Towards generative learning objects on microblogging platforms

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Abstract

In this paper we present a few ideas towards the integration of the generative learning objects (GLO) in microblogging platforms like Facebook and Tweeter. Our approach is focused on a data structure and algorithms (DSA) course which is dedicated to students enrolled in the long form of studies, short form of studies and also distance learning programs. Generative learning objects are learning objects described using instantiable templates thus generating concrete learning objects. Our model of GLO has several features like: automatic instantiation based on random number sets, difficulty level configuration followed by the automatic generation, generative features for each of the three items of an object: sentence, answers and the most important the feedback. The generative learning objects are of several types like: single choice, multiple choice, short answer, long answer or even games embedding game mechanics. The considered DSA lecture has competence taxonomy of four levels like: domains, general competences, specific competences and variables on which the learning objects are linked. The student gets a generated sentence in order to develop a competence variable, he answers it and then depending on the answer the learning object will issue the necessary feedbacks to drive him to the correct answer along with detailed explanations. For the DSA lecture domain we considered the competences of using in programming: search algorithms, sorting algorithms, trees data structures and graph data structures. The discussed issues regarding the two concepts of GLO and microblogging are: how the information will be transferred between the student and GLO e-learning platform including text, generated images; how should be modelled the GLO platform output and the student input given the fact that microblogging means short message exchange; how can we benefit from the social network in the implementation of a rewarding system.

Keywords: learning object, generative learning object, social network, data structures and algorithms.

1   Introduction

Nowadays students tend to use more and more digital equipment like: mobile phones, tablets, phablets, laptops, tablet PCs etc. Even game consoles and TVs tend to get "smarter" and to enable access on the social networks, social media channels, and microblogging platforms which can be used for education.

In this paper we will present how microblogging platforms in the context of social networks may help improving e-learning based on generative learning objects (GLOs) which are a specialization of learning objects (LOs). We will sketch the profile of an e-learning application accessible on microblogging platforms built on social networks and based on the concept of GLO. Any social network can be easily considered a microblogging platform because of the built-in posting features.

GLOs are abstract learning object models which can be instantiated or generated in order to become concrete learning objects ready to be consumed by students. Usually GLOs contain reusable pedagogical templates which can be reused in different contexts.

We will focus on the GLO model for the Data Structure disciplines from the field of Computer Science (CS). The intent is to target the disciplines which develop programming competences in order to train better and faster more computer scientists and software engineers for the industry.

The paper is structures as follows. In section 2 we will discuss about microblogging issues and how its features fit into the educational process. In section 3 we will present the e-learning application model for the social networks. In section 4 we will present the Data Structures disciplines generative learning objects to be implemented on the e-learning application. In section 5 we present some prototype development insights. In section 6 we present related works. Section 7 concludes and set the perspectives.

2 Microblogging in education

Microblogging [11] concept derives from the concept of blogging and allows users to exchange online small elements of content. Microblogging is the practice of posting small pieces of digital content on the internet like: text, images, links, and videos. Usually, text messages are limited to the extent of 140 characters and links are shortened using special algorithms and online reference storage. The users of microblogging are quite diverse: i) business organizations use microblogging for marketing, public relations; ii) artists announce their concerts or exhibitions; iii) writers announce their next book releases; iv) politicians announce their tour schedules in the political campaigns; v) teachers use it in higher education [9], namely in class lectures, announcing tests, exams, class cancelations etc.

There are several use cases of microblogging in universities which already included it in their curriculum with the purpose of creating a backchannel among the students in a class. For example, in a literature class the teacher can post the main topics of a lecture while students can comment silently in the classroom, contribute or express their opinions on the discussed topics. The disciplines taught with microblogging support seem to be more from the field of humanistic disciplines where the space of ideas and comments on a certain topic is much larger and easy to grasp than in other exact sciences where formulas, function graphics, tables are needed.

Generally, microblogging activities includes: i) posting comments also known as microposts; ii) replying to comments; iii) tagging comments with relevant keywords; iv) searching posts with specific tags; v) creating lists of posts as personal stream of information, usually by the help of aggregator applications or web browser plugins.

For CS disciplines LOs can be designed as such to fit to the input capabilities of microblogging, but other types of interactions are also needed. Some of the interactions can be mapped to text and small images easily handled by microblogging platforms while others cannot because of their complexity. For example, the properties of trees or graphs can be taught easily using small image examples with questions attached expecting short answers, while the steps of a radix based sorting algorithm can be better presented using animation and assessed by a user who has to reproduce interactively the same algorithm moves.

The results of microblogging practices are multiple. Thus, people can have a spontaneous and organic communication channel. Information posting is instant. The content is not verified by censors except with some small restrictions of word filtering. When participating in an event people may express directly their own involvement. On the other hand, microblogging can supplement the traditional sources of information. It can help people give updates of crisis situations in countries where traditional media is under political control.

In education microblogging could help forming a personal learning network (PLN). We consider this idea in our approach in order to get support from the colleagues with the learning objects when the content is very difficult to the student. The selection of such a helping colleague or temporary tutor must be accomplished by using data from the social network graph but also from the e-learning system. The friend status of a student will enable better confidence level for the assigned temporary tutor. A good competence assessment result for the temporary tutor will enable the necessary authority to help the student. On the other hand a load indicator must be set in order not to overload the temporary tutor with many helping demands. In the case where the algorithm cannot find a suitable tutor then the in class teacher should be selected.

There are also several drawbacks of microblogging. Some people consider microblogging a waste of time for just reading are writing small talk messages. A good design with motivating user interface will increase the time spent on the content and the continuous interaction will keep them active. On the contrary, during the student dead time, like traveling time, waiting time in contexts where no performant terminals are available nor operable due to harsh conditions, with mobile device he could develop competences on such a GLO based online e-learning application.

In the context of mobile phones text messages have fees attached, so it can get expensive. Microposts have to be relevant and of certain importance for the use in order to keep his interest and to have some economic or personal value, otherwise microblogging may become a tedious activity. Good motivational LOs have to be designed in this sense in connection with industry needs in order to ameliorate this aspect.

Another drawback is related to revealing of personal information like the current location, participation to events which may expose the microblogger to several kinds of threats like harassment, stalking or other criminal activities. Answering to generated LOs and tutoring colleagues will not automatically expose too much privacy. The public assessment results may be a potential target for head hunting companies.

Instant posting has the drawback of releasing very easily sensitive information which otherwise would be restricted or protected. In the context of our e-learning application the microposts channel could be made private or available only to the students of the class and maybe to recent generations to get tutors.

Also legal or copyright issues may arise since posting is a kind of authoring activity. The legal issues can be settled by signing user agreements at the beginning of the enrolment and they depend on the local laws.

Microblogging platforms can be accessed on mobile operating systems like: Android, Windows Mobile, iPhone, Blackberry. In our approach we consider that Android is the most important mobile platform where the

porting of the e-learning application would have the biggest impact. On workstations and laptops the application can be accessed uniformly from browsers like: Internet Explorer, Mozilla Firefox, Google Chrome, Safari. A careful implementation of the e-learning application based on standardized web libraries will enable uniform behaviour on these platforms. There is also the choice of desktop applications and third party outlook application plugins we consider not of great interest because of the limited impact. Microblogging is enabled by microblogging platforms, some open source, which usually offer a basic set of services which are used by third party aggregator applications.

3 The e-learning application model

In our approach we intend to experiment the model of GLO based e-learning application which is designed to develop competencies in the field of CS disciplines, namely the discipline of Data Structures and Algorithms. The competencies are organized on a three level structure: general competences, specific competences and variables.

The GLO model is based on static theoretical descriptions and generated questions, answers and feedback. A GLO will have several sections: i) scenario – informal description of the GLO parameters and behaviour, used only in the development of the GLO; ii) theory – a small description of the competence variable; iii) generated question – according to the scenario; iv) generated answer – according to question; v) generated feedback – according to the question and the answer; some can be general and some can be specific to the use case. We intend to have three sorts of GLOs with specific purposes: i) learning – the generated LO will expose all its sections; ii) training – the generated LO will expose all its sections except the theory; iii) testing – the generated LO will expose only the question section and the answer will be used for assessment. Initially, the student will start with the learning GLOs which should have organized in ordered lists. Then the student should go into the training GLO where he can develop the current competence. We consider that learning and training objects should have links from one to another. The link from learning to training is the natural course of learning while the link from training back to learning should be accessed in the case of repeated training failure. The testing GLOs should be enabled only by the tutor at a specific moment.

Exact detection of competence flaws is hard and in order to ameliorate this problem we designed a dependency relation between the variables. For example, one could not understand sorting algorithms while searching algorithms are still not well understood. Considering the spirit of freedom and respect for the student we will allow him to select whatever GLO he wants to learn.

The e-learning application will issue an adaptive behaviour in the case of repeated training failures taking into account the competence tree prerequisites and suggesting more basic GLOs to start with.

Another supporting idea in this sense is the creation of a keyword glossary index with terms and concepts for the additional competences not included in the current general competence. For example, in the process of learning sorting algorithms expressed in C programming language some students might have code understanding problems. In this case keyword based generated links towards concepts from the glossary could be a feasible solution unless the computer programming discipline is modelled using GLOs.

The e-learning application should operate in several modes. In supervised learning mode it should issue the following features: i) to generate one common question for all students in the class; ii) to read the student answer; iii) to issue the feedback; iv) to show other questions and answers and to allow comments on the subject.

A second mode is supervised testing when the application: i) generates individual actions organized in a list; ii) shows the answers at the end of the action list in the form of a comparison between student produced and computer generated answers.

A third mode is the unsupervised learning, training and testing when accessing the application from outside school. The following ideas should be implemented: i) the system sends a question; ii) the student answers the question; iii) the student sees the other available answers from the students in the past; iv) to recommend students to ask questions to if not clear. Temporary tutors could be selected according to several criteria like: i) by assessment results on the topic; ii) by number of given answers; iii) by friend relation in the social network. The recommendation system can be based on metrics like Euclidian, Pierce, Manhattan, etc.

4 Data Structure discipline GLOs

We took as working content the material from the University Politehnica Timişoara, Romania where the Data Structure discipline is taught during two semesters in the second year of study. In the first semester are taught searching, sorting, backtracking algorithms and data structures like lists, hash maps while in the second semester are studied: general purpose trees, binary trees, B-trees, graphs (oriented, weighted) together with their algorithms. From this set of studied concepts we selected what we consider the most important like: i) linear searching algorithm; ii) binary search algorithm; iii) interpolation searching algorithm; iv) insert, select, bubble, shaker sorting algorithm; v) shell, heap, quick, bin, interchange radix, direct radix sorting algorithm.

These algorithms we consider general competences under which we design the general schema of specific competences. We will exemplify describing the specific competences for the linear searching algorithm. The first specific competence deals with knowing where the linear searching algorithm is used. We designed two variables: i) in what practical situations linear searching algorithms are used and ii) what is the role of that algorithm.

The second specific competence deals with variables containing GLOs responsible for knowing the correct input for the algorithm like on what kind of arrays linear search may be applied. Related variables cover several aspects like: i) knows that the algorithm can be used on a random valued array; ii) knows that the algorithm can be used on a ordered array; iii) knows that the algorithm can be applied on several scalar and non-scalar data type arrays.

The third specific competence deals with variables around the concept of algorithm result. In the case of linear search we need to know: i) what is the result of the algorithm; ii) what is the behaviour in the case of a successful search; iii) what is the result in case of an unsuccessful search.

The fourth specific competence deals with algorithm recognition when several parameters are changed: i) several cycling instructions are used: for, while, do … while; ii) different data structures are visited; iii) different variable names are used.

The fifth specific competence is about knowing the algorithm steps: i) initialization sequence; ii) running sequence; iii) decision and report. For the current case study the steps are just a few but for a more complex algorithm like for example radix sort they are quite many.

The sixth specific competence deals with knowing the logical diagram, pseudo-code and code of the algorithm. We consider of interest: i) making a correspondence between natural language steps and code lines; ii) ordering correctly the blocks from the logic diagram; iii) ordering correctly the lines of algorithm code.

The seventh specific competence deals with making connections between the algorithm steps and code lines. For the current case study we have the index which must move in the search of element.

The eighth specific competence deals with knowing the algorithm variables on aspects like: i) identification; ii) role and semantic.

The ninth specific competence is optional and refers to improved or evolved versions of the algorithm. In the case of linear search the improved version refers to the concept of sentinel which optimises the search with a comparison less at each step.

5   Prototype implementation considerations

The e-learning application seems to fit better into the profile of a Facebook application since the majority of the students have already created accounts. There are some advantages like i) the login mechanism; ii) the access to the social network graph; iii) the already implemented comments mechanism with posts on the user walls.

The application is hosted on a webserver with active POST capability. For the client side we use HTML and JavaScript code. For the server side the PHP interpreter is a non-expensive choice. For the persistence layer we use a relational database engine like MySQL or PostgreSQL equipped with stored procedure to enable data access logging.

The application has two ends a front-end for the student and a backend for the tutor as content designer and editor. The front-end will offer competence development capabilities, knowledge assessment mechanisms and rewarding features. The student will navigate in the competence tree and select the desired learning objects. There should be available the necessary assistance organized on several levels for the student to reach its competence development goals. The helping sessions offered to colleagues is also a measure which needs rewarding with posts on the web other people to see an appreciate them.

The assessment results will be stored according to the standard offered by the Experience API or xAPI [15]. The results will be displayed and promoted at students will on the Facebook walls for others to see it and create a little competition to increase motivation and interest.

A Twitter application could also be considered in the form of a standalone application with filtering channels and specific educational actions. There are two choices: i) as a web application ii) as a desktop application.

6   Related works

This section surveys previous work in the domain of LOs and more specifically GLOs.

The definition of LO content is not very straight forward. According to the IEEE standard a LO is a digital entity which can be user, reused or referenced in the process of technology enhanced learning [12]. The definition was given by Wayne Hodgins in order to enable teaching content standardization all over the world.

SCORM [16] is a different content reference model with the purpose of sharing across multiple learning management systems. They standardize the sequencing of LOs with optimal learning paths.

The concept of GLO was coined by Boyle et al. [2,3] and Morales et al. [13] in order to enhance the potential of LO reusability. The approach resembles to the object concept of object-oriented technology from the software engineering domain. The design principles behind this concept that enables authoring dynamic and reusable LOs are described in [1]. The content of the LO must be somehow generated in an automatic or semi-automatic manner by some kind of technology. There are two known approaches for the LO generation or instantiation: i) based on templates and ii) using meta-programming. The approach of Boyle et al. is to use the GLO Maker tool (www.glomaker.org) which is based on a template technology in order to reuse a best practice pedagogical pattern where several types of content can be embedded. The approach of [8,17] is to use meta-programming for the generation of concrete LO instances.

In [4,18] is presented a GLO based framework for the teaching of computer science disciplines by programming robots at school level. The framework consists in five components like pedagogical activities, technology driven processes, tools, knowledge transfer actors and pedagogical outcomes. The GLOs are considered as black box entities which enable robot based visualization that demonstrate how programs and algorithms are transformed into real world tasks and processes.

In [14] an implementation model of GLOs is presented with applications in the economical domain of accounting, namely on the topic of depreciation. The GLOs include animation, textual instructions, and automatic evaluation in order to increase student interest and to improve the competences on the selected topic. The proposed GLO model embeds also an analytical feature to determine student performance, student time spent on the content in order to determine its performance. In [19] it is presented a framework for generating online assessment based on the Model Driven Architecture principles in two steps: i) meta-modelling and ii) generated prototype implementation.

In [5] is presented an e-learning framework based on generative techniques and dialog in order to develop competences for disciplines like native language and mathematics. In [6] are presented two frameworks that can enable MOOC implementation in the primary and middle schools. In [7] are presented learning objects for the competence assessment process in a few CS disciplines like Data Structures, Programming Language Fundamental Concepts, Operating Systems, and Compiling Techniques.

7   Conclusions and perspectives

We can conclude that the idea of porting GLOs on microblogging platforms is feasible and has a great potential on developing PLNs. The proposed GLO model in the context of microblogging platforms will benefit from: i) increased accessibility; ii) feedbacks of multiple students; iii) choices in selecting a temporary tutor from the best students.

Comparing our GLOs in the context of microblogging approach with classical learning management systems (LMS): i) general statement vs. particular statements; ii) generic tests vs. static tests; iii) generic answers vs. static answers; iv) generic feedback vs static feedback; v) complex LO model vs. simple LO model. The drawback of our approach is that GLOs are: i) difficult to design because needs programming skills and some prior knowledge of the template library; ii) difficult to implement since may need writing some new code; iii) difficult to test since the generation will enable a huge number of states in the N dimensional space taking into account the multiple parameters of the GLO.

As perspectives we intend to fully implement the e-learning application based on the GLO and microblogging ideas. We intend to use the GLOs with students enrolled in undergraduate evening studies programmes, distance learning programmes but also in undergraduate day studies programmes. On midterm perspective we estimate that GLOs – second generation objects – will be available in classic LMSs having more or less expressivity power depending on the level of complexity embedded in them.

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