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PerLCol: A Framework for Personalized e-Learning with Social Collaboration Support

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Abstract: The emergence of Web 2.0 technologies like social media has enhanced the interaction and social collaboration support in the educational field. On the one hand, the integration of such sources equips learners with channels to share information, resources, ideas, as well as expressing opinions and comments during the interactions. On the other hand, such integration raises some issues related to personalization by filtering the collaboration support and provide a tailored pedagogical intervention to provide adequate hints and feedback as a means of adaptivity. Existing learning management systems provide restricted collaboration features and are not tailored to students' characteristics like knowledge level and individual traits. In order to overcome these issues, we propose a framework to upgrade the virtual learning environment to provide flexible collaboration and be adaptive to learners' needs. The framework integrates social media tools for seamless collaboration. In addition, it utilizes the generated content during collaboration to identify discussed concepts and learners' characteristics to provide a personalized learning package accordingly. Descriptions of the notions required to develop the framework and an overview of its components and functionality are provided in this paper.

Keywords: Collaborative learning, Personalized e-learning, Collaboration filtering, Adaptivity.

1. INTRODUCTION

Nowadays, students are the most active and enthusiastic users of the Web 2.0 tools for flexible communication, collaboration, resource sharing and managing personal profiling. Therefore, they expect to experience the same features when performing learning activities in an e-learning environment. However, current virtual learning environments like learning management system (LMS) are providing limited and restricted interaction and collaboration manners between stakeholders [1]–[4]. Therefore, integrating Web. 2.0 tools like social media platforms can enhance the LMS to provide flexible social collaboration support. Besides, generated contents during social collaboration can be a source of information to understand the students' needs and preferences. Thus, analyzing these contents and identifying the students' characteristics help to provide a personalized learning experience [5]. This will result in overcoming the lack of personalized content support in LMS [6].

Collaborative learning is one of the learning methodologies motivated by the emergent of social media tools. The characteristics of these tools enhance the adoption of collaborative learning activities in the educational field via the learning environments. The concept of a collaborative learning environment requires establishing a networked environment. This environment facilitates active participation, interaction, and collaboration [1] besides sharing and accessing of learning resources among users [7]. The active participation opens the door for students to express themselves and share information explicitly or implicitly related to their knowledge, preferences and needs. Thus, such information needs to be extracted to offer personalization features to students as it is demanded in today's educational environments [8]–[10].

One of the most important segments in today's development and use of the e-learning system is the personalization of content, collaboration support, and building of user profiles based on the learning behavior of each individual user [11]. Personalization is a form of student-Centered learning activity which offers learners greater freedom to learn in their own way [10]. The incorporation of Web 2.0 tools opens up a range of new possibilities for collaborative activities in the era of personalized e-learning [10], [12]. Most of the personalization techniques use the former aspect of personalization [8]. Adaptive learning, tailored to user characteristics, is one of these aspects. This aspect depends mainly on student's characteristics like knowledge level, interest, learning style, etc. in relation

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to the topics or concepts required to be learnt. However, the main problem of online learning environments is their lack of personalization according to the learners' preferences [13]–[15]. Besides, the targeted information in building user profiles is mainly related to personal information such as name, address, e-mail, interest, etc). whereas personalization also requires aggregating data extracted from the chat and discussion take place between learners during social collaboration. This includes valuable information related to the learner's knowledge and preferences as well as concepts under discussion in addition to the shared learning resources. Extracting all the above-mentioned information is valuable to build the user model containing students' characteristics and domain model holding the concepts to learn in the adaptive learning environment.

In this study, we are aiming to propose a framework which provides personalization using adaptive learning techniques. The PerLCol framework is defined as a conceptual model that contains key components in order to generate personalized learning content with the support of social collaboration tools. The adaptive parameters are derived from the student interaction during the learning activities using collaboration tools. The framework also facilitates the sharing and accessing of learning resources. As we are tackling the issues of restricted collaboration and personalization in an e-learning environment, using a framework is more applicable. The framework generally provides a skeletal abstraction of a solution to a number of problems that have some similarities by outlining the steps or phases that must be followed in implementing the solution [16].

This paper starts with an introduction in section 1 followed by giving a background overview about the notions used in the development of the framework which are collaboration tools in LMSs, collaborative learning using social media, and personalization using adaptive learning (section 2). Related works attempted by other researchers in adding the social dimension with the adaptive learning by integrating Web 2.0 functionalities are discussed in section 3. Section 4 describes the architecture of the framework (PerLCol) followed by the processes carried out to attain personalization in section 5. The paper is concluded in section 6.

2. BACKGROUND

A. *Collaboration tools in LMSs*

One of the most commonly used forms of e-learning platforms is the learning management systems (LMSs). Most educational institutes like colleges and universities incorporate LMS in their learning-teaching process. As a result, the development of such platforms has been enhanced to include the social software tools for collaboration purposes. Adding such tools upgrade the functionalities of LMSs to be more than software for delivering, tracking and managing education by being a platform for interaction and collaboration [2], [17], [18]. LMSs offer learners an active role in their own learning by enabling them to be more actively engaged in the construction of their own knowledge, enjoy considerable autonomy and to work collaboratively [19].

Although LMS such as Blackboard, Moodle, Edmodo, and Sakai provide collaborative and social learning tools [18], [2], they lack the personalization feature of these collaborative tools as well as restraining users with its set of tools and functionalities [20], providing a limited interaction channel and collaboration manner between learners and educators, and restricted interaction and collaboration scope within courses [1]. Therefore, there is a need to upgrade the collaboration support provided by these systems to be more flexible and tailored to student needs and abilities.

B. *Collaborative learning using Social media*

Many technologies have passed across the learning systems in the last decade. The inauguration of Social Media (SM) presented as social networks, blogs, wiki, e-portfolio, etc. caught the interest of researchers and educators to discover how these tools can make a difference in the learning practice. However, the argument should be how to use them to add real value to the learning [21]. Therefore, the focus should be on how to integrate social software creativity to improve education, reduce cost and widen participation.

Social media provides technologies support interaction and collaboration among users, allowing them to build communities and exchange content. In terms of pedagogical advantages, the author in [22], believes that social media tools offer great opportunities to exchange rich multimedia information, collaboration, synchronous and asynchronous communication, social interaction, and personalization . Therefore, using such communication techniques will significantly help the integration of collaboration features in learning scenarios through chats, discussions, and forums [23]. As stated by [24], "This phenomenon does not affect only the way a learner perceives education based on social networking but also affects how training establishment can achieve their goals related to e-learning". State of the art in this area indicates that there is a lack of crucial knowledge in some attributes required in developing e-learning environment using social media tools for collaborative learning [12]. This indicates the need for more studies to fulfil all requirements. Integrating such tools in the LMS will overcome the restrictive aspects of existing environments. In addition, the personal information stored in SM tools and the generated content during collaboration can be used to understand the needs of each student. Consequently, his/her learning experience is personalized.

C. *Personalization utilizing social collaboration context*

The personalized learning environment is becoming more demanding in today's academic world [10], [25], [26]. According to [27], the aim of personalized learning

is to "tailor teaching to individual needs, interests, and aptitude". This form of online learning has the potential to serve the learners by providing a learning-teaching process according to the learners' needs and "enable learners to take ownership of their learning" [10]. Providing personalization as a medium of adaptation techniques helps to ensure the most effective knowledge transfer for each learner [28].

In addition, personalized courseware requires a connection with various tools like learning networks for collaboration and performing learning tasks/activities. Therefore, by incorporating interactive Web 2.0 technologies, personalized learning derives new opportunities for collaborative learning" [10]. Consequently, issues open up in this area like addressing personalization strategies and techniques, considering the whole context of the learning experience [25] including the aggregation, extraction and analysis of data generated via social interaction using Web 2.0 tools [5].

Personalization techniques like adaptive support might be a better way for targeting the individual needs of students [29]. The system adaptation should be reflected in the adaptation of presentation materials, methods of communication, interaction, and collaboration, according to requirements and characteristics of students [30]. With the emergence of Web 2.0 technologies, there is a lot of shared information in the connected network that changes rapidly, therefore only important and required information should be filtered at an individual level [31]. In the adaptation field, it is very important to differentiate between two terms – adaptivity, which is the modification done by the system, and adaptability, which is performed by the learners via selecting certain parameters of the learning experiences [32].

Adaptive hypermedia solution is an alternative to the traditional "one-size-fits-all" approach in the development of hypermedia systems aiming toward "one-on-one tutoring" dynamic web-based application. A variety of adaptive educational hypermedia-based learning tools have been explored [33]. For example, AHA! is an open-source software which is one of the most commonly used architectures in the field of adaptive web-based applications. AHA! aims at bringing adaptability to all kinds of web-based applications through a simple yet powerful adaptive engine [34]. AHA! applications mainly consist of a set of concepts. These concepts can be used to represent topics of the application domain, e.g. subjects to be studied in a course. According to [35], the core of the architecture of an adaptive application is formed by three closely linked components which are: the domain model (DM); the user model (UM); and the adaptation model (AM). In a learning application, for instance, the user model will keep track of the user's knowledge of each of the concepts in the domain model. The adaptation model defined the rules that state how the adaptation must be performed and the actual adaptation performs by the adaptive engine [35].

3. RELATED WORK

Presently, there are several studies that have attempted to add the social dimension with the adaptive learning by integrating Web 2.0 functionalities with the adaptive educational hypermedia. Frameworks like WHURLE 2.0, SLAOS, GRAPPLE, Topolor, ALEF and SALT are good/commendable examples.

WHURLE 2.0 [36] consists of five independent web services that collaborate with each other to tailor a unique view of the learning content for a given learner, and a delivery service (LMS) where the learner views this adaptive content. The framework incorporated adaptive educational hypermedia systems and web services. The WHURLE 2.0 has been tested for its adaptation and social collaborative interactive functionalities by providing it with the LMS's built-in tools such as a forum, chat, and wiki to perform the social activity. However, the aim of the study was only to investigate the extent to which students make use of the collaboration tools and if they aid in their learning process. Besides, the system separated the personalization and collaboration processes.

SLAOS [13] is a framework aiming to bring together three features which are; Web 2.0, e-learning and adaptive personalization . The framework extended the adaptive hypermedia framework by integrating a social layer. This layer has features like collaborative authoring and social annotation. The authors' approach allows students to be part of the authoring stage but with some sets of privileges. The collaborative facilities in SLAOS rely on Web 2.0 techniques, such as group-based authoring, cooperation in creating the courses, tagging the content, and rating. However, the support provided on the domain modelling level and the ability to support collaboration based on user-generated content is limited.

GRAPPLE [17] is another framework that supports the learning process via adaptive guidance and personalized content. The framework consists of two key components which are GRAPPLE Adaptive Learning Engine (GALE), where the content adaptation is performed, and GRAPPLE User Modelling Framework (GUMF), in charge of managing user model data. LMS, GUMF, and GALE are communicated through GRAPPLE Event Bus (GEB). The framework aggregate and enrich the user modelling in GUMF by embodying Mypes service which exploits dataspaces to connect, aggregate, align and enrich user profile information from social media tools [37]. However, the focus was on the personal information located in the user profile which does not provide enough information about user knowledge and other characteristics.

Topolor [38], is a framework that introduces Web 2.0 tools into an adaptive educational hypermedia system. The framework is a layered-based architecture and consist of two layers; the storage layer and the runtime layer. Topolor has a Facebook-like appearance and supports social annotation and collaborative learning by introducing the Affiliate Model. The framework provides a social e-learning environment where learners can comment on a topic, ask or answer a question, create and share notes. It also supports learning content adaptation, learning path adaptation and peer adaptation. However, Topolor does not consider the use of data on preferred items for adaptation. In addition, the framework considers the look of only one social interaction tool, which is Facebook, as a mean of a simple interaction between learners.

ALEF [39] is an Adaptive LEarning Framework. It is a framework for creating adaptive and highly interactive web-based learning systems. The system proposed a generic model namely domain model based on lightweight semantics which opens new possibilities of automated course metadata creation and student model. ALEF combines different learning activities (such as learning from explanatory texts, questions or exercises) along with highly interactive and social environment of the Web 2.0. The framework provides a personalized learning by recommending learning objects tailored to the student needs according to the student's knowledge. However, the framework suggested a limited number of social interaction mechanisms and does not support the learning object authored by students.

SALT [15] is a framework for social learning that integrates social network functionality with traditional adaptive educational hypermedia to engage students into learning through teaching and adapt learning pathways to individual student needs based on collective learning experiences. The users (student and teacher) interact with each other by contributing in constructing a small learning content in a form of mini lessons (lesslet). SALT implements self-organized personalization through learning pathways. However, the research focus is mainly on crowdsourcing and scalability issues like grouping students based on similar user's performance.

As presented in this section, the utilization of the user-generated content and social interaction functionalities for personalization is tight and not fully consumed. In fact, the potential for providing a personalized learning based on social interaction and collaboration features remains not fully explored.

Therefore, the aim of this paper is to address the above-mentioned gap by proposing a framework for Personalized e-Learning with Collaboration support (PerLCol). The framework provides personalization using adaptive learning techniques based on the information generated using the collaborative tools during the interaction between stakeholders. The collaboration and social interaction are flexible using different social media tools. The following section will discuss the proposed framework (PerLCol).

4. PERLCOL ARCHITECTURE

The PerLCol architecture is illustrated in Figure 1. The architecture presents the framework in five layers named as User Interface, Interaction, Extraction, Adaptation, and Storage.

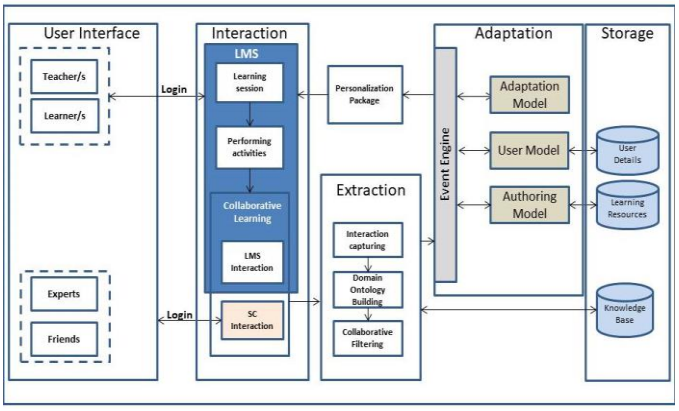

Figure 1. PerLCol Architecture

The first two layers (user interface and interaction) represent the interaction area in the framework. The user interface consists of the actors and the login mechanism used to access LMS and social collaboration tools like social media. The interaction layer is composed of the main interaction mechanism via the LMS starting from learning session, performing activities and interaction session through the collaborative learning session. The interaction happens using social software tools in LMS or an external social interaction tool. The Learning Management Systems (LMSs) like (Moodle, Blackboard, Sakai, etc) have been used to facilitate the learning process and students' administration support. The purpose of adopting LMSs in this proposed framework is to enhance the restrictions applied during communication and collaboration functionalities to be more flexible. This flexibility can be attained by the adoption of social media tools. Social media tools will help to give learners space for discussion and interaction without any restrictions. Besides, allowing them to interact with people outside the learning environment as an expert in the area of the activity or concept under discussion is called social collaborative activities [40].

The interaction layer is followed by the extraction layer for capturing the interaction during activities and performing the collaborative filtering process, based on the created domain ontology. The extraction of information starts by the interaction of the capturing task. This task involves collecting the chat conversations from different collaboration tools by using aggregation and mapping techniques. It also requires applying text mining and transformation technique to guide the building of the

domain ontology. The domain ontology will be the reference for the execution of the collaborative filtering task. The collaborative filtering is aiming to identify two learners' characteristics which are knowledge level and learning style. This can be accomplished by extracting information related to the student domain knowledge and type of learning resources the learner prefers.

The adaptation layer (adaptation area) consists of four components which are User Model, Adaptation Model and Authoring Model. The Event Engine component is used to facilitate the communication between these components in a smooth manner.

- **Event Engine:** This engine facilitates the communication between the various models in the adaptation area as well as communication with the interaction area via the interaction capturing and adaptation filter. The use of such an event engine to exchange information/data means that all components need to understand communication only via the event engine.
- **User Model:** This model represents the different characteristics of the learners that can be used to generate an individualized learning experience. The data in this model can be gathered from the users' profiles in the LMS and or the social media tools to deal with personal information and via interaction to gather data related to knowledge level and the student preferences and abilities. It is worth mentioning that this model will be updated throughout the learning process.
- **Adaptation Model:** This model contains the rules and strategies that determine how to present the personalized entities such as contents, feedback or hints.
- **Authoring Model:** This model is used to define the conceptual and pedagogical structures of a course, and to associate content and relationships between the concepts.

The output of the extraction layer is the source of information for the adaptation layer components. For instance, the domain ontology will help to feed the authoring model, while the identified learner's characteristics will be used for building the user model. Performing the personalization task requires the interaction between three models; user, authoring and adaptation which is managed by the event engine component. The event engine also manages the interaction between the extraction layer and the adaptation as well as between the adaptation layer and personalization package component. The latter is responsible for passing the adaptation output to the learner via the learning session in the LMS.

In addition to the adaptation layer, there is a storage layer to store all the data required for the personalization task. The knowledge base stores the knowledge extracted from the interaction session. All the details about learners will be saved in the user details, knowledge base and learning resources stores data related to the domain model concepts and learning resources.

5. PERSONALIZATION PROCESS IN PERLCOL

The personalization meta-model presented in Figure 2 shows the concepts involved in the personalization process. The social collaboration interaction is all about the discussion of the learning concept(s) related to the learning activity entered via the learning session in LMS. The interaction capturing concept which is linked to the collaborative filtering concept aims to collect the generated content at the social collaboration interaction and performs some pre-processing and ontology modelling tasks. The collaborative filtering concept responsible for identifying learners' characteristics (learning style and knowledge level) will be stored in the user model. The interaction capturing concept also associated with the domain model. This model is classified by the learning concept and learning content. The adaptation (personalization) is performed by the adaptation model. This model is associated with three linked concepts to generate and deliver the personalization. These concepts are the domain model, user model and personalization package. The latter is associated with the learning session to deliver the personalized learning content related to a specific learning concept.

The personalization process in PerLCol is divided into five stages. Each stage will be responsible for performing part of the personalization process. This section is discussing each stage.

Stage 1: In this stage, the interaction between the learners and teachers or others, such as experts and friends, occur for the purpose of constructing knowledge and performing an activity. This interaction takes place using either social media tools as an external service plugged into the learning environment or using the discussion forum available in the LMS. This plugin aims to ensure the privacy of the LMS (Moodle). A mashup by aggregation approach [41] has been used to provide a single interface (space/dashboard) which aggregates different social media tool (SM interaction) components.

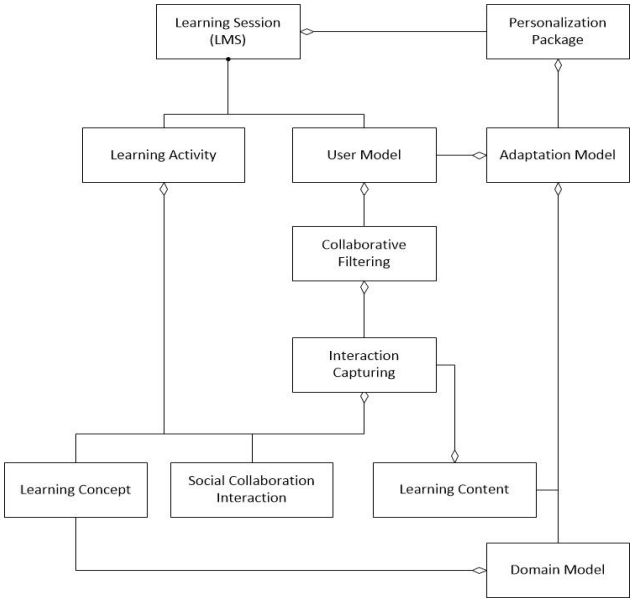

Figure 2. Personalization meta-model

Stage 2: The interacting process which took place in the first stage needs to be captured from the interaction software. This capturing is performed in two steps. The first step is by collecting the data of the interaction session using different web crawling techniques. Some social media platforms like Facebook, Twitter, and YouTube offer an application programming interface (API) for data tracking and collection. Others, like blogs and online discussion forums, offer rich site summary (RSS) feeds to make it easy to track and collect the data. The collected data will be in a different format and use different attribute names. Therefore, a mapping technique is required for providing a common unified structure for the data collected from different social media tools as a means of aggregation and standardization.

However, the collected data is not yet ready to be processed in the collaboration filtering model. Therefore, a pre-processing technique is needed where raw data is transformed into a usable format, mainly by cleaning, assigning attributes, and integrating data. Subsequently, we have applied various data mining and text mining techniques to examine the data sets in order to create the domain model and gain insights about the learner's knowledge level and preferences [42]. To facilitate the text mining process, GATE [43] has been selected. GATE is an example of a tool for text mining which allows you to combine all the necessary natural language processing (NLP) components. This is considered the second step in the capturing process.

Stage 3: The third stage is the domain model creation from the cleaned data. As reported in [44], IMS Learning design is more effective in supporting collaborative and adaptive learning experiences because it can easily be understood by both educators and students. Therefore, the learning design adopted in this study is based on IMS learning design. Based on this model, a learner has a role in the learning process towards certain outcomes related to some learning concept. This can be done by performing a learning activity within an environment. The environment, such as collaborative learning, involves using some social media tools or LMS's discussion forum. This type of environment consists of learning objects related to the concepts which belong to the learning activity. The proposed model (see Figure 3) is similar to the approach in [45] where the target concept or domain is the learning activity (LA). This learning activity has a list of vocabularies representing terms or concepts related to the LA. This relation called HasPart, which means that the term/concept is part of the LA. These concepts/terms can be also related to each other using the IsRequiredBy relation. Another connection is the HasResource relation where each concept/term connect to a learning object (LO) using the HasResource relation. Identifying these concepts and relations will use concept extraction and relationship discovery.

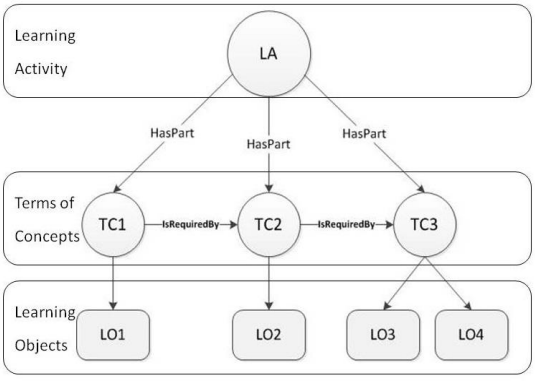

Figure 3. Semantic Relations in Learning Activity model

Stage 4: The fourth stage in this process is the filtering of the data. The filtering is performed in the collaborative filtering component. This part is performed after the construction of the domain model. The aim of this task is mainly to build/update the user model by estimating the knowledge level of the learner and identifying the learning style. The modelling of the user is a combination of overlay and stereotype approaches. The learning style is represented in stereotype and knowledge level based on the domain model is represented in the overlay approach. The information related to the performed activity expresses opinions and shared resources will be used in this stage. This stage is referred to as user modelling process (see Figure 4)

For the purpose of estimating the knowledge level of a student, the focus will be on the user-generated content related to the topic of the activity (domain model) which can identify the engagement of student. This engagement can identify how active the student is in the discussion and consequently help to identify the knowledge level by calculating the rich of the shared content. The measure of

the knowledge level can be obtained by calculating how rich the content shared by a learner is. In this study, the authors adopt the same measure concept used by [46] to define the content richness score.

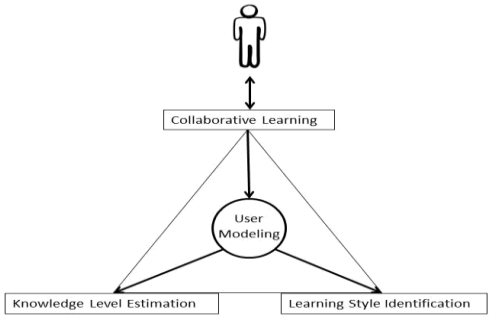

Figure 4. Triangular learner model based on collaborative learning

Identifying the learning style of each learner based on the LO preferences was gathered in the previous stages. The Felder-Silverman Learning Style Model (FSEL) [47] has been adopted in this study. The Dynamic Bayesian Network (DBN) technique is used to model the learning style identification. To determine the learning style (LS) of any student, there is a need to extract information related to the learner's preferable format of learning objects as they have a direct relationship with the LS identification. Based on the preferable learning objects, the learning style can be identified. Table 1 shows the categorization of the learning styles based on the preferable LOs as proposed by [48].

TABLE 1. Learning styles categorization based on preferable LOs

Learning style	Preferable Learning Object Type
Visual	Image, Video, Animation, Hypertext, Chat Application
Verbal	Audio, Video
Sensing	Image, Animation, Chat Application
Intuitive	Text, Hypertext
Active	Chat Application
Reflective	Text, Hypertext
Sequential	Text, Audio, Hypertext
Global	Chat Application

Stage 5: In this stage, the extracted knowledge will be used to update the user model and the authoring model. More importantly, the updated data is the key to providing the learner(s) with a personalized learning package which will be generated by the adaptation model. The adaptation is based on rules and strategies that determine the suitable content to be presented to the learner based on his/her learning style and knowledge level in relation to the domain model.

The learning package will be delivered to the learners via the adaptation filter within the learning session when the learner initiates the session the second time. The delivery is controlled and decoded by the adaptation filter.

Since the LMS (Moodle) is the interface used by the learner for the learning process, the personalized package will be delivered to them within the learning session. The package will consist of the preferable type of learning objects of the topic which required to be learned by the learner according to the estimated knowledge level.

6. VERIFICATION AND TESTING

To verify the framework, a collaborative learning platform has been developed and used by a class of 24 learners who are enrolled in Information Technology major to discuss software development lifecycle. The discussion is related to the learning activity or main concept waterfall model and term of concepts; requirements, design, implementation, verification and maintenance. As the first stage for verification, the discussion has been collected and analyzed to identify the learning style of the learners. All the details about the identification are discussed in [49]. This step gives a clear information about the preferable learning object/s and the anticipated learning style/s as illustrated in Table 2. The collected data has also been used to estimate the knowledge level of each learner based on how rich the shared comments is. The calculation of the knowledge level is discussed in [50]. The sample estimated knowledge level for the participated learners in the main concept (waterfall model) is represented in Figure 5. These representations indicate the level of knowledge categorization (Low, Medium, High), based on the definition of knowledge level measurement of low (0.00 - 0.33), medium (0.34 - 0.66) and high (0.67-1.00). Based on the results indicated in Figure 5, 46% of the participated students are in the low category, 33% in medium and 21% in high. The effectiveness of the framework identifying the learning style and knowledge level supports the next step which is to provide the personalization package. Using these two learners' characteristics, the personalized learning package is generated using an identified algorithm. An example of generated package is depicted in Table 3.

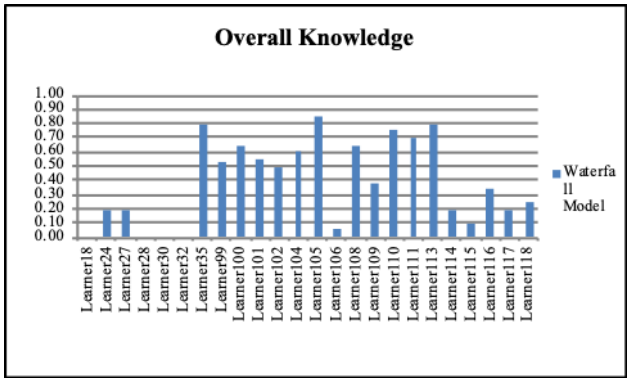

Figure 5. Estimated knowledge level for waterfall model main concept

TABLE 2. PREFERABLE LEARNING OBJECTS AND LEARNING STYLE IDENTIFICATION

Name	Preferable type/s of LO	Learning Style
Learner18	doc, pdf	Intuitive, Reflective Sequential
Learner24	Ppt	Visual, Sensing
Learner27	doc, doc	Intuitive, Reflective Sequential
Learner28	Doc, doc	Intuitive, Reflective Sequential
Learner30	Doc, doc	Intuitive, Reflective Sequential
Learner32	Ppt, of	Visual, Sensing
Learner35	Doc	Intuitive, Reflective Sequential
Learner99	Ppt, image	Visual, Sensing
Learner100	Ppt, image	Visual, Sensing
Learner101	Image, video	Visual
Learner102	Image, video	Visual
Learner104	Image, Image	Visual
Learner105	Image	Visual
Learner106	Image, Image	Visual, Sensing
Learner108	Ppt, image	Visual, Sensing
Learner109	Image, ppt	Visual, Sensing
Learner110	Ppt, Ppt	Visual, Sensing
Learner111	Image, Image	Visual
Learner113	Ppt, Ppt	Visual, Sensing
Learner114	Ppt, image	Visual, Sensing
Learner115	Ppt, image	Visual, Sensing
Learner116	Ppt, Ppt	Visual, Sensing
Learner117	image, video	Visual
Learner118	Ppt, image	Visual, Sensing

TABLE 3. EXAMPLE OF GENERATED PERSONALIZED LEARNING PACKAGE

Name	Personalized learning package
Learner18	Audio, Video, Text, Hypertext
Learner24	Image, Video, Animation, Hypertext, Chat Apps
Learner27	Audio, Video, Text, Hypertext
Learner28	Audio, Video, Text, Hypertext
Learner30	Audio, Video, Text, Hypertext
Learner32	Image, Video, Animation, Hypertext, Chat Apps
Learner35	Image, Video, Animation, Hypertext, Chat Apps
Learner99	Image, Video, Animation, Hypertext, Chat Apps
Learner100	Image, Video, Animation, Hypertext, Chat Apps
Learner102	Image, Video, Animation, Hypertext, Chat Apps
Learner106	Image, Video, Animation, Hypertext, Chat Apps
Learner109	Image, Video, Animation, Hypertext, Chat Apps
Learner114	Image, Video, Animation, Hypertext, Chat Apps
Learner115	Image, Video, Animation, Hypertext, Chat Apps
Learner116	Image, Video, Animation, Hypertext, Chat Apps
Learner117	Image, Video, Animation, Hypertext, Chat Apps
Learner118	Image, Video, Animation, Hypertext, Chat Apps

7. CONCLUSION AND FUTURE WORK

As the utilization demand of social media tools in the field of collaborative learning has increased, there is a need to embrace such advanced learning techniques in the e-learning environments to provide a more engaging experience to its learners. Adopting such tools requires addressing issues related to integrating external services into a learning environment and provide learners with some personalization characteristics along the learning process. Despite the good attempts by e-learning developers to provide collaborative and social interactive platforms with some personalization features, they failed to address all issues related to seamless collaboration and personalized e-learning.

Therefore, this study is an attempt to provide the learners with a more engaging learning space which uses technologies such as social media to improve student collaboration and learning by providing a tailored pedagogical intervention using adaptive learning techniques. This technique aims at providing intelligent hints and feedback to improve individual students' learning. The framework proposes a novel technique in aggregating the chat information from different social collaboration tools and then perform analysis and data mining techniques to construct the domain and authoring models and to update the user model. Learning session

in Moodle is the interface used to deliver the personalized learning package.

The results from the framework evaluation and the analysis of the user-generated content during social collaboration are positive and promising. This motivates us to continue working in this direction and conduct more evaluation with more students from different courses. We believe that social collaboration features promote student engagement, participation and collaboration. Consequently, these enhance the possibility of understanding the students' characteristics to support, providing the personalization feature.

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