A Student-Centered Collaborative Learning Environment for Developing Communication Skills in Engineering Education

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Abstract— Communication skills development is one of the main goals of engineering education. We propose an integrated student-centered collaborative learning environment for developing communication skills, using project-based learning methods and peer assessment. In our learning environment, projects are assigned to small groups of students under teacher supervision, documented in a wiki-editing tool and presented during a public poster session. By combining wiki entries and poster presentations, we intend to facilitate students (1) to gain access to the project of their peers and share their results, (2) to analyze and comment critically the project of their peers and provide them with feedback, and (3) to enhance their writing and oral skills. Previous experiences encourage us to promote this integrated learning environment. Wiki environments allowed students to improve the quality of their projects and to develop a critical attitude towards their projects and the projects of their peers. The poster session was found to be more dynamic than traditional oral presentations. Students got engaged in a more open and critical manner with the project of their peers, and students presenting their project had the chance to improve the quality of their presentation on the fly, by presenting their work several times in the duration of the session. In future courses, we will implement a learning environment that combines both wiki-based and poster session approaches. We expect that the implementation of both approaches will help to develop the communication skills of engineering students.

Keywords- communication skills; collaborative learning; wiki; poster session; project based learning.

I. INTRODUCTION

One of the main goals of engineering education and higher education in general, is to enhance students' communication skills, which comprise abilities such as reflection, critical thinking and analyzing, writing and oral skills, and teamwork. Engineering curricula sometimes include courses that are specifically devoted to developing communication skills. Another common approach is to develop them as transferable skills and create in any course, irrespective of its contents, a learning environment that promotes reflection, criticism, analysis and bidirectional communication between the teacher and the students, and among students themselves.

A successful way of enhancing communication skills is by organizing students in groups, which are assigned specific tasks or projects. Group projects are being increasingly used in higher education in general, not only because they facilitate the intellectual and social dimensions of education, but because they mirror industrial approaches to problem solving [1]. Group projects promote discussion between the members of the group, i.e. intra-group communication. In addition, presenting projects in oral sessions further enhances communication skills at inter-group level and serves as a basis to disseminate students' work among their peers. Finally, group project approaches, in both intra-group and inter-group dimensions, open up the possibility of peer assessment, which constitutes an interesting experience for critical thinking and analyzing [1]. Nevertheless, in certain cases as for example, when there are a large number of students, achieving agile dynamics in the classroom when using group project approaches can be difficult. In this scenario, disseminating the work of each group and collecting feedback from their peers can be problematic, and oral presentations can be lengthy and passive.

Communication skills development can benefit from the use of web-based collaborative environments. The emergence and rapid proliferation of web-based collaborative environments, notably the Wikipedia [2], has revolutionized the traditional models of understanding the nature of knowledge itself, and has promoted the creation of global knowledge communities. As an inevitable consequence of this knowledge revolution, web-based collaborative environments have entered the classroom too, mainly in the form of a wiki. A wiki is simply an on-line editing tool that allows its users to create, comment and navigate a collection of documents, which are also known as entries. Web-based collaborative environments have been implemented for different purposes in the classroom. Some authors have emphasized the use of wikis and similar tools as repositories of shared knowledge [3] [4]. Taking the constructivist paradigm as a basis, other authors have highlighted the opportunities that wiki environments offer in education [5]. Reflective learning and critical thinking can also benefit from wikis [6] [7]. Finally, wikis allow coordinating group projects on a global scale [8].

In this paper we propose an integrated student-centered collaborative learning environment aiming at enhancing communication skills. Specifically, this environment promotes the development of fundamental abilities such as writing and oral skills, critical thinking, analyzing and teamwork by using project-based approaches, wiki-based environments, poster presentations and peer assessment. The rest of the paper is organized as follow. In Section II we describe the design of our integrated learning environment. In Section III, we present the outcomes of previous teaching experiences that included some of the fundamental components of our proposal. Finally, Section IV conveys our conclusions.

II. LEARNING ENVIRONMENT

Communication skills comprise a collection of abilities, which include reflection, critical thinking and analyzing, writing and oral skills, and teamwork. We propose a learning environment to enhance communication skills that can be implemented in an engineering course, irrespective of its contents. We form our approach based on constructivism. According to this paradigm, the best way that people can learn is by means of constructing knowledge itself. The main features of constructivism are the following [9]:

- Knowledge is constructed through reflective abstraction.
- Cognitive structures facilitate learning.
- Cognitive structures are in continuous development.

Taking constructivism as our starting learning theory together with student-centered teaching approaches, the basic ingredients that form our learning environment are two, namely project-based methodologies and peer assessment. By organizing students in project groups we seek to facilitate students to construct knowledge, to engage students with the subject matter of the course, to promote discussion among peers in the same project group, i.e. to promote intra-group communication, and to stimulate teamwork. Peer assessment favors reflection, critical thinking and analyzing, and peer communication.

In order to create a learning environment that integrates all these elements coherently, we propose to implement two strategies to promote communication, documentation and dissemination of knowledge in both the writing and oral dimensions. The strategy for enhancing writing skills uses a wed-based collaborative tool, namely the wiki. The strategy for enhancing oral skills consists of a poster session during which students present in public their projects. They are described hereafter.

A. The writing dimension: Wiki environment

A wiki is an on-line editing tool that allows its users to create, comment and navigate a collection of documents that are known as entries. By extension, this collection of documents is sometimes referred to as wiki as well. With respect to their accessibility, wikis can be either of three categories. Wikis are public when any user can gain access to

their contents and modify them. They are semi-public when any user can gain access to their content, but only authorized users can modify them. Finally, they are private when only authorized users can access and modify their contents.

Wikis possess the following interesting features. Firstly, since many users can edit their content they are suitable for *collaborative* applications, in which users collaborate to create knowledge. Secondly, public and semi-public wikis are visible to anyone, and therefore their contents can be *shared*. Finally, any authorized user can *revise*, *discuss* and *modify* the content created by other users. If we accept the constructivist paradigm together with student-centered approaches, these three features can make of a wiki a useful tool for the classroom:

- Projects or in general assignments that are documented by means of traditional editing tools, such as handwriting and computer text editors, usually reach the teacher and hardly a few students. On the contrary, an assignment edited in a wiki can reach the whole class no matter how large the number of students. Therefore, assignments can be shared and any student can benefit from the work of their peers.

- When the documentation of a project reaches all in the classroom, everyone can participate in the process of critical analyzing, discussing and providing feedback. Additionally, wikis provide with the necessary tools to revise and discuss each project. In other words, wikis' features facilitate peer assessment and inter-group communication.

- As opposed to other knowledge repositories such as books, that too many times are perceived as absolute and definitive, the use of a wiki can make the process of constructing knowledge transparent to students.

In summary, wikis constitute an interesting tool that provides a framework for students to construct knowledge critically and to enhance communication skills.

B. The oral dimension: Poster session

Public oral presentations constitute an excellent opportunity for students to develop their communication skills and stimulate inter-group interactions, reflection, and critical thinking and analyzing. When the number of students is limited, it is doable to promote an environment in which everyone participates. However, when the number of students is large, the most common situation is that at any time one group presents their project while the rest of the classroom act as a passive recipient. In these cases, attention is lost quickly and only the most active students from the audience participate, relegating the rest to a second plane. As a consequence, the scope of public oral presentations is greatly reduced.

Public poster sessions can overcome these difficulties while still enhancing communication skills. During a poster session, every group or only a few groups present their projects

simultaneously in different stands that are distributed on the same physical space. In the same poster session, students can play both the roles of audience and presenters. Furthermore, students distribute themselves spontaneously forming small groups around a single project and as a consequence, personal interactions are greatly promoted and the average level of students' participation increases.

Another advantage of poster sessions is that students presenting their projects can increase the quality of their presentation during the session, since they present their projects several times in the whole session. This feature constitutes an interesting opportunity to promote self-reflection in students, who will try to analyze their own performance every time they present their project and will try to repeat those positive features and correct the negative ones.

III. PRELIMINARY RESULTS

For the past two years in our department, we have implemented in three courses a wiki environment using the free and open web-based software MediaWiki [10], and we have put into practice the experience with a poster session in another course. Results have been overall very positive and have encouraged us to propose the integrated learning environment that was described in Section II.

The first course that implemented a wiki environment last year was devoted to wireless technologies and involved senior engineering students [11]. The aim of the wiki approach was to enhance students' understanding of the industry sector of wireless technologies and its professional opportunities. Students were organized in small groups consisting of two or three members that were assigned the project of investigating the industrial sector of one wireless technology. They were told that the aim of their projects was to help them and their peers to understand each industrial sector by collaborating. Thus, project assignments were presented to students as a common goal, in which each group investigated one particular sector for the common benefit. Projects were documented in the wiki and course evaluation took into consideration both contents created in the wiki and a final oral presentation. Nevertheless, the possibilities of the wiki environment were not discussed in the classroom, no common format for each wiki entry was outlined and no ways of interacting between groups were considered. In other words, students were free to make the use of the wiki that they thought was the most suitable.

Students considered that compared to classic paper alternatives, the process of elaborating a wiki had been very positive and confirmed that the wiki approach had allowed them to learn about other projects, whose entries they visited regularly. Additionally, students said that the visibility of their projects had been a stimulus to increase the quality of their projects and had favored some spirit of competition among different groups. In summary, they benefited from sharing their projects and they were encouraged to be more critical about their work and their peers'. Nevertheless, we observed that they did not use all the expressivity that the wiki offered

and as a consequence, wiki entries resembled a *virtual* version of classic assignment with the only difference that they were accessible to everyone. For instance, they did not link their projects to other projects and they did not attempt to develop a document structure other than linear. The degree of inter-group interaction was also observed to be more limited than initially expected by teachers.

We have tried to overcome the problems encountered last year by enhancing the role of the teacher in coordinating the wiki environment. Once again, we have implemented the wiki environment in the same course for students to document their projects [12]. However, this year we have outlined a common standard for entries elaboration. Even when this initiative limits students' freedom to use the wiki, we consider that the advantages of creating a common language and specifying basic rules overcome its limitations. Specifically, we have succinctly specified a common format for each wiki entry, including aspects such as extension and organization, use of references and use of images and intellectual property. Furthermore, we have devoted one session to discuss how to use our wiki environment, notably introducing non-linear document structures, and we have coordinated the interaction among students in the following way. Two deadlines have been established. In the first deadline, a preliminary version of each project must be available in the wiki. After this deadline, and during a week, students have to read their peers' projects and provide them with feedback to improve their assignments. Based on the feedback from their peers and from the teacher, the final version of their project must be available for the second deadline. After that, projects are presented in public. To date, projects have met the first deadline and students have provided their peers with feedback on their projects. Compared to last year's initiative, we have observed a noticeable increase in the quality of the wiki, which we attribute to the efforts to clarify the uses of our wiki. Students have said that reading their peers' projects has helped them to understand and learn about other technologies. Furthermore, the first deadline has given them the chance to reflect on their own work and some have confirmed that they will adopt some solutions found in other projects. Additionally, students have critically commented their peers' work, and they have said that the comments on their projects will definitely allow them to increase their quality.

The implementation of a public poster presentation in a course on digital image processing was very successful. Following project-based approaches, students were organized in groups consisting of two members and they were assigned one project. This initiative took place in a single session and there were altogether 15 groups. The session was scheduled as follows. During a time period of two hours and a half, teachers approached each group to evaluate their project. During evaluation, it was necessary that both members be there to explain their project and answer various questions. Meanwhile, in the rest of the groups one member had to stay at their stand to discuss it with their peers while the other could approach their peers' stands to know and discuss their

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projects. Halfway through the session (approximately after an hour and 15 minutes), group members would exchange their roles.

With this initiative, teachers achieved increasing students participation. Students commented in turn that the discussions that originated were open and lively. Interestingly, students agreed that repeating the presentation of their project several times gave them the chance to reflect on their exposition and continuously improve it. In fact, teachers observed that the best presentations were the last ones, probably because of this spontaneous self-improvement process. In general, compared to traditional oral presentations the poster session increased the motivation and enthusiasm among students. The success of this approach is that it facilitates that students remain active for the duration of the session, while in traditional presentations their attention span is limited to 10-15 minutes. Additionally, it allowed other students and teachers from other courses to attend and participate.

IV.   CONCLUSIONS AND FUTURE IMPLEMENTATIONS

In this paper we have proposed an integrated student-centered collaborative learning environment for developing communication skills. We adopt a constructivist approach according to which, the best way of learning is by constructing knowledge. The main ingredients of our learning environment are project-based methodologies and peer-assessment, and we propose two strategies to put our method into practice. The first one is a wiki environment, and it is used to document projects, enhance writing skills and facilitate content sharing, reflection, discussion, inter-group communication, and critical thinking and analyzing. The second one is a public presentation based on poster session, and allows us to enhance oral skills, promote participation, inter-group communication, and critical thinking and analyzing.

We have implemented both mechanisms for the past two years in different courses and the results are very positive. Our previous experiences have allowed us to reflect on their outcomes and to improve their practical implementations. In the future, we will implement in other courses our integrated learning environment, by combining both wiki approaches and public poster sessions in a coordinated manner.

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