; Curriculum Development Division, 2018). For further studies, the elements and principles of multimedia can be taken into consideration to study the effectiveness of the model towards students' behavioural and attitude change.

References

Alessi, S. M. & Trollip, S. R. (2001). *Multimedia for learning: Methods and development (Third Edition)*. Boston, Mass: Allyn and Bacon.

Başaran, S. & Mohammed, R.K.H. (2020). Usability Evaluation of Open Source Learning Management Systems. *International Journal of Advanced Computer Science and Applications*, 11, 400 – 410.

Barritt, C. & Alderman, F.L. (2004). *Creating a reusable learning objects strategy: Leveraging information and learning in a knowledge economy*. San Francisco, CA: Pfeiffer

Chong, Y.N. (2012). *The Integration Of Instructionism And Constructivism Strategies With Reusable Learning Object (RLO) In English Literature Component*. Thesis Ph.D. Universiti Sains Malaysia.

Cisco Systems (1999). *Reusable information object strategy: Definition, creation overview, and guidelines*. San Jose, CA: Cisco Systems, Inc.

Cisco Systems (2003). *Reusable learning object strategy: Designing and developing learning objects for multiple learning approaches*. San Jose, CA: Cisco Systems, Inc.

Curriculum Development Division (2018). *A Guide for Modular Approach in Teaching and Learning*. Ministry of Education.

Curriculum Development Division (2021). *Home Teaching and Learning Manual Version 2*. Ministry of Education.

Dejene, W. (2019). The Practice of Modularized Curriculum in Higher Education Institution: Active learning and Continuous Assessment in Focus. *Cogent Education*. Available online at: https://doi.org/10.1080/2331186X.2019.1611052

French, S. (2015). The Benefits dan Challenges of Modular Higher Education Curricula. *Issues dan Ideas Paper, Melbourne Centre for the Study of Higher Education.* Available online at: www.chse.unimelb.edu.au/issuesideaspaper

Gog, T.V. & Paas, F. (2008). Instructional Efficiency: Revisiting the Original Construct in Educational Research. *Educational Psychologist*, 43, 16 – 26.

Hedges, M.R., Pacheco, G.A. & Webber, D.J. (2013). What Determines Students' Choices of Elective Modules? *Economic Papers 1307, University of the West of England*. Available online at: http://www1.uwe.ac.uk/bl/bbs/bbsresearch/economics/economicpapers.aspx

Hennessy, E., Hernandez, R., Kieran, P. & MacLoughlin, H. (2010). Teaching and Learning Across Disciplines: Student and Staff Experiences in A Newly-Modularised System. *Teaching in Higher Education, 15(6), 675-689*. Available online at: http://dx.doi.org/10.1080/13562517.2010.507301

Jonassen, D.H. (2004). *Learning to solve problems: An instructional design guide*. San Francisco: Pfeiffer.

Kanimozhi, A. & Cyrilraj, V. (2016). An Adaptive Reusable Learning Object For E-Learning Using Cognitive Architecture. *Advanced Computing: An International Journal*, 7, 19 – 28.

Khan, M., Naz, T. & Hamad Medani, M.A. (2019). A Multi-Layered Security Model for Learning Management System. *International Journal of Advanced Computer Science and Applications*, 10, 207 – 211.

Paas, F., Renkl, A. & Sweller, J. (2004). Cognitive load theory: Instructional implications of the interaction between information structures and cognitive architecture. *Instructional Science*, 32, 1–8.

Santiago, J., Ramirez, J.M.O., Rodríguez-Reséndiz, J., Dector, A., Garcia, R.G., González-Durán, J.E.E. & Sánchez, F.F. (2020). *Sustainability*, 12, 1 – 17.

Sweller, J. (1994). Cognitive load theory, learning difficulty and instructional design. *Learning and Instruction*, 4, 295-312.

Sweller, J., van Merrienboer, J.J.G. & Paas. F. (2019). Cognitive Architecture and Instructional Design: 20 Years Later. *Educational Psychology Review*, 31, 261–292.

van Merriënboer, J.J.G., & Sweller, J. (2005). Cognitive Load Theory and Complex Learning: Recent Developments and Future Directions. *Educational Psychology Review*, 17, 147 – 177.

Tate, J.F., Schubert, C. & McCoy, C. (2014). Understanding Modular Learning – Developing A Strategic Plan to Embrace Change. *I-Manager's Journal on School Educational Technology, 9(4), 32 – 44*.

Wiley, D. (2002). *Learning objects need instructional design theory*. In Rossett, A., The ASTD E-Learning Handbook, pp 115. New York: McGraw Hill.