# A Knowledge Management System to Classify Social Educational Resources Within a Subject Using Teamwork Techniques

María Luisa Séin-Echaluce[1(✉)], Ángel Fidalgo Blanco[2], Francisco J. García-Peñalvo[3], and Miguel Ángel Conde[4]

[1] University of Zaragoza, Zaragoza, Spain
mlsein@unizar.es
[2] Technical University of Madrid, Madrid, Spain
angel.fidalgo@upm.es
[3] University of Salamanca, Salamanca, Spain
fgarcia@usal.es
[4] University of León, León, Spain
miguel.conde@unileon.es

**Abstract.** The traditional way to develop contents for a subject is based on the faculty perception and experience, however students should be taken into account. This work proposes a methodology that promotes the creation, classification and organization both teachers' and students' learning resources within the same subject scope in a timeless manner. Teamwork process is monitored by a proactive method that makes possible the generation of resources collaboratively. A knowledge management system allows to Classify, Search, Organize, Relate and Adapt the generated resources and includes a semantic search engine, based on ontologies, which provides a final product for users' needs. A first iteration of an action-research allows answering questions such as the types of resources created during the teamwork (with academic, social and service orientation), how to stablish a common organization of the created knowledge for all potential users and improve educational resources of an academic subject with these collaborative resources.

**Keywords:** Knowledge management system · Educational repositories · Teamwork competence · E-learning · Service learning

## 1 Introduction

Before Internet became as permanent tool in education, teachers used to use books or notes as learning resources. Students got those books, the teacher's notes or the notes taken by them. Current proliferation of online systems and the social media make extremely easy and quick to achieve different learning resources and share them among peers.

On the one hand, teachers often provide learning contents through the Learning Management Systems (hereinafter LMS), usually structured according the syllabus of


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the subject. The organizational structure depends on the specific technology. Teachers select the sequencing and timing for the resources availability, and students can access to them through the platform as a simple consumer.

On the other hand, the use of teamwork methodologies has increased exponentially in higher education, specially demanded from professional fields. Among the teamwork benefits, Boundless [1] emphasizes the following: increased efficiency, greater effectiveness and faster speed (by the combination of individual efforts), more thoughtful ideas (from the ability to focus different minds on the same problem) and mutual support and outcomes, that make better use of resources. In this sense, Collaborative information created by students during an official subject enriches student learning and experience of teachers. Schuster [2] also says that "Collaborative document creation enables humans to solve complex problems in a team, to exchange ideas, and to benefit from synergistic effects."

Moreover, teamwork increasingly converges to the knowledge management fields [3] and Nonaka and Takeuchi [4] stress the importance of teamwork in the conversion of tacit knowledge into organizational knowledge. In educational organizations the knowledge created by the work teams and related with the topics of a specific subject, can improve its resources (academic contents) if they are accessible to the next subject's edition students. In particular, academic contents related to social and service aspects increase student motivation and improve student learning. Astin et al. [5] show, in a study of 22,236 students, that service learning influences positively on different dependent measures such as writing skills, critical thinking skills, values, self-efficacy, leadership, etc.

In that sense, the information generated by students is only usually used during the period of subject teaching (increasingly smaller with biannual subjects) and has a very limited impact. But if resources created by students can be used outside the spatial and temporal subject's context, this fact produces an experience's enrichment to all stakeholders (creator students, prospective students and teachers). Some authors pose that thinking and creating resources has a big impact on the students' learning but using repositories, with contents created by other authors, encourages critical thinking and avoid "reinventing the wheel" [6].

This work proposes a methodology that promotes, classifies and organizes both teachers' and students' learning resources within the same subject scope in a timeless way, allowing students from different classes to introduce new resources. Students generate new resources by means of collaborative and reflective teamwork methodology. The academic contents, generated in a specific subject, are integrated with social and service motivations (explaining academic contents to the course fellows, motivating to start to future degree freshmen or showing opportunities to future graduates). Both collaborative and service learning offer obvious benefits to students [7, 8].

Also a knowledge management system (hereinafter KMS) is used. It makes possible to classify the resources created by the teams during a subject edition. This provides access to authors, prospective students and faculty, the access to the resources created. Moreover the KMS provide adapted searches to students based on their particular needs so the resources can be really useful to them [9].

In order to carry out this work an action-research methodology is used, which has the following features: (1) It takes the context into account,which means that may some problems of a specific context; (2) It is *collaborative*, addressing collective concerns of the agents included in the present context that, grouped in teams, are based on review and reflection; (3) It facilitates self-evaluation, the discussion and reflection process produces a permanent assessment of the practice and its results directly affect their improvement [10, 11]. In this case the context is a specific academic subject and the aims are: categorizing, organizing and accessing to resources created collaboratively (during TW) and studying its impact on improving learning. This paper is the first iteration of action-research and provides the basis for optimizing the classification, organization and access to content created collaboratively. The assessment and improvement of resources and of the impact on the learning of the users of these contents is the objective of other work already underway.

Therefore, the following questions arise here:

- What kind of knowledge, based on student experience, can be generated by themselves to help prospective students of the same subject/degree?
- Can the knowledge, based on the students experience in a subject, be organized and published in a common way to all of students?
- Is it possible to create educational resources from the knowledge generated by students?

In order to achieve the objective of this work it is essential that students were motivated, active and organized; and what it is still more important is that they explain their experience to help their peers. This experience exchange process is facilitated by the proactive method *Comprehensive Training Model of the Teamwork Competence* (hereinafter CTMTC) [12, 13]. This method has been used to promote dynamic cooperative work teams to form and assess the teamwork competence.

But the knowledge generated collaboratively must be managed flexibly and dynamically. This will generate new relationships between knowledge, that allows finding useful information for a further application in different contexts. To manage knowledge the CSORA system (Classify, Search, Organize, Relate, Adapt) [14] is applied. This system contains, among other features, a semantic search engine which allows searches based on ontologies, logically connected, which define the search target. Categorizing the generated contents is a key element of its management and subsequent search.

In the following sections the context of action research is exposed, the proactive method CTMTC for the students to create contents based on their experience is described, as well as the CSORA system. Finally the main results obtained in this first iteration of action-research and the conclusions of this work are presented.

## 2 Research Context and Teamwork Methodology

This study involves 107 students (grouped into 18 teams) of the subject “Programming Fundamentals” of the Biotechnology degree, taught at the Technical University of Madrid. The topics included in the teamwork process are Web 2.0 and Cloud Computing.

These teamwork topics are the 25 % of the total subject's contents and they are associated to a 25 % of the final grade. The remaining 75 % of the subject is based on traditional taught (lectures and labs).

Teamwork monitoring and individual and group teamwork assessment are done with the method CTMTC [12, 13]. It is a proactive method based on three aspects: teamwork phases (mission and goals, map of responsibility, planning, implementation and organization of documentation), collaborative creation of knowledge and cloud computing technologies (wikis, forums, social networks and cloud storage systems). Team members collaboration and individual evidences are continuously monitored by faculty along the teamwork phases and through this cloud technology. This monitoring carries out training assessment by teachers to guide students' individual learning. At the same time, this method allows teacher to do partial summative assessments in order to compose the final summative evaluation of TW. The work [7] shows the potential of this method.

Team members, team coordinator and works topic are all chosen freely. This last one has to fulfill two conditions: current subject students must be the target audience and knowledge must be generated from the personal academic experience (in the subject, other subjects or as a result of the academic life).

Teamwork is developed online along the course (forums and wikis/Dropbox are used to communicate and store contents respectively). Every four weeks a classroom session is carried out in order the teams can present their partial results. Faculty use these presentations to teach and stimulate discussion and reflection.

During teamwork process, team members interact with the systems used (the LMS and Dropbox). These interactions are individual evidences of students' activity. Specifically the evidences taken into account are: interventions in forums or usual mobile communication applications (mainly WhatsApp messages), group evidences (on the achievement of the TW phases, mission and goals, map of responsibility, planning, etc.) and outcomes (final resources of teamwork). Individual and group evidences of a team are accessible only by faculty and team members. However, the final result should be accessible via the Internet and the teams can choose an online tool (wikis are recommended, but other systems such as web pages are used).

Work teams optionally make a video (10 min maximum) to present the final result, describe how the team is organized and partially show individual and group work evidences.

## 3 Results

In this section the typology of contents, generated by work teams, and their inclusion in a KMS are presented. It is important to point out that the high cooperation among team members made possible the creation of resources with high quality and usefulness. Regarding the cooperation between team members during the teamwork development, the average number of messages per member was 83,94, only in the official forum. All messages were grouped in thematic threads to describe the different phases (that were created for different issues of phases). Work teams have an average of 29,33 thematic threads.

### 3.1 Types of Generated Knowledge

All teams finished the work and organized their resources (texts, videos, presentations, etc.) through online systems. 66,34 % of total teams organized the work result in a wiki, while 33,33 % did it in a website. Each final work (wiki/website) had an average of 25,16 individual content pages.

Regarding the format of the created resources, the 88,89 % of total teams made a video to present briefly their final work. All these videos also include a description of how the forum was used to facilitate the communication between team members and the team's organization with the aim to produce collaborative knowledge.

Regarding the source of knowledge generated by teams, it can be grouped in: Knowledge generated by students of a specific subject, knowledge generated by students of other subjects and knowledge generated by graduates integrated into professional environment.

Each team members identified previously the type of contents to be created and its usefulness for the rest of subject's students. Table 1 includes the specific type of knowledge observed in the results, grouped by their source.

**Table 1.** Types of generated contents from their sources

| Subject's students |
|---|
| Academical support (organization, subjects, competences, teamwork, etc.) |
| Wellcome pack |
| Biotechnology degree information in Technical University of Madrid |
| Information about other universities with Biotechnology degree |
| Subjects' information |
| Faculty's information |
| Students and faculty poll on the first bi-annual subjects |
| Center spaces (classrooms, labs, etc.) |
| Center Associations |
| Freetime, transport, events, courses, etc. |
| **Subject's external students** |
| Grants, financial support |
| Academical itineraries |
| Advices |
| Interchanges |
| **Graduates** |
| Professional opportunities |
| Companies |
| Research institutions |

### 3.2 Knowledge Organization

The work teams organized their experience with their own criteria and without a common organization of resources. Finding a particular resource means that the user needs to access to 18 websites and browse in more than 453 specific web pages. But web search engines are not suitable to only search on specific websites as a set. The number of websites will increase each academic year and, consequently, the organization of knowledge generated by students will be much more complicated.

In this paper a KMS is used to solve the mentioned difficulties. Once the typology of resources has been analyzed in the previous section, they are classified by means of ontologies in the KMS which includes a semantic search engine. The system is called CSORA (Classify, Search, Organize, Relate, Adapt) and was developed by one of the authors in the "Laboratory of information technologies' innovation", Technical University of Madrid [14]. This system is being successfully used in the "Information Points Network on Research Development and innovation activities". It has shown its effectiveness to search R&D&i projects because the user's searching is based on generic search targets, without knowing the specific nature of what is searched [15].

An ontology (set of tags) is proposed for this educational environment. It is based on the traditional models used in innovation [16], which have been already tested in educational innovation contexts [17]. The proposed tags are grouped in categories following the classification: input, process and output. Input includes categories referred to the knowledge source. Process refers to academic activities related with the knowledge. Output refer to the type of created knowledge: academic support, welcome pack, professional opportunities, etc. See Table 2 for more details about example tags included in the categories.

**Table 2.** Proposed ontology

| | Category (tags) |
|---|---|
| **INPUT** (knowledge source) | **Author** (Students, Faculty)<br>**Academic Course** (2013-2014, 2014-2015)<br>**Degree** (Biotechnology, Energy, Mining)<br>**Subject** (Computing and Programming, Programming fundamentals)<br>**Topic** (Numeric, Computing, Algorithms, Matlab) |
| **PROCESS** (usefulness and activity related to resource) | **Learning** (Theory, Laboratory, Examples, General description, Notes, etc.…)<br>**Activity** (Exam, Practical session, Theoretical session, Teamwork)<br>**Teamwork competence** (Mission and objectives, Chronogram, Results, etc.)<br>**Technology** (Wiki, Dropbox, Website, Forum) |
| **OUTPUT** (type of knowledge) | **Type of knowledge** (Professional opportunities, Welcome pack, Degree information, Academic support, Leisure, Students' Associations, etc.) |

The search engine included in CSORA system allows defining a search based on logical expressions, with connectors (and, or), between different ontologies and by means of text.

Also, CSORA allows several ways of selecting and organizing the contents. Any user of this search engine (current students that create the contents and contribute to the repository, future students that will use the search engine and teachers) can generate a portfolio (file with editable text) with a selection of resources obtained during the search. Faculty also can organize the search outcomes as a personalized webpage with their own selection. See Fig. 1. An example of a search with the following tags: "Example" and "Teamwork" and ("Chronogram" or "Planning") and "Professional opportunities". This search generates examples and chronograms (or planning) during teamwork process about professional opportunities.

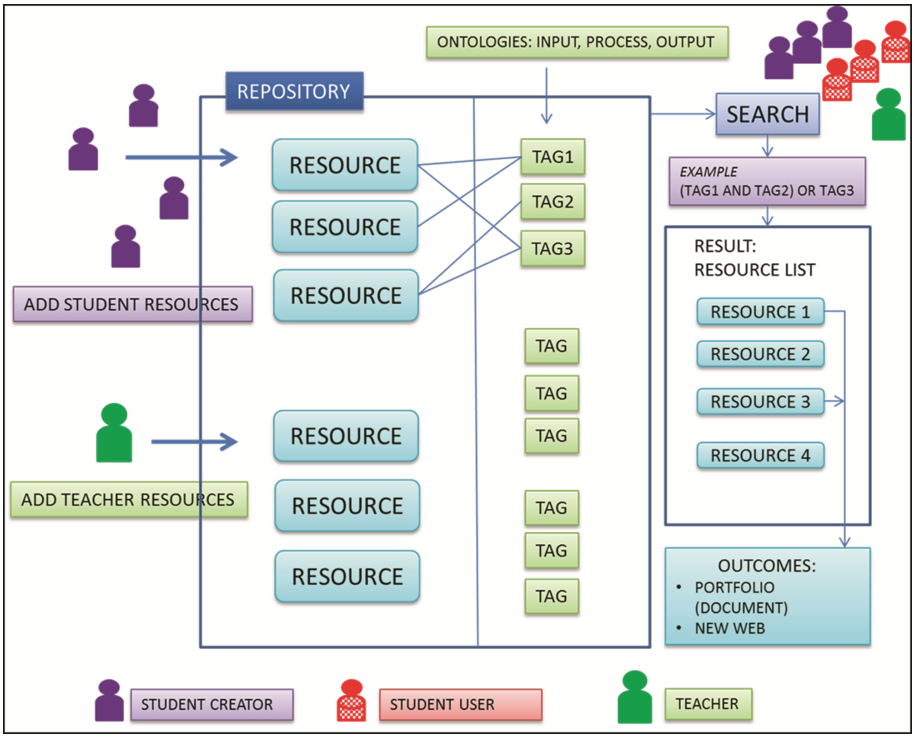


**Fig. 1.** Design of search methodology

## 4 Discussion

The previous considerations try to answer the questions proposed in the introduction.

What kind of knowledge, based on experience, can be generated by students to be helpful for prospective students of the same subject/degree? The authors have carried

out an analysis of of the types of resources generated collaboratively. Students have been interested in the creation of academic knowledge included in the subject and also in the knowledge as a service to academic life (helping present and future students). Both types of knowledge improve students learning [8]. This knowledge has been obtained through the interaction with other people in the same school of engineering (students of higher courses and faculty external to subject) and outside the school (external professionals and research organizations). The analysis shows the typology of knowledge generated by students: academic support for current subjects, information about their own experience to choose the Biotechnology degree, information about services and necessary places to carry out academic and learning activities, information about different formative itineraries, scholarships, grants and professional opportunities.

Can the knowledge, based on the students experience in a subject, be arranged in a common way to all of students? Students have chosen wikis and website builders to organize their generated contents and publish the evidences of the teamwork. However, it is necessary to organize the learning contents under a common point of view to give service to both current and future faculty and students. In this proposal the tacit knowledge (informal, personal and social) becomes organizational knowledge [4] and the common point of view of its management is based on both the nature of the generated contents and their applications. The considered KMS (CSORA) allows classifying, organizing and searching the contents regarding to indicators common to all students and covering different search objectives.

Is it possible to create educational resources from the knowledge generated by students? In this research students have generated resources from the reflection inside the team, but also with the rest of students during the sessions oriented by the subject's teachers. In addition each team has chosen freely the topic of the generated resources and has linked academic topics with social and service motivation. All of this provides educational features to the resources which help authors to learn [2]. Besides the resources, educational examples and good practices are included to the subjects for future students.

## 5 Conclusions

Students generate learning contents from their own experience acquired from: subjects they are studying, interaction with their own context (degree, school) and from the interaction with their peers, as for instance students in upper courses.

CSORA searches allow the definition of new resources by identifying and joining learning contents created by the different teams. Initial expectations of this work have gone further away. From the traditional contents based on specific contents of the subject, students have generated social and helpful learning contents. For this reason it is possible to develop learning resources, assessment resources and even services both for past, present and future students (for example, degree orientations or professional opportunities). The generated resources can also be helpful for the mentorship planning that most of universities carry out, because mentors could make use of these resources to orientate students in lower courses.

Regarding the teamwork, students have generated resources to explain how they have interacted, how they have used cloud computing tools (forums, wikis and online storage) and to show the final work.

The analysis of the generated learning contents in this work highlights that this is the first step for freshmen to initiate a reflexive path into service learning, which will report great benefits in their academic learning and the future professional life. Astin et al. [5] shows that reflexive service learning provides improvements and says "the power of reflection as a means of connecting the service experience to the academic course material".

For future studies the starting point will be the current repository of contents generated by teams. The following stages of the action-research will be carried out by means of: studying the impact on the learning process of new subject's students and students with the same needs in other subjects, the evaluation of resources already created regarding to their usefulness to improve them and orientate the creation of new ones, the integration with the educational resources generated by faculty and the future access to the repository's resources by their own authors.

With respect to the applicability of the generated resources, the start up of the mentors' usage is another future work line. In that sense, mentors could identify the students' needs (symptoms), establish a training plan (diagnostic), use the learning resources available in the system (rehabilitation plan), generate a document with these resources using the search engine and monitor the results (check the effectiveness of the training plan in order to maintain it or change it, introducing useful comments about the process inside the generated document). The final generated document will be stored in the KMS to help other mentors. This way the generated knowledge jointly with learning resources will help students with similar needs.

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