

PEDAGOGY

for Online Learning

Theory and Practice

Rodrigo M. Velasco
Ruel F. Ancheta
Chinaza Solomon Ironsi
editors



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Preface

During this unprecedented time, almost all educational institutions have shifted from traditional learning to online learning. When the COVID-19 hit the world, online teaching was no longer an option but a necessity. Due to government restrictions and other related protocols, schools, colleges, and universities opted to deliver academic instructions into online to ensure that students still receive quality learning they deserve. Online learning is a tool in which teaching and learning process still become student-centered, innovative and flexible. However, online learning can also become a disadvantage as there are many challenges associated with online teaching and learning. This e-book offers the different perspectives on online learning: framework, learning experiences both on students and teachers and its associated future management.

The introductory part of this book gives an overview and framework of online learning. It provides technical discussions of learning management systems and teaching and learning modalities used in online learning. It serves as guide in the development of the appropriate learning management system and modality relevant to the capacity and necessity of the academic institutions. The authors shared their actual experiences in the development and management of the systems and programs in online learning.

Part 2 of the book contains the efficacy of online learning experience as per the students' perspective. It highlights the attitude of students towards distance learning at the peak of

the pandemic termed as ‘behavioral Coronaphobia.’ This part also highlights the expectations of high school and higher education students on online learning and teacher-created videos as a tool in the online learning. The authors shared the results of their studies on the actual experience of their students which unveiled the various positive and negative facets of online learning.

In part 3, the efficacy of online learning as per teachers’ perspective is presented. This part highlights the experience of the rural science teachers and the school administrator during the new normal in education. Recommendations outlined on this part serve as bases for further analysis in terms of online teaching-learning implementation. Meanwhile, the future of online learning is outlined in part 4, which can be a basis for further review. The model contained in the paper can be particularly applied in higher education where online platform may be adapted for long in the post-pandemic new normal.

This e-book offers major research results on the conduct and implementation of online teaching and learning in the context of COVID-19 pandemic. It provides a unique perspective on the research issues regarding the effects of online learning from many experts in this field.

Let us learn from the various personal experiences and perspectives of the researchers from various fields of specialization!

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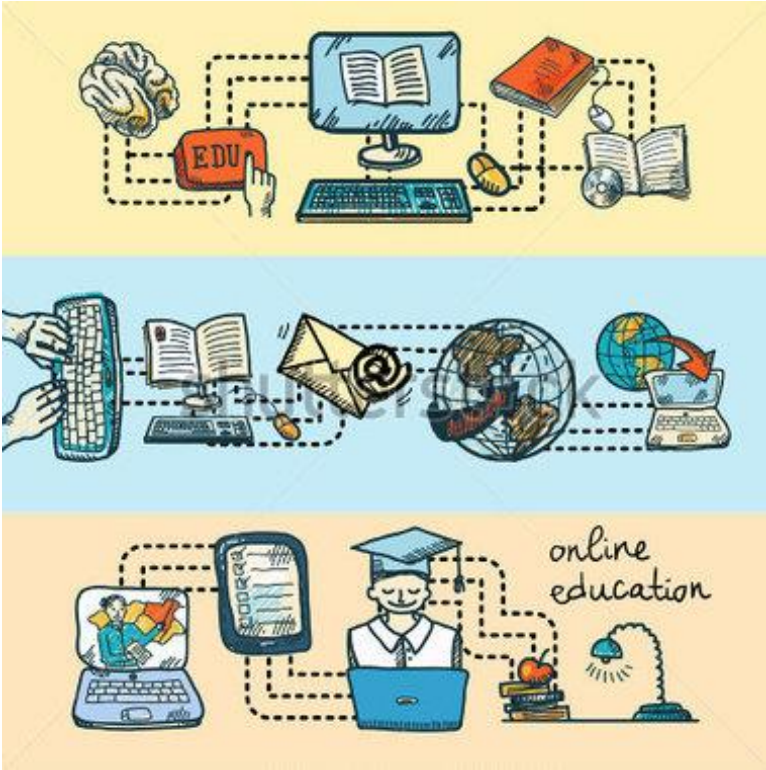
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Part 1

The Framework of Online Learning



Source: <http://clipart-library.com/clipart/2064412.htm>

Learning Management System for Data Structures and Algorithm

Marco Paulo J. Burgos

Introduction

LMS is a boundless data framework utilized in numerous higher education institutions to encourage instructive challenges. The framework can be utilized for help in campus courses, courses directed on the Internet, and obviously a combination of these utilizations. It is a web-based innovation used to plan, execute, and evaluate a particular learning measure which furnishes an educator with an approach to make and convey content, screen student participation, and survey student performance.

Due to the effects of Covid-19 pandemic, the education system worldwide had to adjust to the existing new normal. Higher education institutions shifted to online class and modular learning. During this learning mode, the LMS benefits the students in terms of easily accessing the modules and answering examinations and quizzes through online enrichment and module assessment, hence eliminating the physical submission of paper requirements. In addition, students can get the frequently-asked information from the chatbot, an automated answering features of the LMS, which also supplements the communication gap or response time between the students and teachers. This can also be coded with a program in simulator inside the system. For the teachers, the broadcast of announcements is easier and much clearer as opposed to social media and e-learning platforms where messages are in the thread. Moreover, the computation of grades became easier because of the automated save features.

With the benefits of LMS, this study developed and evaluated the use of LMS at a particular higher education institution in the Philippines. It was particularly developed for the subject Data Structures and Algorithms offered in the second year of Bachelor of Science in Information Technology at the School X.

Literature Review

a. *Development of LMS through Waterfall Method*

According to Andersson (2019), LMS is a product application or web-based innovation used to plan, execute, and evaluate a particular learning measure. Ordinarily, it furnishes an educator with an approach to make and convey content, screen student participation, and survey student performance. It may likewise furnish students with the capacity to utilize intuitive highlights such as threaded conversations, video meetings, and conversation forums. When building up a data framework, various models can be utilized as help support for the development. The most customary methodology is the Waterfall Model of the Systems Development Life Cycle (SDLC).

According to Rainer et al. (2015), the model illustrates the advancement into six stages: requirements analysis, system design, implementation, testing/verification, deployment, and maintenance. The various stages have clear characterized tasks, and if challenges happen in one phase, the researcher needs to return to past stages to tackle the challenge. The (1) requirements analysis stage recognizes the genuine needs, utilizes a feasibility study, which looks at technical, economical, and social perspectives all together. Conversations on the different business challenges that the advancement should tackle, happen in the framework investigation stage, subsequently assembling data pretty much all the necessities and a final output of a bunch of framework prerequisites. In the (2) system design stage, the framework is set up and particulars of the arrangement is endorsed, where also the programming and testing happens. In the (3) implementation stage, the LMS is developed. In the (4) testing phase, the new framework is in a pilot adaptation to the groups of respondents while the (5) deployment phase which alludes to the actual implementation of the system to the benefactors' usage, where in this study pertains to the system of the Department of the Computer Education of the School X. The last stage is the (6) maintenance of the new framework, where

the identified challenges from the uploaded web application of LMS for Data Structures and Algorithms are addressed.

In a study by Muhand, et al. (2020), the Waterfall Model was utilized in designing a web-based LMS. It has been depicted how the plan of the framework in the advancement of LMS on this site. Subsequently, it was inferred that the teaching and learning process in a website permitted students to have materials downloaded straight through the site. Thus, the degree of connection among teachers and students increased the online correspondence media, where students and teachers can associate with one another through this LMS application.

b. *Software Evaluation and Quality Assurance*

According to Krouska et al. (2019), utilizing ISO 25010 international standard for the assessment of any software is fair and dependable. It also depends on the proper standard attributes to access the quality of educational software. The audit targets the indication of advancement of master frameworks in e-learning because of the rise of interpersonal interaction and the commitment of its qualities to the educational process. The development of high quality software is imperative because the learning networks nowadays are PC-educated and have rising expectations for the systems being used.

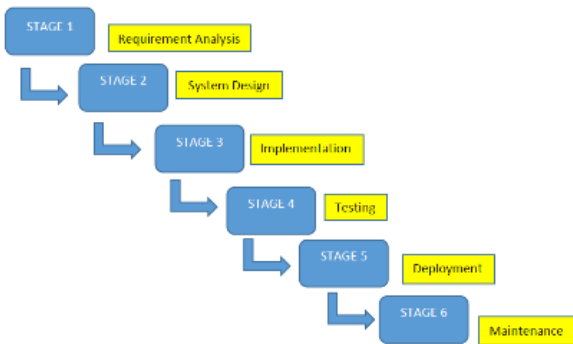
E-learning is generally alluded to the use of Information and Communications Technology (ICT) for conveying instructive educational programs. It is quickly developing because of the wide Internet use, the abilities of ICT to help the learning cycle and the diminished expense of online training. It gives electronic guidance through which students can get to online course materials. A conventional methodology of e-learning is the LMS. It is an amazing instructive programming for overseeing course substance and students and offers online mastering, appraisal and preparing asset and understudy management. Not only to convey course content, it gives a more student-focused guidance.

By utilizing an ISO-based model, the dependability of framework assessment is expanded as it depends on standard attributes legitimate to survey the nature of programming items or the potential quality being used. Additionally, this sort of assessment can demonstrate that a framework meets all the requirements and gives clients the affirmation of item quality. ISO 25010 is a broadly acknowledged and very much perceived quality standard that has been applied to an assortment of programming item assessment cases. Notwithstanding, there are just couple of uses of this model to the e-learning conditions.

Methodology

This study utilized the developmental research through descriptive design in developing a framework following the Waterfall Method. Part of gathering information is about the current and existing methods of teaching for Data Structures and Algorithms in School X. This assessed the current situation to gather necessary information and data for further understanding and investigation.

Figure 1
The Waterfall Model



Source: Introduction to Information Systems, 5th ed, by Raimor, Prince, & Cegielski, 2015, John Wiley & Sons Singapore Pte. Ltd.

The Waterfall Method was utilized in creating the proposed system. Waterfall formulations are usually used in computer program improvement which reacts to irresoluteness changes. The

model illustrates the advancement into six stages: requirements analysis, system design, implementation, testing, deployment, and maintenance. These stages correspond as to how the first research objective was answered.

The population frame for this study were IT experts, faculty members, and former students enrolled in the subject Data Structures and Algorithms at the School X during the current semester. As a sampling scheme, the study used the convenience sampling method. It is an exemplification of non-random/non-probability sampling wherein sample individuals from the reference populace that meet a certain level of functional standards are incorporated for study purpose. Considering the present pandemic situation where everyone was required to stay at home, the study had to select the experts, teachers, and students who have active internet connection at home. The samples selected were then subjected to the new treatment method, utilizing the LMS.

The total respondents were ninety (90), composed of sixty (60) students, fifteen (15) faculty members, and fifteen (15) IT experts. The respondents were the former students enrolled in the subject Data Structures and Algorithms at the School X, faculty members who were teaching or have taught the subject, and IT professionals composed of experts from the industry and the IT administrator of Bachelor of Science in Information Technology in School X. The respondents were interviewed to gain understanding on their needs and to prove that the proposed system was needed for the school. A set of carefully prepared and logically ordered questions were used to collect data.

The study utilized a set of instruments in gathering the vital data. These were the adopted questionnaire, interview guide, and document analysis. The adopted checklist questionnaire in a Google Form was the standardized assessment tool based on ISO 25010. This is a significant tool to evaluate the respondents' perspectives on the current system or the new framework. The said tool was founded on ISO 25010:2011 standard for software development designed to evaluate and to determine the level of

acceptability of LMS for Data Structures and Algorithms with respect to functional suitability, performance efficiency, usability, and reliability. The questionnaire was answered by the students, faculty, and IT experts. The Likert scale was used to determine the level of acceptability which answered the second research objective.

The interview guide was utilized to determine the challenges experienced by the respondents during the assessment, different remarks, and recommendations that maybe considered for the improvement of the system. An interview was conducted through online messaging because of the limitation on the face-to-face meeting. The respondents were asked on the considerations in utilizing the developed program. The meeting principally comprised of the inquiries with respect to the usefulness of the created framework such as the adjustments in the functionalities and the challenges experienced in using the program. These data correspond to the fourth research objective.

There were documents analyzed which include outcome-based teaching and learning (OBTL) and the subject modules for Data Structures and Algorithms. Meanwhile, the ANOVA was used to answer the third research objective on the significant difference in the evaluation of the three groups of respondents. For the data analysis, Microsoft Excel and SPSS programs were used. The statistical techniques utilized were Weighted Mean and One-Way Analysis of Variance (ANOVA).

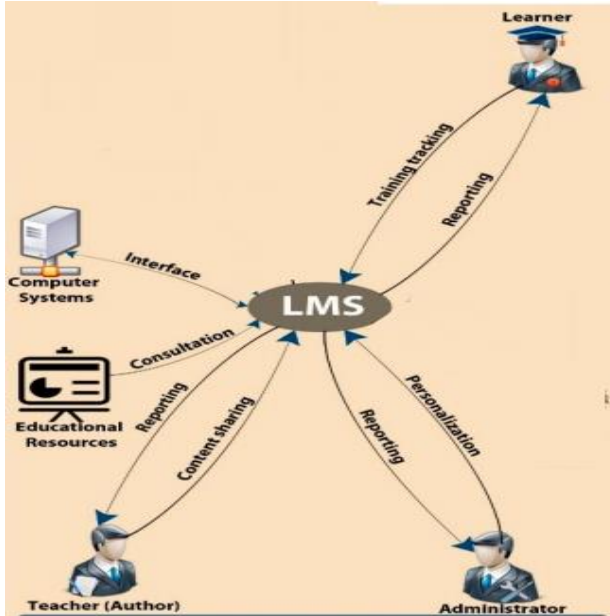
Results and Discussion

The waterfall methodology comprised of the following phases: requirements analysis, system design, implementation, testing, deployment, and maintenance phases as shown in Figure 1.

The E-Learning Platform denotes the significance of the theoretical framework to the study as it represents the overall principle of the operation of an e-learning LMS platform for Data Structures and Algorithms by introducing the key highlights

related with the primary benefactors: students, teachers, and administrators.

Figure 2
The e-learning platform

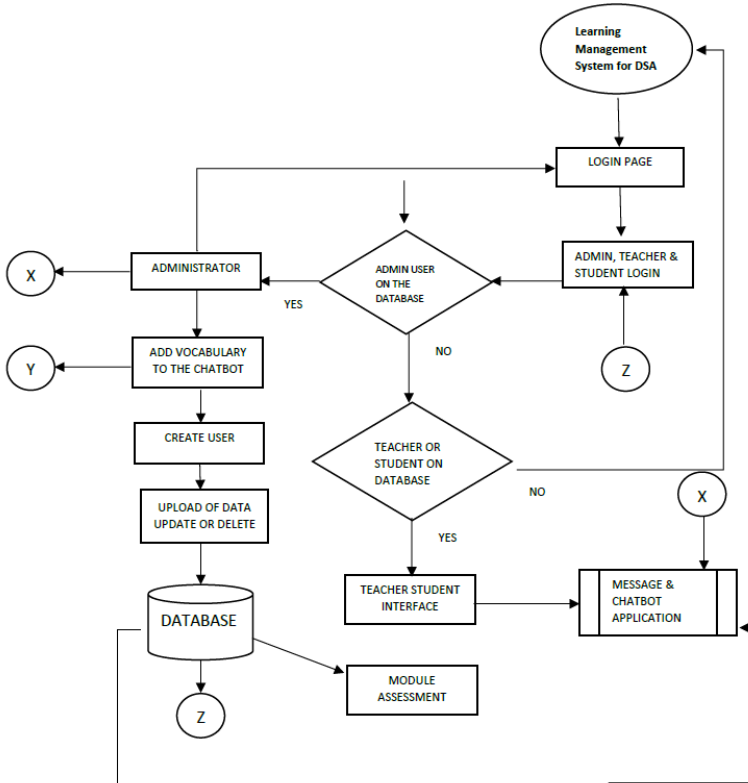


Source: Educational Modeling of a LMS by Ouadoud, Chkouri, and Nejjari (2018)

As shown in Figure 3, the flowchart reflects the process of LMS development for Data Structures and Algorithms. All users are prompted to the login page of the system which serves as the security. Depending on the users' profile, the system has different menu features based on the user's role in the LMS. For example, the administrator has control of all the accounts. The Module & Assessment is saved to the cloud server where the teachers and students basically interact. The chatbot was added to help teachers and students adapt the system and learn the subject Data Structures and Algorithms.

Figure 3

LMS Flow Chart for Data Structures and Algorithms



Level of LMS Acceptability

The LMS for Data Structures and Algorithms was evaluated by the three groups of respondents – the students, faculty members, and IT experts. Table 1 shows the functional suitability as perceived by the students, faculty members, and IT experts.

Table 1
The Functional Suitability of the LMS

Functional Categories	Students		Faculty		IT Experts		Overall	
	WM	VI	WM	VI	WM	VI	WM	VI
Functional completeness. Degree to which the sets of functions covers all the specified tasks and users objectives	4.53	HA	4.5	A	4.40	A	4.5	A
Functional correctness. Degree to which system provides the correct results with the needed degree of precision.	4.67	HA	4.60	HA	4.40	A	4.6	HA
Functional appropriateness. Degree to which the functions facilitate the accomplishment of the specified tasks and objectives.	4.58	HA	4.5	A	4.47	A	4.5	HA
Overall Mean	4.59	HA	4.5	HA	4.42	A	4.5	HA

Legend: WM- Weighted Mean, VI- Verbal Interpretation, HA- Highly Acceptable, A-Acceptable, MA-Moderately Acceptable, U Unacceptable, HU-Highly Acceptable

The overall mean gathered from the three functional categories was 4.51. This indicates that in terms of functionality, the respondents perceived the LMS as highly acceptable. The students perceived that the system operates according to its desired functionality as the calculated mean is 4.59 which is interpreted as ‘highly acceptable’. Additionally, the faculty members has the same ‘highly acceptable’ perception of functional suitability with a mean of 4.51. Moreover, the IT experts perceived that the developed system was able to provide its intended function with a mean of 4.42 which is acceptable. Functional suitability is used to determine if the product provides functionalities that meet all the stated or implicit requirements when used under specific conditions. According to ISO 25010, it is a collection of characteristics that lean on the beingness of a set of purposes and their nominative characteristics. The purposes are those that fulfill explicit or implicit conditions.

Table 2 shows the evaluation of the LMS in relation to performance efficiency. It indicates that the developed system is interpreted as ‘acceptable’ with an overall mean of 4.32. Henceforth, the respondents reckoned that the LMS for Data Structures and Algorithms is efficient to use and it meets the requirements.

Table 2
The Performance Efficiency of the LMS

Functional Categories	Students		Faculty		IT Experts		Overall	
	WM	VI	WM	VI	WM	VI	WM	VI
Time Behavior. Degree to which the response and processing times and throughput rates of the system, when performing its functions, meet requirements.	4.60	HA	4.3	A	4.40	A	4.44	A
Resource utilizations. Degree to which the amounts and types of resources used by the system, when performing its functions, meet requirements.	4.42	A	4.40	A	4.27	A	4.36	A
Capacity. Degree to which the maximum limits of the system parameter meet the requirements.	4.37	A	4.2	A	4.33	A	4.32	A
Overall Mean	4.46	A	4.3	A	4.33	A	4.37	A

Legend: WM- Weighted Mean, VI- Verbal Interpretation, HA- Highly Acceptable, A-Acceptable, MA-Moderately Acceptable, U Unacceptable, HU-Highly Acceptable

The students evaluated that the developed system was able to meet the requirements in time behavior, in utilizing its resources when performing tasks and it met its maximum limit of the system parameter required. The faculty members perceived that the developed system was able to perform efficiently with a mean of 4.23. Lastly, the IT experts perceived the developed system as acceptable with a 4.33 mean for all categories.

As for the interview organized after the evaluation, the respondents observed that the system was able to act in response to requests in an apt and judicious manner. It was also derived from the interview that the system was able to serve several users at the any one particular point in time. Performance efficiency is dictated by how an application carries on under expressed condition. It influences consumer loyalty, labor force profitability, application adaptability, reaction time debasement, and insufficient utilization of preparing or capacity assets. Despite the fact that the general performance efficiency of an application is wanted, the individual parts execution of an application influences the general presentation proficiency of the created framework just as the interconnectivity of these individual segments. According to ISO 25010, it is a collection of characteristics that lean on the connectedness between the level of performance of the product and the mensuration of possession utilized, under explicit stipulation.

The table 3 presents the assessment on the usability of the system.

Table 3
The LMS Usability

Functional Categories	Students		Faculty		IT Experts		Overall	
	WM	VI	WM	VI	WM	VI	WM	VI
Appropriateness Recognizability. Degree to which users can recognize whether the system is appropriate for their needs.	4.53	HA	4.67	HA	4.33	A	4.51	HA
Learnability. Degree to which the system can be used by specified users to achieve specified goals of learning to use the system with effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use.	4.65	HA	4.67	HA	4.53	HA	4.62	HA
Operability. Degree to which the system has attributes that make it easy to operate and control.	4.62	HA	4.53	HA	4.53	HA	4.56	HA
User error protection. Degree to which the system help users against making errors.	4.33	A	4.20	A	4.20	A	4.24	A
User interface aesthetics. Degree to which a user interface enables pleasing and satisfying interaction for the user.	4.32	A	4.40	A	4.40	A	4.37	A
Accessibility. Degree to which the system. can be used by people with the widest range of characteristics and capabilities to achieve a specific goal in a specified context of use.	4.47	A	4.40	A	4.40	A	4.42	A
Overall Mean	4.49	A	4.48	A	4.40	A	4.45	A

Legend: WM- Weighted Mean, VI- Verbal Interpretation, HA- Highly Acceptable, A-Acceptable, MA-Moderately Acceptable, U Unacceptable, HU-Highly Acceptable

In terms of suitability, users recognize that the LMS is acceptable as the overall mean from the three groups of respondents for the six usability categories is 4.45. Respondents reiterated during the interview that the framework is genuinely simple to use without specialized foundation as well as it is good for a wide range of clients.

The students recognized that the system is easy to use and always accessible receiving a mean of 4.49 which is ‘acceptable’. Meanwhile, the faculty members acclaimed that the system operates according to their usage requirements with a mean of 4.48. Lastly, the IT experts identified that the system is appropriate for their usage requirements with a mean of 4.40. Usability refers to the ease of usage and the learnability of the

created framework. It additionally alludes to the time distributed to play out an undertaking, blunders made and the span it takes for the client to be equipped in utilizing the framework. According to ISO 25010, it is the amount a component or model can be used by known clients to do bespoke goals with practicality, competency and consummation in a predefined background of utilization.

Table 4 reports the assessment of the LMS reliability.

Table 4
The Reliability of the LMS

Functional Categories	Students		Faculty		IT Experts		Overall	
	WM	VI	WM	VI	WM	VI	WM	VI
Maturity. Degree to which the system, product or component meets the needs for the reliability under normal operation.	4.52	HA	4.33	A	4.33	A	4.39	A
Availability. Degree to which a product or system is operational and accessible when required for use	4.60	HA	4.53	HA	4.53	HA	4.56	HA
Fault Tolerance. Degree to which the system operates as intended despite the presence of the hardware or software faults.	4.17	A	4.27	A	4.27	A	4.23	A
Recoverability. Degree to which the system can recover the data directly affected and re-establish the desired state of the system	4.37	A	4.40	A	4.40	A	4.39	A
Overall Mean	4.41	A	4.38	A	4.38	A	4.39	A

Legend: WM- Weighted Mean, VI- Verbal Interpretation, HA- Highly Acceptable, A-Acceptable, MA-Moderately Acceptable, U Unacceptable, HU-Highly Acceptable

The respondents appraised the LMS as ‘acceptable’ in which it worked dependably under ordinary working conditions and updates with a weighted mean of 4.39. The students remarked that the program addressed the challenges for reliability since it accumulated a mean of 4.41. The faculty members and the IT experts assessed the system with an acceptable reliability (WM - 4.38).

The interview revealed that the framework is accessible and has the option to offer assistance whenever the user requires. The reliability of a product framework is a proportion of how well clients are furnished with the services required. It is characterized as the likelihood of mistake free activity for a particular time in a particular climate and for a particular reason. According to ISO

25010, it is a collection of constructs that lean on the ability of the program to keep its steady execution under declared premises for an expressed time period.

LMS Implementation Plan

Table 6
The School X Knowledge Transfer Plan

No.	Task Name	Location	Owner	ETC (HRS)	Planned Start Date	Planned End Date
1	Knowledge Transfer for Learning Management System		School X	10 Days	Jan. 1, 2021	Jan. 10, 2021
2	Integration Testing Learning Management System		School X			
3	Interface Testing		School X	10 Days	Jan 11, 2021	Jan. 20, 2021
4	User Acceptance Testing (Learning Management System)		School X	5 Days		
5	Phase I- Implementation Admin Module		School X			
	User Training (Input Module)		School X	2 Days	Jan. 21, 2021	Jan. 22, 2021
	Installation and Pre-Production Run (Operationalize)		School X		Jan. 23, 2021	
6	Phase II-Implementation Faculty/ Teacher Module		School X	3 days		Jan. 25, 2021
	User Training (Input Module)		School X	2 Days	Jan. 26, 2021	Jan. 27, 2021
	Installation and Pre-Production Run (Operationalize)		School X	3 days	Jan. 28, 2021	Jan. 30, 2021
7	Phase III-Implementation Student Module		School X			
	User Training (Input Module)		School X	2 Days	Jan. 31, 2021	Feb. 1, 2021
	Installation and Pre-Production Run (Operationalize)		School X	3 days	Feb. 2, 2021	Feb. 4, 2021
8	Cut Over		School X	1 Day		

The implementation plan denotes the scheduled plan of instruction for each group of users. This also contains the matters discussed and training method used. As shown in Table 6, the project targets and the Gantt chart for the implementation of the program were illustrated.

Conclusion

The Waterfall Model was used in the development of LMS for Data Structures and Algorithms. This method encompassed several methods which are requirements analysis, system design, implementation, testing, deployment, and maintenance phases. The overall assessment indicated that the system is ‘acceptable’ as supported by the weighted means of 4.49 for the students, 4.43

for the faculty members, and 4.38 for the IT experts. Furthermore, the weighted means for each component are 4.51 for functionality, 4.38 for performance, 4.45 for usability, and 4.39 for reliability. These numerical evidence prove that the LMS for Data Structures and Algorithms serves its purpose and greatly benefits the end users especially in terms of functionality, performance, usability, and reliability in accordance with the standards of ISO 25010. Meanwhile, the ANOVA showed no significant difference in the LMS evaluation of the three groups of respondents in terms of functional suitability, performance efficiency, usability, and reliability. Therefore, the null hypothesis is accepted.

An implementation plan was also developed for the use of the LMS. It shows comprehensive procedures that elucidate the distinct functionalities of the system. A Gantt chart was created to have an idea of the timeline for the implementation. The methods in the user manual have been evaluated and tested to facilitate the understanding of the detailed usage of the LMS.

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Collaborative Interaction Management System (CIMS) for Higher Educational Institutions

Dr. Salvacion M. Domingo

Introduction

In the traditional lecture-based method of teaching and direct instruction, learning is primarily perceived as involving the simple transfer of fixed knowledge from the teacher to the students. In this paradigm, the teacher's main responsibility is to cover as much course material as possible and deliver knowledge to their students. In such a setup, learning is conceptualized as a mere additive process where the minds of students are viewed as empty vessels in which knowledge can easily be poured into. As such, learning is simplistically presumed to have occurred when students have individually acquired the knowledge they received in their heads (Bloom, 1956). While such methodology and perspective has been around for a long time, and remains the most common form of instruction, it nevertheless has numerous disadvantages (Terenzini et. al., 2001; Baghcheghi et. al., 2011).

Today, spurred by the development of several learning principles, approaches on classroom instruction have evolved considerably. Educators have increasingly realized the inadequacy of the lecture-based approach and have started to view learning as a process that is based more on student's personal experiences. This realization has spurred the re-conceptualization of learning from an additive process to a developmental one wherein students are viewed to independently and continually re-organize knowledge and had created new representations for them. In this new paradigm, learning is defined as being context-sensitive and focused on self-discovery and exploration. Knowledge therefore is viewed as being created more within a group process where interaction between individuals and the sharing of experiences in the learning activities are the primary motivators. The teacher's

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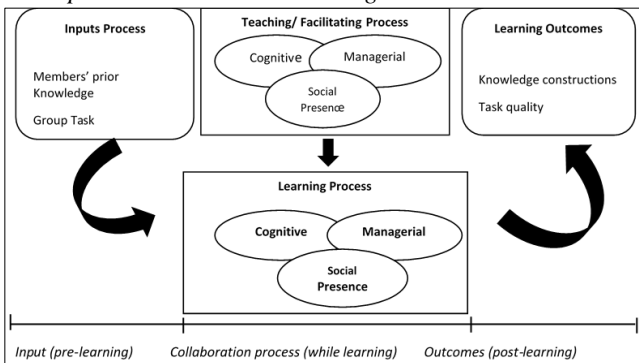
responsibility in this scenario is also shifted towards getting students to interact with each other in a productive and supportive manner rather than simply delivering course materials.

In light of the need to develop discussion support tools that can help improve the utility of educational forum discussions, the proponent sustains the idea that an environment (similar to LMS and CMS) specifically suited for implementing online forums and managing student’s collaborative interaction are necessary precursors to promoting wide-spread utilization of this communication technology among higher educational institutions in the Philippines. In this research, such technology is referred to as Collaborative Interaction Management System (CIMS). The development of CIMS is the focal interest of this study. The general objective of this study is to explore the feasibility of developing a CIMS environment suitable for use by teachers and students in the Philippine settings. Specifically, it aims to design a framework that can be used to develop the CIMS environment and implement it in a prototype web-based software artifact.

Theoretical Framework

Jahng, Nielsen, and Chan (2010) provided a sample conceptual framework describing the new teaching paradigm as shown in Figure 1.

Figure 1
Conceptual Framework Describing a Collaborative Learning Paradigm



Learning environments that emphasize the social nature of learning are considered as valuable tools in this new paradigm. Tools like forum discussions that pay particular attention to promoting and encouraging communicative cooperation and collaboration are good examples of this kind of environment. In fact, in the e-learning panacea, both in the academia and the industry, discussion forums are gaining tremendous popularity as a mechanism for increasing learner interaction (Rosenfeld and Gregory, 2012).

Unfortunately, utilization of discussion forum in academic setting has been often problematic. The main culprit is the enormous amount of time and effort that it levies to implementing teacher-mediators in monitoring and guiding student interaction. Another factor is the high level of difficulty faced by the implementing teachers in evaluating the contributions of students in such online interactions (Roig and Rosales, 2012). In the field of eLearning, similar problems are being addressed through the development of specialized environments such as the Learning Management System (LMS) and Content Management System (CMS).

The work described in this study aims to adopt the same strategy by designing a framework that could be used to develop a management system that could potentially provide teachers some assistance in managing the student's collaborative interaction in forum discussions. Such environment can be referred to as a Collaborative Interaction Management System (CIMS). It also aims to propose a strategy for constructing and developing an application that implements and demonstrates the capabilities of the proposed framework.

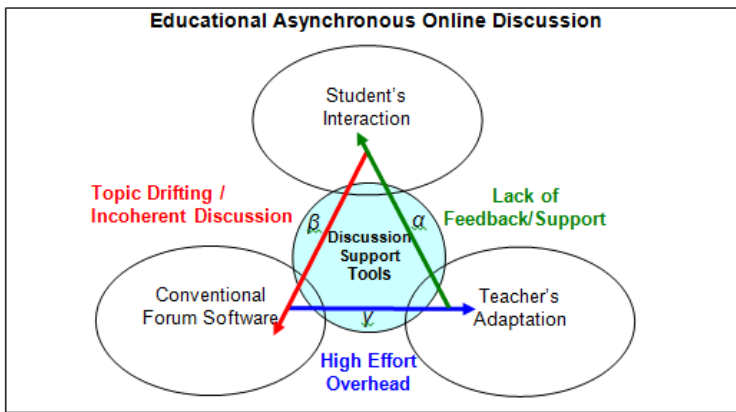
The conceptual model, shown in Figure 2, of the three important components of an Educational Asynchronous Online Discussion environment proposed by Raga (2013) provides the paradigm guiding this study.

The model highlights the three components of an educational forum environment: (1) The Discussion Forum software, (2) The Interacting Students, and (3) The Teacher Moderator. It also

shows that there is a problematic relationship that exists between each of these components. The model also highlights the importance of discussion support tools. These tools can provide functions that can act on the problems specified in order to neutralize or at least minimize its occurrence. These functions are represented as α , γ , and β in the above model.

Figure 2

Components of educational asynchronous online discussion and the problematic relationship between them



Source: Raga (2013)

For example, discussion support tools can provide information that can minimize the number of decisions that teachers have to make with regards the utilization of their time and attention and can also provide assistance with the assessment of individual student's performance (γ). Such functions can give teachers more flexibility in fulfilling their tasks as discussion moderators (α). At the same time, issues related to topic drifting and incoherent discussion can also be addressed by allowing students some access to the interaction visualizations that automated support tools can generate (β).

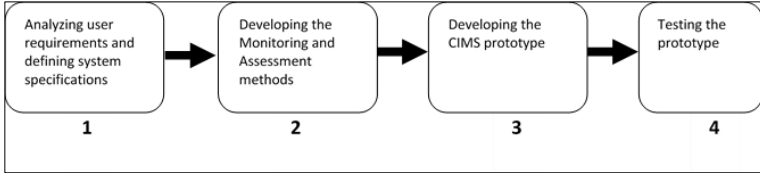
Methodology

System Prototype Development

Figure 3 depicts the outline that was followed in the development process of the system.

Figure 3

Outline of prototype system development process

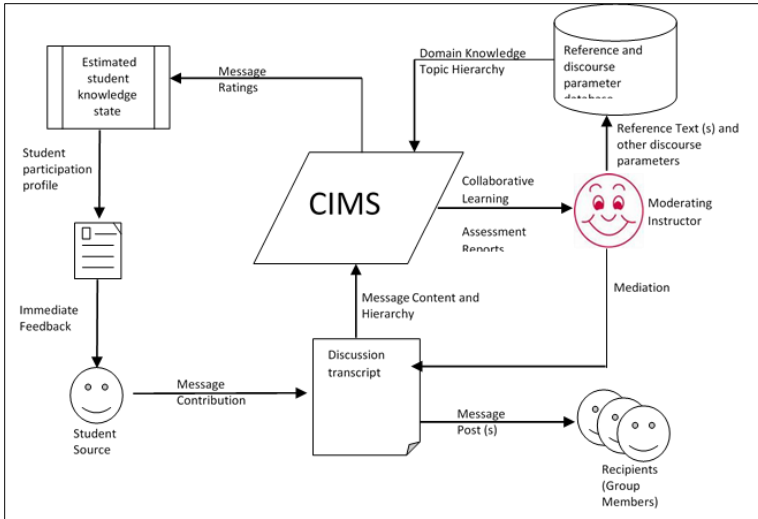


In general, problems associated with implementing educational forums can be summarized into two key issues: (1) Discussion moderation, and (2) Assessment and Feedback. As such, at the most fundamental level, the purpose of the CIMS environment is to monitor incoming message contributions of students in order to track the collaborative activity of student groups and automatically provide assessment reports on learning progress to moderating instructors. The context diagram in Figure 6 outlines some of the salient details illustrating the general applicability of the CIMS environment for this purpose.

For the activity monitoring to commence, the mediating instructor must first provide the system with reference texts/learning materials for the topic to be discussed along with other discourse parameters. The reference texts will be used as background domain knowledge by the system in generating numeric ratings of the topical relevance of each message contributions.

The numeric ratings of the message contributions, in turn, will be used to estimate the domain knowledge state of individual students, which will also form part of his/her participation profile. The participation profile will be made accessible to all students in order to ensure immediate participation feedback, allowing students to independently adjust their participation level/pattern.

Figure 4
Proposed architecture of the CIMS environment



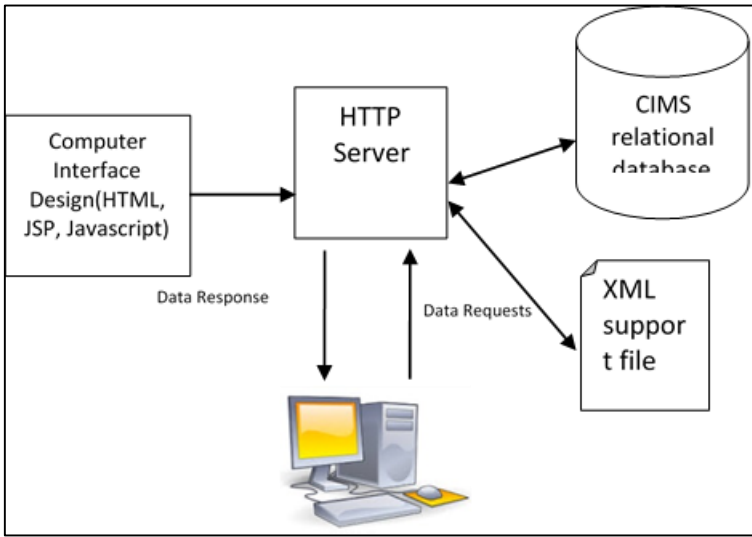
The technical skills utilized by the proponent that has an impact on the development of the CIMS environment included the following:

- programming skills for Java Server Pages (JSP), Javascript, and HTML;
- administrative knowledge of webserver, more particularly, resin-server
- database design and implementation using Microsoft Access

Utilization of these tools is described as follows:

- HTML (Hypertext Markup Language) was used to develop the front-end Web pages of the system
- JSP (Java Server Pages) was used to create a dynamic Web page interfaces that interact with the database;
- Javascript was used to write client-side validation scripts
- Resin Server was used as a proxy web server.
- The appropriate database structure was created to hold the system data and implemented in .mdb format
- Support data was stored either in XML format.

Figure 5
High level system overview of the system design



Due to the short span of development time allotted to this study, the design and behavior of the system was tested using only alpha testing and limited beta testing. To evaluate the system's compliance with the specified requirements and functionalities, the alpha testing was done as follows:

- Testing of all hyperlinks in the system Web-based interface;
- Entering of sample data via the Web-based interface to test database functionality and system displays;
- Testing of all input fields for JavaScript validation where relevant.

Two sets of forum transcript data will be used as dummy inputs follows:

1. Malfunction dataset. This dataset will be intentionally designed so that it may cause the system to malfunction or return incorrect information. The purpose of this is to cull out any unseen bugs in the system in order to fix it and improve the ability of the system to adapt and respond to incorrect input.

2. Performance dataset. This dataset will be designed to measure the system's implementation of the assessment methods along with the individual processes and data flows.

Assessment Issues

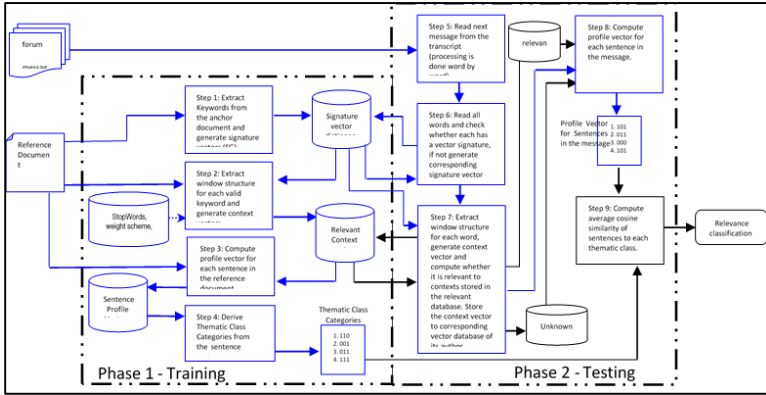
The approach developed by Raga (2013), a word space-based approach for measuring the topic relevance of message contributions in asynchronous discussions was adopted in this study. The approach implements an algorithm that combines two of the most important text signatures used in the representation of word semantics, (1) the lexical distribution similarity and (2) the statistical word regularities, in order to generate the topical relevance ratings of individual messages. Figure 7 specifies the basic schematic of this approach.

The approach consists of a two-stage process: (1) the training phase, and (2) the testing phase. The training phase requires a reference document input to be used for generating background domain knowledge of the system while the training phase processes incoming forum message contributions and measures the semantic proximity of its contents of the current domain knowledge of the system. Both phases heavily rely on Natural Language Processing Technologies (NLP).

The message ratings are addressed to the mediating instructor, wishing to distinguish the important contributions of a forum, for further examination, thus helping him/her to diminish the workload required with traditional methods (e.g. reading all the messages sequentially). Thus this approach is suitable for use in large forae, containing many threads, produced by many users, similar to the environment which is the context of this study.

Figure 6

The word-space based approach proposed by Raga (2013) for measuring the topic relevance of message contributions



The word-space-based approach enables any system to visualize the topic structure of any forum discussion. However, it only generates numeric ratings for individual messages. For this reason, to model the collaborative learning interaction of students and generate numeric group ratings, the proponent suggests the following formula which simply averages the numeric ratings of all the messages over the total number of messages generated in a group.

A word-space model is a spatial representation that derives the meaning of words by plotting these words in an n -dimensional geometric space (Sahlgren, 2005). The process of plotting words in a word-space is similar to the way points are plotted in a two dimensional graphing paper. The main difference is that, in the case of a word-space, the dimension n can be arbitrarily large; the size of which is determined by the number of unique word type in the set of words to be plotted.

Usually, the coordinates used to plot each word depends upon the frequency of the contextual feature that each word co-occur with within a text. For example, words that do not co-occur with the word to be plotted within a given context are assigned a coordinate value of zero. The set of zero and non-zero values corresponding to the coordinates of a word in a word-space are recorded in a so-

called *context vector*. Because most of the words in any text dataset will never co-occur with a particular word, the coordinates recorded in a context vector will often be sparse or full of zero values.

By itself, the position of a word in a word space does not indicate anything about its meaning. To deduce a certain level of meaning, this position needs to be measured relative to the position of other words. In this sense, a linguistic concept known as the “Distributional Hypothesis” is applied. This concept states that: “words that occur in the same contexts tend to have similar meanings”. Having similar contexts means that words are surrounded or that they co-occur with same set of words, thus, if we plot these words in a word-space they would be positioned close with each other. The level of closeness of words in the word-space is often referred to as the spatial proximity of words. This spatial proximity is what is used to represent the semantic similarity of words. A common approach used to determine spatial proximity is to measure the cosine of the angle between the context vectors; this approach is known as the cosine similarity measure. The formula for computing cosine is as follows:

$$\text{Equation 1} \quad \text{CoSim}(Q, D_j) = \frac{\sum W_{Q,j} W_{i,j}}{\sqrt{\sum W^2_{Q,j}} \sqrt{\sum W^2_{i,j}}}$$

Where: Q is a vector representing one term or document, D is a vector representing another term or document related to Q, and *w* are term weights

Currently, there are three major approaches to implementing a word space. These include Latent Semantic Analysis (LSA), Hyperspace Analogue to Language (HAL), and Random Indexing (Sahlgren, 2005). For our purpose, we opted to use the Random Indexing approach.

$$\text{Equation 2.} \quad \frac{\sum_{msg=1}^n \text{tnr}_{msg}}{n}$$

Where:

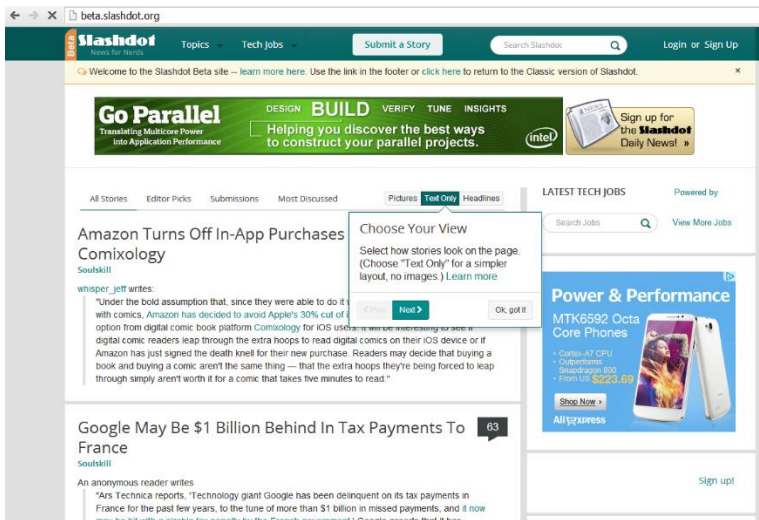
tnr is the topical numeric rating of each message

n is the total number of messages in the discourse transcript

Since this formula hinge on the numeric ratings generated by the word-space-based approach, validating its efficiency also hinges on the efficiency of the measures generated by the word-space-based approach. However, the only means of measuring the efficiency of any automated system is to compare it with the decisions generated by human analysis. Such inquiry will no doubt require a huge amount of data transcript, not to mention, manpower.

To go around this issue, this study resorts to experiments that compare the performance of the system on educational discourse transcripts downloaded from the Slashdot forum. Slashdot is a popular online technology-news and discussion site with a large membership. Its main feature is its community based moderation system that awards an explicit rating of between -1 and +5 for every message posted in its threaded discussion, where posts considered as less interesting are rated -1 and highly interesting and quality posts are rated 5. Studies show that this rating system can be used to separate particularly good and bad content from the average ones.

Figure 7
The SlashDot Discussion Board



The message data from SlashDot was considered as providing a suitable proxy data for the assessment of CMIS’s performance for two reasons:

1. The format of the Slashdot forum is fairly similar to an educational discussion type of interaction where a reference document is provided and the participants are asked to align the topic of their contributions to the topic represented by the reference document.
2. The ratings that Slashdot assigns to each message is fairly synonymous to a relevance rating since it (Slashdot) also uses these ratings to implement a recommender and reputation feature for participants that only want to read selected messages. This means that the message ratings can be interpreted and used as code tags (e.g., Relevant or Not Relevant) for the messages and this code tags can be compared to the ratings generated by CMIS.

A total of one thousand messages from SlashDot will be downloaded for this purpose and Cohen's kappa (Cohen, 1960) will be used to compare the decision of the system and the ratings of assigned by SlashDot. Cohen's kappa (K) measures the agreement between two raters who each classify N items into C mutually exclusive categories. The equation for K is:

$$\text{Equation 3.} \quad K = \frac{P(A) - P(E)}{1 - P(E)}$$

Where: $P(A)$ = the number of judgments on which the coders agree

$P(E)$ = the number of judgments for which agreement is expected by chance.

After computing for the value of K, the magnitude guidelines shown in Table 1, as suggested by Landis and Koch (1977) can then be used to interpret this kappa value.

Table 1

Interpretation of the magnitude of Kappa values as suggested Landis and Koch

Kappa (K)	Strength of Agreement
< 0.00	Poor
0.00 – 0.20	Slight
0.21 – 0.40	Fair
0.41 – 0.60	Moderate
0.61 – 0.80	Substantial
0.81 – 1.00	Almost Perfect

To give an example of how Cohens Kappa is used. Consider a scenario where two coders are tasked to classify N items into one of two possible categories (e.g., Relevant (R) or not relevant (NR)), the format of the contingency table that will be generated will be as shown in Table 2.

Table 2

Contingency table used in computing Cohen's Kappa

		Coder 2		
		NR	R	Total
Coder 1	NR	A	B	G = A+B
	R	C	D	H = C+D
	Total	E = A + C	F = B + D	N = A+B+C+D

In this table, A is the number of items that both coders classified into the NR category, while B is the number of items that Coder 1 classified into the NR category but Coder 2 classified into the R category, etc. With this contingency table, computing for P(A) and P(E) are as follows:

Equation 4.
$$P(A) = \frac{(A+D)}{N}$$

and

Equation 5.
$$P(E) = \left(\frac{E}{N}\right) \left(\frac{G}{N}\right) + \left(\frac{F}{N}\right) \left(\frac{H}{N}\right)$$

To get an idea of how the kappa statistics work, consider the contingency tables provided in Table 3. Both tables describe the classification decisions of two coders on a 50 items set.

Table 3

Sample contingency tables for computing Cohen's Kappa

		Coder2	
		NR	R
Coder1	NR	2	
	R	4	37

Contingency table #1

		Coder2	
		NR	R
Coder1	NR	16	6
	R	8	20

Contingency table #2

Computing for the kappa of the two coders in the first contingency table, we get:

$$P(A) = \frac{(2 + 37)}{50} = 0.78$$

$$P(E) = \left(\frac{6}{50}\right)\left(\frac{9}{50}\right) + \left(\frac{44}{50}\right)\left(\frac{41}{50}\right)$$

$$P(E) = (0.12)(0.18) + (0.88)(0.82)$$

$$P(E) = 0.022 + 0.722$$

$$P(E) = 0.744$$

$$K = \frac{(0.78 - 0.744)}{1 - 0.744}$$

$$K = 0.14$$

On the other hand, if we compute for the kappa of the two coders in the second contingency table, we get:

$$P(A) = \frac{(16 + 20)}{50} = 0.72$$

$$P(E) = \left(\frac{24}{50}\right)\left(\frac{22}{50}\right) + \left(\frac{26}{50}\right)\left(\frac{28}{50}\right)$$

$$P(E) = (0.12)(0.18) + (0.88)(0.82) = 0.5$$

$$K = \frac{(0.72 - 0.5)}{1 - 0.5} = 0.44$$

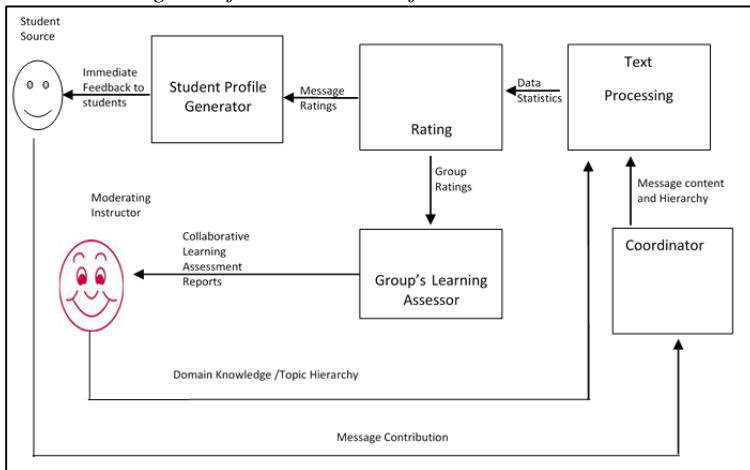
Findings and Discussion

The CIMS Software Prototype

Viewed from the perspective of its main feature, the system is composed of five blocks: the Text Processing, the Rating Generator, the Profile Generator, the Group Assessment Generator, and the main Coordinator module. Figure 9 shows the block diagram of the system and the items below describe the corresponding modules and interfaces.

Figure 8

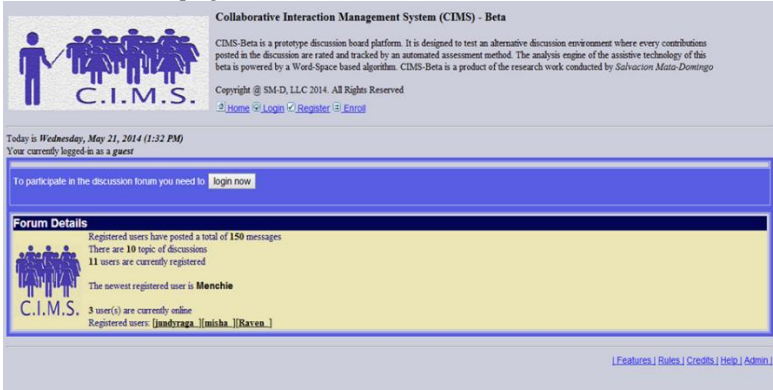
Low Level diagram of the CIMS main function



Almost the entire system (approximately 98% of all functions) was developed in JSP. The data manipulated by the system, i.e. Discussion text, participant's data, reference texts and message representations, are stored in a relational database using the .mdb format. Supporting data used by the word-space based algorithm, in turn, is stored in XML files. As the files are read, corresponding data structures and representations are created and loaded into memory by JSP functions. The web-based interface, which is responsible for the system's dynamic interaction with the users in the discussion forum environment, was developed using

combinations of JSP, HTML, and Javascript. Figure 10 shows the homepage interface of the CIMS prototype environment.

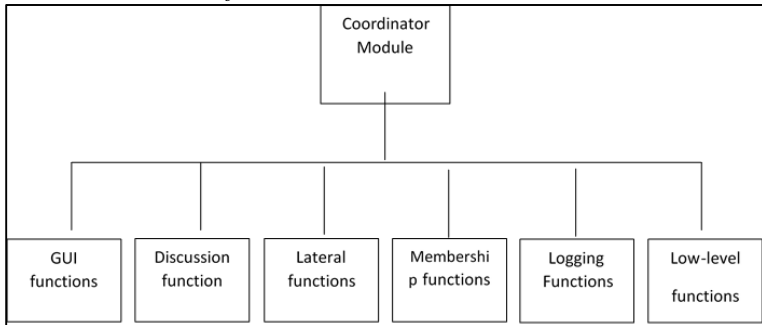
Figure 9
The CIMS Homepage



The Coordinator Module

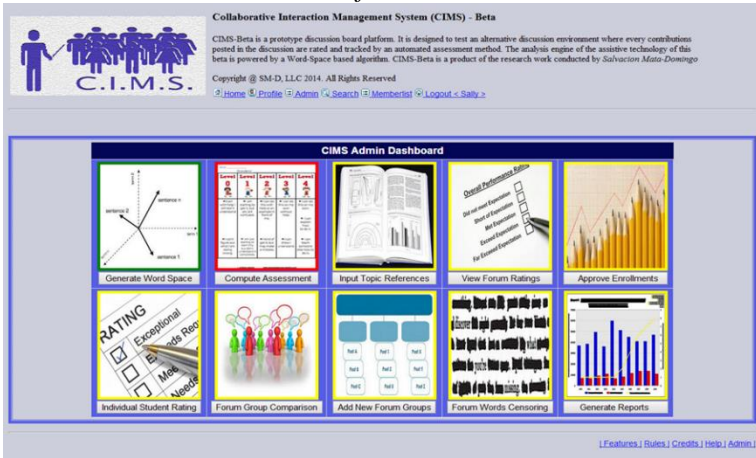
The coordinator module acts as the glue of the system. It's the source of data for all the other modules because it manages the interface that implements the discussion environment enabling CIMS to collate message contents and its hierarchy. In addition, the coordinator module also handles and activates a large number of lateral functions, which represents the various features incorporated into CIMS, as illustrated in figure 10.

Figure 10
Varied Functions of the Coordinator Module



Many of these functions were designed to be conveniently accessed by the teachers through the CIMS Admin Dashboard shown in figure 11.

Figure 11
CIMS Admin Dashboard Interface



The GUI functions. These are the functions responsible for the low-level processing of text contributions such as adding/deleting/editing messages and managing the list of participants.

The Discussion functions. Functions that perform all actions required to launch a discussion, i.e. To distribute the issues among the participants and to build the initial configuration of the discussion environment.

The Lateral functions. These are functions that are not necessarily essential to the conduct of the forum discussion, but provide additional convenience to the users such as Spell Checking, Topic Display Options, Forum Statistics, Searching, etc.

The Membership functions. These are functions responsible for collecting and maintaining profiles of participants.

The Logging functions. These are functions that implement security in the system and the update of maintained log files.

The Low-level functions. These are the functions responsible for the low-level processing of text contributions such as

adding/deleting/editing messages and managing the list of participants.

The Text Processing Module

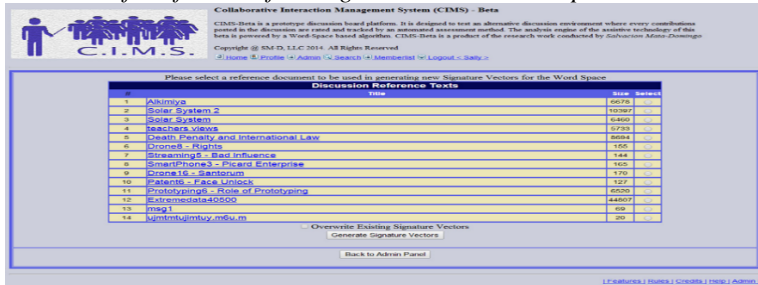
In order for CIMS to produce automated ratings of forum messages it needs a diagnostic engine that can analyze the text contents of each message. The analysis process, among other things, is responsible for manipulating the text component of messages and makes use of NLP technology to extract descriptive statistics from these texts and passes these to the rating generator module.

The Rating Generator Module

In order to generate ratings for the messages, the Rating Generator module compares the text statistics of the contents of each message to the overall text statistics generated in the reference text provided by the instructor. The measured amount of similarity is treated as the pedagogical value of the message. It then uses the formula provided in (2) to generate corresponding learning assessment for the group. Figure 16 displays the interface for converting text data into word space values which is used to compute for the ratings of the ,messages. This interface is available to the teachers through the admin interface of CIMS.

Figure 12

CIMS Interface for transforming text data into wordspace values



After the appropriate word-space have been generated, the second step of the rating process is to convert each message into its equivalent word space form and compare it numerically to the word-space of the reference text. The comparison is run through using the cosine-similarity measure which generates a value

In a nutshell, the process of generating the student profile involves collecting all the highly rated content-bearing keywords in the reference text and assigning a numeric value to each by comparing the context of how it is used in the message as oppose to the context of how it was used in the reference text. The teacher is responsible_for_configuring/selecting the final set of keywords to be used as profile templates of the students. Figure 15 shows a sample student profile generated by CIMS including the graphic representation of this profile automatically generated by CIMS.

The representation serves the purpose of providing immediate feedback to the students when interacting with each other, allowing them to self-assess and dynamically adjust their level of participation independent of their instructor.

The Group Learning Assessor Module

Along with the individual message ratings, CIMS was also designed to generate group ratings representing the perceived collaborative learning accomplishment of the group. The formula described in (1) was used to compute these ratings.

Figure 15
Summary of Group Appropriacy

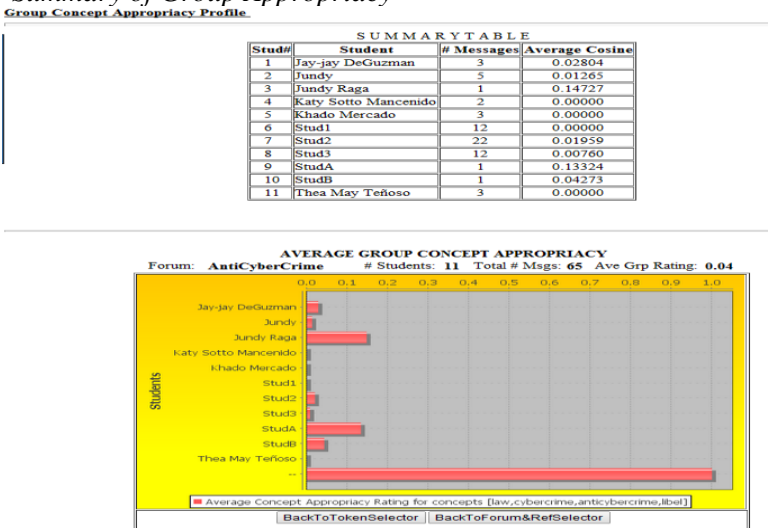
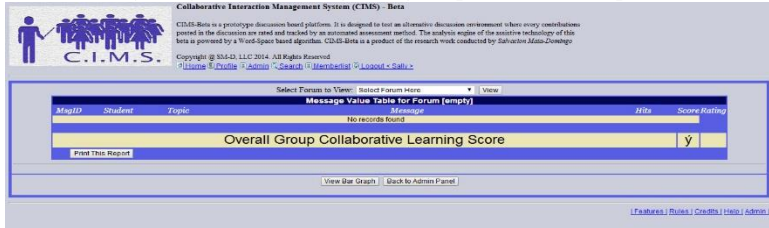


Figure 17 shows the CIMS interface for activating the process for group assessment while figure 17 shows a sample output of this process.

Figure 17

CIMS Interface for activating the group assessment process



The accuracy and reliability of the performance of the system

The validity of the assessment analysis generated by CIMS depends on the quality of the numeric ratings assigned to each message by the rating generator module. The task of measuring the quality of numeric ratings automatically generated by a system can only be accomplished by comparing it to the decisions rendered manually by human judges. This, however, is not an easy task for several reasons. Firstly, a huge bulk of data must be used to ensure sufficient amount of examples. Secondly, there is the task of asking the human judges to read each message manually in order to render their judgment.

As such, in order to go around these problems, the assessment strategy adopted is to simply compare the ratings generated by the system to the ratings assigned to messages in the Slashdot forum. The objective of this strategy is to determine whether the numeric ratings assigned by CIMS will match the actual ratings assigned by human moderators of the SlashDot forum.

Table 2 summarizes the performance dataset used for this purpose. The number of discussion threads extracted from the SlashDot Forum along with the Thread topic and the number of messages extracted for each thread are also provided.

Table 2
Summary of the results of the SlashDot Tests

Thread Topic#	Accuracy	Precision	Recall	Kappa	# of ref. docs	Total size of ref. docs used
1	0.95	1.00	0.94	0.77	3	1,732
2	0.92	0.90	1.00	0.71	2	1,176
3	0.86	0.88	0.88	0.70	13	5,373
4	0.85	0.93	0.72	0.69	5	1,745
5	0.84	1.00	0.76	0.68	7	2,941
6	0.87	1.00	0.83	0.68	7	3,387
7	0.84	0.90	0.86	0.66	6	3,170
8	0.93	0.93	0.96	0.63	6	2,597
9	0.82	0.87	0.83	0.63	6	3,942
10	0.84	0.88	0.90	0.63	9	4,239
11	0.81	0.69	0.92	0.62	5	7,735
12	0.80	0.70	0.93	0.61	6	2,711
13	0.81	0.75	0.94	0.61	6	2,342
14	0.84	0.86	0.90	0.61	4	2,666
15	0.89	0.97	0.90	0.60	8	4,224
16	0.80	0.77	0.89	0.60	4	1,938
17	0.78	0.78	0.88	0.58	3	4,558
18	0.83	0.91	0.85	0.57	1	3,959
19	0.79	0.58	0.85	0.54	3	836
20	0.81	0.83	0.91	0.54	3	1,144
21	0.81	0.87	0.87	0.53	2	856
22	0.79	0.77	0.93	0.51	11	7,084
23	0.73	0.61	0.90	0.48	6	5,054
24	0.74	0.74	0.82	0.47	5	3,102
25	0.72	0.61	0.91	0.46	5	2,643
26	0.69	1.00	0.58	0.41	1	336
27	0.70	0.62	0.87	0.41	5	2,353
28	0.71	0.74	0.83	0.34	4	6,022

The results of this test, to some extent, provided evidence of the ability of the prototype software to generate acceptable results. In addition, the experiment also offered some very interesting insights into the characteristics of the system’s performance. The results, for example, revealed some evidence that increasing the

amount of training data also increased the reliability of the systems decisions if the additional training data also focused on topics covered by some of the messages.

Novelty of the Study

Currently, available discussion forum systems lend support to on-going discussions by merely storing messages and organizing the discussion transcript in some form of hierarchy (e.g., threaded or linear). Although these structures provide distinct advantages and have gained considerable success, they also tend to promote poor results from group interactions (Romiszowski, 1995) and levy considerable effort to teachers in identifying and mediating dispersed learners.

The study aims to provide a framework that can be used to extend the capabilities of in-place structures of current forum systems for supporting online discussions. The framework will need to incorporate features that monitor the discussion and alleviate the task of facilitating and mediating it by providing both the teacher-mediator and the student-participants with an automated means of measuring the quality of posted messages. This quality measurement in turn will serve as a basis for generating continuous evaluation that will provide:

- (1) Hints to the student-participants, during message production, on the level of relevance of their contributions to the topical direction of the discussion
- (2) Feedback to teacher-mediators regarding the current status of each individual student's exerted level of participation as well as the overall quality of the interaction.

For the teacher-mediator, the feedback will provide a clear indication of problems that could develop within the discussion atmosphere ahead of time. For the student-participants, the hints during message production will provide self-assessment capabilities.

Conclusion

This study developed a framework that can be used to build a forum environment, referred to as a Collaborative Interaction Management System (CIMS) that incorporates an automated method of assessing student's individual contributions and group collaborative learning. The framework was fine-tuned by conducting a survey that identified 20 major features that faculty and students from various universities mostly prefer to be included in a forum environment. A web-based prototype software was then developed that implements the framework along with the assessment method and the 20 top features. To determine the validity of the main feature of CIMS (i.e., The assessment method), sample forum data consisting of 28 threads with a total of more than 1000 messages spanning various topic domains was collected from the Slashdot forum and the numeric ratings assigned to messages in this data was used to measure accuracy and reliability of the numeric ratings assigned by CIMS by analyzing it using Cohen's Kappa. Using Grove et al's (1981) acceptable criteria of $K > 0.5$, results show that CIMS was able to achieve acceptable consistency with a Kappa rating $K > 0.5$ among 78.57% of the threads while it was able to achieve the standard the standard acceptable kappa $K > 0.6$ among 57.14% of the threads. Although not perfect, these figures indicate that the numeric ratings generated by the system can be dependable to some degree. Finally, while establishing the consistency of the assessment methods of the system, there is also a need to determine the quality level of its software characteristics. While the ISO 9126 software quality model defines several criteria to follow, the nature of the CIMS prototype dictates that Functionality, Reliability, and Usability were the primary criteria that is easily assessable by its user groups. In other words, these are the criteria that can be adopted to enable faculty and students to assess the prototype software. Based on the results of the survey, the overall means have identified that both faculty and students feel that the prototype software are functional, reliable, and usable enough.

During testing, it was found that the procedure for processing text data inside the system proved to be a lengthy process and may not

be feasible for implementation for medium-large sized classes. It is recommended that research can be done to try and improve the procedure by minimizing overheads processes. There is also plenty of space for optimization with regards to the time and space complexity requirements of the system. At the moment, based on experience, running the assessment method to compute assessment scores with some messages will already take a few minutes to complete. In a real-world application, this would also be unacceptable. There is also no complete report printing functionality implemented. This would prove to be very useful if a tool of this kind were to be used in a real-educational situation.

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