A scaled-down conference model for courses covering ever-changing fields in computer science undergraduate degree programs

Julio Molleda, Rubén Usamentiaga, Juan Carlos Granda
y Joaquín Entrialgo
Universidad de Oviedo (España)

The ability to keep up to date in fast-evolving fields of knowledge is essential for all students, but it is especially important in computer science degree programs. However, few computer science curricula provide courses covering these skills. In this paper, the effectiveness of a scaled-down conference model approach aimed to develop these skills is analyzed. The proposed model was applied to a core subject in the third year of the computer engineering undergraduate program of the University of Oviedo: Technology of Computers. The model is intended as a platform for the activities related with creating a survey paper and a poster, and presenting them to a conference organized in the course, while encouraging teamwork, critical thinking, decision making, time management and communication skills. The model was applied in three academic years: 2007-2010, with 182 students, who voluntarily enrolled this methodology. The effectiveness of the model for driving TC activities has been evaluated based on the feedback provided by students and the quality of the papers and posters submitted to the conference. A slight improvement in overall student performance was noticed, and students assessed the methodology highly and reported that the new methodology had helped them to acquire the expected skills.
Keywords: Constructivist learning, collaborative learning, teamwork skills, learning management system, online learning.

Un modelo de conferencia reducido para asignaturas de contenido de evolución constante en titulaciones informáticas. La capacidad de mantenerse actualizado en campos de conocimiento de rápida evolución es esencial para todos los estudiantes, y más en informática. Sin embargo, en ocasiones esta habilidad pasa desapercibida en los programas que abarcan estos estudios. En este artículo se analiza la eficacia de un modelo de conferencia destinado a desarrollar esta habilidad aplicado a una asignatura de tercer curso de Ingeniería Técnica en Informática de la Universidad de Oviedo, Tecnología de Computadores. El modelo se utiliza como marco de trabajo para desarrollar un artículo y un poster, así como su presentación en una jornada de conferencia organizada en la asignatura, mientras se fomenta el trabajo en grupo, el razonamiento crítico, la toma de decisiones, la gestión del tiempo y la comunicación. El modelo ha sido aplicado en tres cursos académicos consecutivos, 2007-2010, en el que participaron un total de 182 alumnos inscritos de forma voluntaria. La eficacia del modelo ha sido evaluada en base a cuestionarios y a la calidad de los trabajos desarrollados. Se observa mejoría en el rendimiento de los estudiantes, que valoran la experiencia de aprendizaje de forma positiva, indicando que la metodología les ha ayudado a adquirir las competencias perseguidas en la asignatura.
Palabras clave: Aprendizaje constructivista, aprendizaje colaborativo, habilidades de trabajo en grupo, sistema de gestión de aprendizaje, aprendizaje en línea.

Computer science graduates are lifelong learners in a technology-intensive environment that evolves rapidly (ACM-AIS, n.d.). In such a scenario, although the knowledge

base acquired in the degree program remains valid, adaptability is one of the most essential qualities for graduates (Sutherland & Crowther, 2006). Graduates have to be able to command the latest improvements in technology as soon as they become available. Therefore, skills on how to keep up to date in fast-evolving fields of knowledge must be addressed. In computer courses, students must also acquire collaborative and communication skills, among others. However, few computer science curricula provide courses to acquire these skills.

Computing is not only a branch of theoretical mathematics. As reported in ACM-IEEE (n.d.), all students of computing should acquire some understanding and appreciation of the functional components of a computer, their characteristics, their performance and their interactions. This understanding is based on computer architecture and organization, which is closely related with technology (Hennessy & Patterson, 2011). Students must be provided with knowledge of the technology of each of the main components of a computer, such as the processor, buses, memory, and storage system. These topics are included in the core units of the computer science curricula. However, as rapid and revolutionary changes in technology greatly affect both the design and the exploitation of a computer system, the most important skill to be addressed in a course on computers' technology is how to acquire knowledge about the improvements of technology.

A constructivist approach can be used as a means to teach skills on how to keep up to date in fast-evolving fields of knowledge. Constructivism is a learning theory focused on the role of experience in student education, i.e. it explains the accumulation of human knowledge as an active construction of meaning based on personal experiences (Duit, 1995). This learning theory encourages students to work in groups, which leads to a more effective educational approach (Johnson, Suriya, Yoon, Berrett & Fleur, 2002). Therefore, active student participation is required. Several models that require active student participation and knowledge building instead of memo-

rization have been developed (Cole, 2009; Sigala, 2007). Some of them are centered on the ability of the student to acquire research and communication skills. Online platforms can be used to make it easier to implement constructivist approaches (Khalifa & Lam, 2002; Knuth & Cunnigham, 1993).

In this paper a scaled-down conference model is proposed. The conference model is a constructivist approach aimed to teach research, collaborative and communication skills. In the full-scale conference model, students are given the task of planning and organizing a conference, including peer review, the conference program and the presentation schedule.

In Tapper & Gruba (2000) a conference model refined after three academic years aimed to improve students' communication skills in computer science is presented. In this approach, students were charged with all tasks of both organizing and running a conference, including peer review, publicity, web design, conference program, and presentation schedule. The success of this work is qualitatively estimated based on students' feedback, reported to teachers after the conference. This success relies on the facts that communication takes place for real purposes and real audiences and peer-reviewed tasks encourage constructive critiques amongst students.

In Borstler & Johansson (1998) the conference model is mainly used to improve students' research, writing and communication skills. The methodology used in this approach consists of organizing the whole course like a real conference, with a call for papers, a submission process, a program committee that evaluates the submissions, the conference itself and the proceedings with all accepted contributions. This work concludes that students need help to narrow the topic of their work and to structure their presentations. Also the students had difficulties in presenting the context of their work and focused on specific technical details.

In the scaled-down conference model proposed in this work teachers adopt the role of the committees and the reviewers while students are asked to work in teams for proposals for written papers, posters and oral presenta-

tions. The proposed model is intended to focus on teamwork, critical thinking, decision-making, time management and communication skills while helping students with the difficulties involved in organizing a conference. A web-based Learning Management System (LMS) to provide support for the students to develop the activities as well as for the teachers to manage these activities is also described.

The scaled-down conference model approach proposed in this paper is also intended to serve as a basis to migrate a technology of computers course from the Spanish educational system to the European Credit Transfer and Accumulation System (ECTS) in a computer undergraduate program. ECTS is a learner-centered system for credit accumulation widely used in formal higher education and can be applied to other lifelong learning activities (European Commission, n.d.). Thus, the activities in the proposed approach are learner-centered.

In this paper the effectiveness of a scaled-down conference model approach aimed to develop skills on how to keep up to date in fast-evolving fields of knowledge is analyzed. The proposed approach was applied to a core subject in the third year of the computer engineering undergraduate program of the University of Oviedo, Spain. This subject is Technology of Computers.

Technology of Computers (TC) is a core subject in the third year of the computer engineering undergraduate program of the University of Oviedo, Spain. A course in technology of computers is not an end in itself, but lays the foundation for lifelong computing learning. In a course of technology of computers, where the core units are mainly descriptive, the classic teacher-led lessons methodology can result in a lack of student motivation. Furthermore, this methodology demands a great effort on the part the student to achieve the expected learning outcomes, and it does not easily allow active student participation. Moving TC from traditional teacher-centered instruction towards student-centered learning, allowing students to construct knowledge from their own experiences, implies designing activities that encourage knowledge building instead of memorization. The transition from the Spanish educational system to the ECTS system provides a framework in which the migration of the subject can be accomplished, setting up the learning activities according to the ECTS guidelines (Khalifa & Lam, 2002).

TC is a 4.5 ECTS credit subject with a syllabus divided into several blocks, covering the technologies involved in the development of the main functional components of a computer system, as seen in many texts about technology of computers (Morley & Parker, 2010; Mueller, 2011). After a brief introduction to the history of technology in computing, the first block covers the functional units and the technologies related to the brain of a computer: the central processing unit. In the second block, the technologies involving the memory system and the input/output interfaces of a computer are analyzed. The third block covers the main technologies of the storage system of the computer. Finally, the fourth block covers the video and audio technologies of the hardware devices which make the computer a multimedia system. As prerequisite to the technology of computers course students must have covered most of the contents of the computer science program, such as computer foundations, architecture and organization.

Method

Participants

The students enrolled in TC voluntarily chose to participate in the conference model proposed in the course. A total number of 182 students participated in the model in the three academic years of its implantation: 73 in 2007-2008; 55 in 2008-2009; and 54 in 2009-2010. All of them were third-year students of the computer engineering undergraduate program of the University of Oviedo.

Assessment instruments

The effectiveness of the conference model for driving TC activities is evaluated based on the feedback provided by students and the quality of the papers and posters submitted to the conference. Student feedback is obtained through two anonymous surveys based on a Likert scale. The

Table 1. *Workload of Technology of Computers course*

Learning activity	Estimated time
Lectures	1 contact hour/week
Seminars	1 contact hour/week
Laboratory	1 contact hour/week
Tutoring	1 contact hour/week
Conference paper and work	3 non-contact hours/week
Practical work	1 non-contact hour/week
Self-study	1 non-contact hour/week
Examination	5 hours/course

first is carried out by the Vice-Rector for Professors, Centers and Departments of the University of Oviedo. This survey consists of 6 items focused on course content, evaluation criteria and procedures. The second survey is carried out by the teachers of TC. This survey consists of 10 items covering personal perceptions about the methodology followed in the course, the proposed activities and the collaborative resources of the LMS. The performance of the students is analyzed based on both the percentage of students passing the subject and the marks obtained in the activities related with the conference model. In order to promote sincerity in the answers provided by the students, they participate voluntarily and anonymously. Prior to filling these questionnaires, a motivational talk was conducted explaining the purpose of the activity and its future use in research.

Design

The scaled-down conference model for driving some TC activities is designed based on the proposed approach described below. The model covers activities related with the skills the TC student is expected to acquire. This makes both their acquisition and the engagement in the subject more attractive. These activities constitute 65 % of the final mark of the course. The final exam is replaced by three written exams distributed over the course. These exams make up 35 % of the final mark of the subject. Table 1 shows the workload of TC at the University of Oviedo according to the ECTS system and the proposed conference model approach.

The scaled-down conference model approach proposed in this paper follows the collaborative learning methodology. The proposed approach is divided into three main activities designed to be developed in collaborative groups. Collaborative learning provides many advantages for the student, such as increased motivation, opportunities to develop critical skills, and the potential for a social atmosphere where all students are afforded an opportunity to share, consider, and challenge the ideas of other students to construct new knowledge (Bruffee, 1999).

Secondary goals of the scaled-down conference model involve teamwork, critical thinking, decision-making, time management, and communication skills. Several collaborative activities are designed to be developed online, decreasing the need to coordinate schedules to meet with group members due to the nature of asynchronous group meetings (McConell, 2000). The rest of the collaborative activities are designed to be developed in the classroom for face-to-face student communication in order to reduce the time needed to make decisions.

At the beginning of the course, students are required to form teams and are provided with a guideline of the activities. Grouping students to form effective teams is the first task in the conference model approach. Several methodologies can be used to assign students to a team (Sancho-Thomas, Fuentes-Fernández & Fernández-Manjón, 2009). Although, several frameworks can be used to form groups based on the teaching methodology, such as that
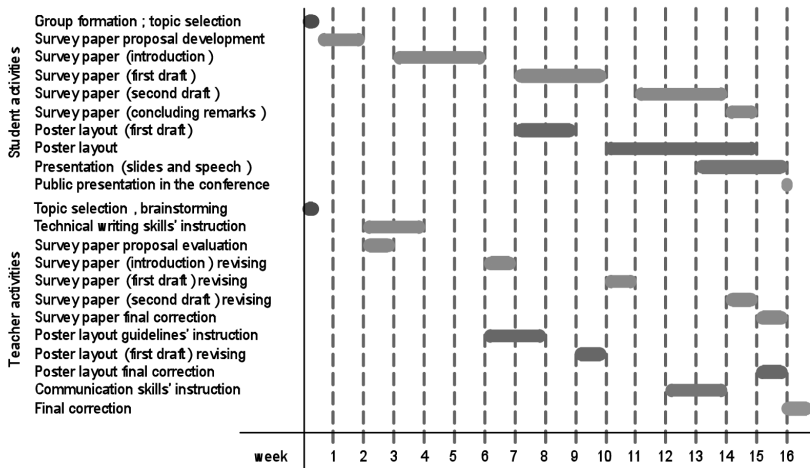
Figure 1. *Activities in the scaled-down conference model approach in a 16-week course*

proposed in (Isotani, Inaba, Ikeda & Mizoguchi, 2009), in the conference model approach proposed for TC the students are free to organize their own teams.

At the end of the course, each team is asked to present the results of the collaborative activities in the classroom. The scaled-down conference model approach is designed so that each team is immersed in the activities related to presenting a paper to a conference, while they acquire the above-mentioned skills. Each team is free to choose the topic of the paper, with the solely limitation of being included in the syllabus of the course. The conference model requires each team to develop three main activities. The first one involves writing a survey paper in the native language of the team. The second one involves creating a poster summarizing the topic of the survey paper, written in a foreign language. The third task involves presenting the paper and the poster in a public session of the conference in the native language of the team. Figure 1 shows a schedule representing the activities for both students and teachers in the proposed scaled-down conference model for driving a 16-week course.

Survey paper

The first main activity of the proposed scaled-down conference model approach invol-

ves collaborative writing of a survey paper. Once a team has been formed, a group creativity technique, such as brainstorming, is used in the presence of the teacher to find the most exciting topic for all the members of the group. After the topic is chosen the team is required to send its purpose for the survey paper to the teachers of the course, who act as the *organizing committee* of the conference. If any potentially problematic issues are detected, the team is required to refocus its work.

Once the purpose is accepted, the team is requested to start writing a survey paper covering the topic chosen. The paper is required to summarize material gathered from many information sources, such as books, Internet, and other papers, and it must be pitched somewhere between a personal essay and an encyclopedia article. Since writing a survey paper is a difficult task, each team is required to pass several milestones during the course, which lead to the final version of the paper.

The main goal of this activity is to give the students skills on how to keep up to date in fast-evolving fields of knowledge, but this activity also encourages the acquisition of other skills. The way a team works, with no supervisor but the teacher, allows a leader to appear to drive the team in the accomplishment of the assignment. Therefore, leaders-

hip skills are also acquired. Collaboratively writing a survey paper encourages critical thinking and decision making to determine the significance of whatever information the team reviews. Furthermore, as the milestones of the activity are scheduled from the beginning of the course, time management is a skill also acquired to achieve group effectiveness.

Poster

The second main activity in the proposed scaled-down conference model is to develop a poster which graphically summarizes the survey paper written in the first activity. This activity can be overlapped in time with the previous one. Although its development can be started at the beginning of the course, students should not be required to do it until the main body of the paper has been reviewed by the teachers.

This activity is intended for students to acquire critical thinking and decision making skills, striving to link existing ideas in the topic related with the survey to express them in as comprehensible a form as possible. The poster must be written in a language foreign for the team. Thus, foreign language skills are also trained during this activity. The development of the poster is divided into several scheduled milestones; thus, time management is another skill developed in this activity.

Oral presentation

Once the survey paper and the poster have been developed, in the third main activity of the proposed approach, each team is required to prepare an oral presentation of their work in their native language. A public session is scheduled for each team to present their survey to both the students and the teachers of the subject. After the oral presentation, there is a period for questioning the team about the work presented. In this activity, skills in oral communication are involved. This activity also encourages self-esteem; many students feel uncomfortable in public speaking, to such a point that a very good project presented by a team lacking confidence may be perceived as being of inferior quality.

Intervention program

Students are instructed on relevant communication skills, such as good manners in speaking, tone of voice, eye contact, gesture, body language and facial expression. These skills were conducted in the tutoring hours at the beginning of the course. Students were asked to make a short presentation of a concept of their choice, and the teachers comment on their strengths and weaknesses, encouraging working on the latter.

Once the teams are formed, each team is provided with some coaching strategies in the tutoring hours at the beginning of the course. These strategies include define milestones, prepare a good plan, associate the plan with individuals, and use appropriate communication modes. Teachers comment on well-known examples of coaching experiences, and ask students to propose alternatives to some teamwork scenarios.

After that, teachers provide in the tutoring hours basic strategies to look for information. Since technological information is rapidly available through the web, these strategies are mainly focused on the Internet. In addition, students are instructed in how to check the validity of such information, one of the weaknesses of the Internet. Furthermore, the analysis of citations and references is also covered in these tutoring hours.

Once the team finished the survey paper and the poster, teachers provide guidelines on fielding questions, both listening to and addressing questions, in the tutoring hours. Critical listening, which is essential to avoid misunderstandings and mistakes, is an essential skill in which most students have received no previous training.

Computer support for collaborative learning activities in the scaled-down conference model

Student engagement in subjects based on teacher-led lessons has declined in recent years, as education undergoes a paradigm shift moving away from teaching-as-instruction towards student-centered learning (Jonassen, 1993). In this shifting process, Web 2.0 technologies, also known as social software technologies, are very useful. Social software in-

cludes web applications such as blogs, wikis, social bookmarking, and discussion forums. With social software, users become producers rather than merely consumers of information. They are able to annotate and edit existing material to create new content as well as to use it in partnership with others (Cole, 2009). Social software makes information sharing and straightforward collaboration possible (Boulos, Maramba & Wheeler, 2006). In addition it is suitable for developing student-centered and cooperative learning environments.

Using computers to support the collaborative tasks of the scaled-down conference model described above can greatly reduce the time required in the activities for both the teachers in charge of the course and for the students enrolled in it. In order to provide support for the students to develop their assignments, a web-based LMS can be adopted to foster online collaboration (Tan, Lin, Yang & Zhao, 2008). In the LMS, two social software systems can be used to support the collaborative activities of each team: a discussion forum and a wiki. These resources are extremely easy to use for computer undergraduate students. They should be used to encourage each member of the team to coordinate different points of view, enhancing reasoning and higher order thinking skills, which in turn promote shared knowledge construction (MacKnight, 2000). Furthermore, these asynchronous discussion resources facilitate student interaction (Pena-Shaff & Nicholls, 2004).

The discussion forum is intended to provide a fast and easy communication and discussion channel between all the members of the team as well as with the teacher. The written contributions in the discussion forum make the process of collaboration more transparent for the teacher and can be used to judge both the group's collaborative process and the contribution of the individual (Macdonald, 2003). The discussion forum should be a private resource available only to the members of the team and the teachers of the course.

A wiki is a website that allows one or more people to build up a corpus of knowledge which can provide several pedagogical benefits, such as evolutionary knowledge building, critical questioning and the ability to judge the work of others. Content is generated by improving or extending the contributions provided by individuals as a collaborative collection of interlinked web pages (Sigala, 2007), leading to incremental knowledge creation. The wiki resource in the LMS is intended to provide an easy way to collaborate in the tasks of the team, such as the production of the survey paper. The wiki is also intended for the teacher to provide feedback on student generated content. The wiki of each team should be a public resource in the LMS writable only by the owner team.

These resources were allocated in the virtual campus of the University of Oviedo, since the students are used to use this campus for the rest of the subjects of the undergraduate program. Furthermore, this platform guarantees an access control where the students are identified, so teachers can track the participation of each team and each member of the team. While presenting the requirements of the model, teachers encouraged students to make use of these resources. However, no additional motivation is required since computer engineering undergraduate students tend to use online platforms very frequently.

Procedure and validation

In this section the teaching experience applying the proposed scaled-down conference model described in Section 2.2 for driving the Technology of Computers course described in Section 1 is presented. The proposed approach is evaluated after three academic years (2007-2010) of teaching TC following the proposed approach. In previous academic years (2005-2007), teachers had noted an increase in the drop-out rate, coinciding with a drop in the average marks. The methodology used in 2005-2007 followed the traditional teacher-led lessons with a compulsory final exam and some informal group activities to try to develop teamwork skills. In 2007-2008, teachers adopted the scaled-down conference model approach described above for driving TC activities.

In the academic years in which the proposed approach was applied, a pretest was
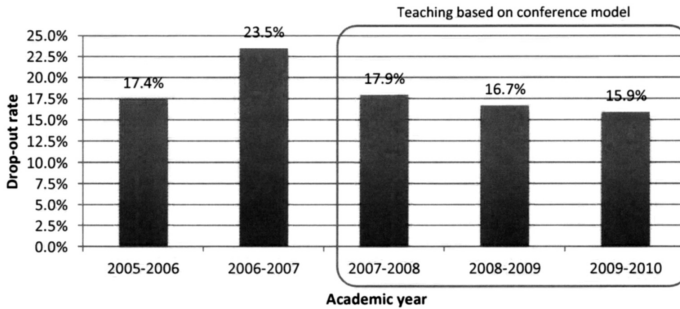
Figure 2. *Drop-out rate of students enrolled in Technology of Computers*

conducted prior to starting the activities related with the conference model. The aim of this pretest was two-fold. First, to evaluate the computer skills of each student related with the resources available in the LMS system selected for the course: Moodle (Moodle, n.d.). Second, to evaluate factors such as learning motivation and attitude towards learning. In these three academic years the results of these pretests show no considerable variations. Thus, in this teaching experience a similar level of computer skills and attitudes towards learning of all the students enrolled in the course are supposed.

At the beginning of the course the students are required to organize themselves into teams. In the proposed model they are free to organize their own teams of four people. Students are provided with guidelines on how to write an academic paper, how to scan the literature and how to browse the Internet to find valuable references for the topic to be covered.

At the end of the course all the surveys written by the students are published in a final compilation as the proceedings of the conference. The best papers ranked by the teachers of TC are included as valuable readings for the students enrolled in the course in subsequent academic years. The students are informed that their papers may be published in these proceedings at the beginning of the course and this serves as extra motivation to develop a high quality paper.

Furthermore, at the end of the course posters are voted by all the students and the teachers in terms of originality, quality and relevance to learning specific concepts in techno-

logy of computers. The best ranked posters are printed and exhibited in a public area of the University, where they can be viewed by all the members of the undergraduate community. Knowing that their poster may be exhibited acts as extra motivation for each team to develop a high quality product.

Results

Although it is not realistic to determine a tendency, the proposed approach seems to achieve good results in terms of reducing the drop-out rate. Figure 2 shows the drop-out rate of students enrolled in TC in the academic years 2005-2010. In the first two academic years the ratio is based on the number of students attending the final exam. In the last three academic years, since there is no compulsory final exam due to the application of the proposed conference model approach, the ratio is calculated based on the number of students attending all the evaluation activities of the subject.

Table 2 shows the student performance in TC in the academic years 2005-2010 using a five-point grade scale. For the academic years 2007-2010 the average of the marks obtained by the students in each activity, as well as the marks in the written exams are shown. The survey paper is 50 % of the mark for the conference model activities; the poster is 30 %; and the presentation is 20 %. Since the new teaching methodology based on student-centered activities aims to motivate the students to complete all the activities of TC, the marks obtained by students in the conference model activities improved each year. However, the

Table 2. *Summary of student performance in Technology of Computers, academic years 2005-2010 (marks out of 5)*

Activity	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
Survey paper	-	-	3.94	3.84	4.32
Poster	-	-	3.81	3.93	3.90
Oral presentation	-	-	4.27	4.50	4.86
Conference activities	-	-	3.97	4.00	4.30
Written exams	-	-	3.77	2.84	2.82
TC subject average	3.48	3.10	3.87	3.42	3.56

TC: Technology of Computers

[0-1,5): Failure, [1,5-2,5): Weak, [2,5-3): Acceptable, [3-3,5): Good, [3,5-4,5): Very Good, [4,5-5]: Excellent

final marks obtained by the students did not show significant variations because of the marks achieved in the written exams. Students tend to focus their effort on the activities related with the conference model, while reducing their effort in preparing for the written exams. Fig. 3 shows the distribution of the student performance in the academic years 2005-2010.

At the end of each academic year, before the students know their final marks in the course, the Quality Technical Unit of the Vice-Rector for Professors, Centers and Departments of the University of Oviedo requests the students to fill out anonymous questionnaires as feedback for the undergraduate program development. These questions focus on course content, evaluation criteria and procedures. Table 3 shows the results of the questionnaires for TC, and the average of the results of the questionnaires for all the subjects in the third

year of the undergraduate program (3Y) in which TC is taught. Each criterion is shown for each academic year on a five-point scale, where 1 means strongly disagree and 5 means strongly agree. Two facts become clear: first, TC students' assessment is higher when the subject is taught based on the conference model approach. Therefore, based on students´ feedback, the proposed approach for driving TC activities seems to be successful. Second, since the assessment provided by students for all criteria clearly outperformed the average assessment for the rest of the subjects in the academic year the methodology used in TC is perceived as successful by the students.

The questionnaires given by the Quality Technical Unit of the Vice-Rector for Professors, Centers and Departments are common for all the subjects in the undergraduate program. These questionnaires do not take into account the specific methodology followed in TC. The-
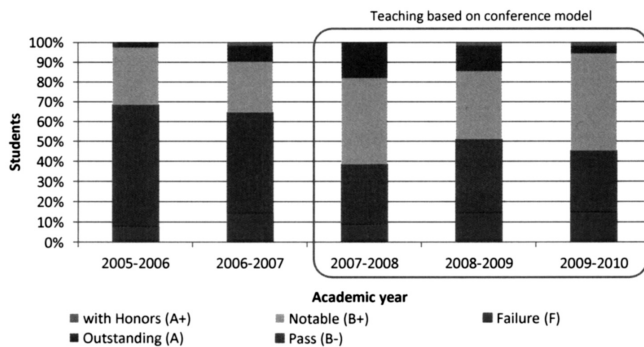

Figure 3. *Grades of the students enrolled in Technology of Computers, academic years 2005-2010*

Table 3. *Technology of Computers and 3rd year of the undergraduate program detailed assessment (ratings out of 5)*

Criterion	2005-2006		2006-2007		2007-2008		2008-2009		2009-2010	
	TC	3Y	TC	3Y	TC	3Y	TC	3Y	TC	3Y
Course contents	4.14	3.67	3.94	3.41	4.71	3.54	4.83	3.88	4.60	3.4
Course activities	3.58	3.11	3.59	2.91	4.50	3.15	4.29	3.78	4.00	3.5
Course evaluation criteria	3.96	3.75	3.97	3.43	4.70	3.59	4.86	3.76	4.27	3.1
Course evaluation procedure	3.88	3.40	3.59	3.15	4.92	3.34	4.82	3.67	4.06	2.9
Teacher knowledge and lessons	3.72	3.74	4.01	3.12	4.80	3.62	4.63	3.98	4.53	3.7
Student learning	3.43	3.46	3.59	2.91	4.62	3.27	4.50	3.49	4.05	3.1
Average	3.78	3.52	3.76	3.15	4.71	3.42	4.65	3.76	4.25	3.2

TC: Technology of Computers
3Y: All the subjects in the third year of the undergraduate program in which TC is taught
1: Very bad, 2: Bad, 3: Neither good nor bad, 4: Good, 5: Very good

refore, at the end of the course the students of TC were asked to complete an additional questionnaire of ten items related with the activities developed in TC and with the collaborative learning resources provided in the subject. This questionnaire is also completed before the final marks of the course are provided to the students. Table 4 shows the average of each question in the academic years in which the conference model is followed for the TC activities: 2007-2008 (the additional questionnaire was completed by 65 students of 95 enrolled), 2008-2009 (47 of 66 enrolled), and 2009-2010 (36 of 63 enrolled). The results are shown on a five-point scale, where 1 means strongly disagree and 5 means strongly agree.

Table 4. *Summary of student survey for Technology of Computers subject, academic years 2007-2010 (ratings out of 5)*

#	Question	2007-2008	2008-2009	2009-2010
1	The methodology followed in the course encouraged and motivated me to develop the proposed activities	4.87	4.79	4.52
2	The methodology helped me to acquire teamwork and time management skills	4.83	4.55	4.61
3	The methodology helped me to acquire oral and written communication skills	4.27	4.13	4.02
4	The methodology helped me to acquire skills on how to keep myself up to date in technology of computers	4.95	4.80	4.87
5	The teaching activities proposed in the subject encouraged learning technology of computers	4.89	4.75	4.91
6	The LMS helped me to develop the proposed activities	4.52	4.67	4.47
7	The discussion forum helped me to exchange information and express opinions about the survey paper	4.31	4.03	4.23
8	The discussion forum helped me to exchange information and express opinions about the poster	4.07	4.41	4.11
9	The wiki helped me to collaboratively develop the survey paper	4.12	3.71	3.87
10	The wiki helped me to collaboratively develop the poster	4.21	4.07	3.98

LMS: Learning Management System
1: Strongly disagree, 2: Disagree, 3: Neither agree nor disagree, 4: Agree, 5: Strongly agree

Students highly assessed the methodology followed in TC (see question #1 in Table 4), and confirmed that the new methodology helped them to acquire the expected skills (see questions #2, #3, and #4). The students' perception about how the proposed activities encourage technology of computers learning received a very high evaluation in the three academic years (see question #5). The students also assessed highly the Learning Management System provided to develop the team activities proposed in the subject (see question #6). Although the global assessment of the LMS is high, when each module is independently assessed its assessment was lower. The discussion forum seems to be the most useful tool, while the wiki does not seem to be as useful as teachers expected for the development of the team assignment (see questions #7, #8, #9, and #10).

Discussion and conclusion

Undergraduate and graduate programs must provide students with skills on how to keep up to date in fast-evolving fields of knowledge. Technology, a blend of science and engineering, is an ever-changing topic in computing. This issue must be taken into account in computer science programs, especially in a course of technology of computers. The core units of a technology of computers course are mainly descriptive and are often taught following the classic teacher-led lesson methodology, leading to a lack of interest and motivation in the students attending the lessons. In this paper, a scaled down conference model approach for the students to acquire skills on how to keep up to date on technology in a technology of computers course is proposed and evaluated. The approach is intended for the students to acquire these skills while developing teamwork, critical thinking, decision making, time management, and communication skills. A web-based Learning Management System has been adopted to provide support for the students to develop the activities proposed in the model, as well as to foster online collaboration through resources such as discussion forums and wikis.

The conference model approach is being applied to a technology of computers course of an undergraduate program in computer science in the School of Computer Engineers of Oviedo (University of Oviedo, Spain). The teaching experience after three academic years was evaluated. Although only a slight improvement in overall student performance was noticed, several conclusions arise from the teaching experience. Students assessed the methodology highly and confirmed that the scaled-down conference model helped them to acquire the skills trained in the course. The questionnaires completed by the students indicate that the assessment of both their own learning and the teacher-focused lessons increased with the described methodology. The questionnaires also indicate that the online collaborative resources provided to support the development of their team assignments should be improved, especially the wiki, which did not receive as positive an assessment as expected by the teachers of the subject.

Considering students' feedback gathered from the general and specific questionnaires, it seems that the proposed scaled-down conference model as a platform for technology of computers is successful since students' perception of their learning is very high and the assessment in comparison with the rest of the subjects in the same academic year is favorable.

The conference model proposed in this paper encouraged students to acquire the expected skills in the course, as in Borstler & Johansson (1998) and in Tapper & Gruba (2000). However, in the proposed model, since the tasks of organizing the conference relies on teachers rather than students, the latter can focus on the tasks designed to acquire the expected skills of the course. Also, avoiding students developing management tasks allows a flexible scheduling of the course, unlike the strict scheduling followed in Tapper & Gruba (2000). Furthermore, in Borstler & Johansson (1998) and in Tapper & Gruba (2000) all the tasks are focused on the student to acquire writing and communication skills, while in the proposed scaled-down conference model the skills acquired by the student also cover how to keep up to date in fast-evolving fields of knowled-

ge, which is of vital importance in in computer science degree programs.

Therefore, the proposed scaled-down conference model proved its adequacy for courses covering ever-changing fields in undergraduate degree programs of computer science. The increase in the workload for the teacher using this conference model approach is significant. However, teachers gained from the new course structure, such as in the supervision tasks of the student's assignments. Taking this increase into account, future work

includes a new design for the described approach in which some of the tasks related with reviewing the surveys and the posters could be carried out by peers, encouraging students looking for information beyond the scope of its own teamwork context. Future work also includes scheduling a public presentation of the papers, rather than a presentation to students enrolled in the subject. Thus, communication will take place for real purposes and real audiences, motivating students to refine their work.

References

ACM-AIS (n.d.). *Curriculum guidelines for undergraduate degree programs in information systems*. Retrieved September 1, 2011 from http://cis.bentley.edu/htopi/IS2010_11-23-2009.pdf

ACM-IEEE (n.d.). *Computer science curriculum*. Retrieved September 5, 2011 from http://www.acm.org/education/curricula/ComputerScience2008.pdf

Borstler, J., & Johansson, O. (1998). The students conference - a tool for the teaching of research, writing, and presentation skills. *SIGCSE Bulletin (Association for Computing Machinery, Special Interest Group on Computer Science Education)*, *30*(3), 28-31. doi: 10.1145/282991.283007.

Boulos, M. N. K, Maramba, I., & Wheeler. (2006). Wikis, blogs and podcasts: A new generation of web-based tools for virtual collaborative clinical practice and education. *BMC Medical Education*, *6*, 1-8. doi: 10.1186/1472-6920-6-41.

Bruffee, K. A. (1999). *Collaborative Learning: Higher Education, Interdependence, and the Authority of Knowledge, 2nd Ed*. Baltimore, MD: Johns Hopkings University Press.

Cole, M. (2009). Using wiki technology to support student engagement: Lessons from trenches. *Computers & Education*, *52*, 141-146. doi: 10.1016/j.compedu.2008.07.003.

Duit, R. (1995).The constructivist view: A fashionable and fruitful paradigm for science education research and practice. In L. P. Steffe & J. Gale (Eds.), *Constructivism in education* (pp. 271-286). Hillsdale, NJ: Lawrence Erlbaum Associates.

European Commission, Office for Official Publications of the European Communities. (n.d.). *ECTS User's Guide*. Retrieved September 12,

2011 from http://ec.europa.eu/education /lifelong-learning-policy/doc/ects/guide_en.pdf

Gruba, P., & Sondergaard, H. (2001). A constructivist approach to communication skills instruction in computer science. *Computer Science Education*, *11*, 203-219. doi: 10.1076/csed.11.3.203.3833.

Hennessy, J.L., & Patterson, D.A. (2011). *Computer architecture: A quantitative approach, 5th Ed*. Waltham, MA: Morgan Kaufmann.

Isotani, S., Inaba, A., Ikeda, M., & Mizoguchi, R. (2009). An ontology engineering approach to the realization of theory-driven group formation. *Computer-Supported Collaborative Learning*, 4, 445-478. doi: 10.1007/s11412-009-9072-x.

Johnson, S. C., Suriya, C., Yoon, S. W., Berrett, J. V., & Fleur, J. L. (2002). Team development and group processes of virtual learning teams. *Computers & Education*, *39*, 379-393. doi: 10.1016/S0360-1315(02)00074-X.

Jonassen, D. H. (1993). Thinking technology: context is everything. *Education Technology*, *31*, 35-37. doi: 10.1016/j.compedu.2008.07.003.

Khalifa, M., & Kam, R. (2002). Web-based learning: Effects on learning process and outcome. *Transactions on Education*, *45*(4), 350-356. doi: 10.1109/TE.2002.804395.

Knuth, R., & Cunnigham, D. (1993). Designing environments for constructive learning. In T. M. Duffy, J. Lowyck,. & D. H. Jonassen (Eds.), *Tools for constructivism* (pp. 163-188). Berlin, Germany: Springer.

Macdonald, R. (2003). Assessing online collaborative learning: process and product. *Computers and Education*, *40*, 377-391. doi: 10.1016/S0360-1315(02)00168-9.

MacKnight, C. (2000). Teaching critical thinking through online discussions. *Educance Quarterly*, *4*, 39-42.

McConell, D. (2000). *Implementing Computer Supported Cooperative Learning, 2nd Ed*. United Kingdom, UK: Routledge.

Moodle. (n.d.). Moodle website. Retrieved November 18, 2011, from http://moodle.org.

Morley, D., & Parker, C.S. (2010). *Understanding Computers, 12th Ed*. Course Technology Cengage Learning. Stamford, CT.

Mueller, S. (2011). *Upgrading and Repairing PCs, 20th Ed*. Que Publishing, Pearson Education: Upper Saddle River, NJ.

Pena-Shaff, J. B., & Nicholls, C. (2004). Analyzing student interactions and meaning construction in computer bulletin board discussions. *Computers and Education*, *42*, 243-265. doi: 10.1016/j.compedu.2003.08.003.

Sancho-Thomas, P., Fuentes-Fernández, R., & Fernández-Manjón, B. (2009). Learning teamwork skills in university programming courses. *Computers & Education*, *53*, 517-531. doi: 10.1016/j.compedu.2009.03.010.

Sigala, M. (2007). Integrating web 2.0 in e-learning environments: A socio-technical approach. *International Journal of Knowledge and Learning*, 3, 628-648. doi: 10.1504/IJKL.2007.016837.

Sutherland, P., & Crowther, J. (2006). *Lifelong learning: Concepts and contexts*. United Kingdom, UK: Routledge.

Tan, W., Lin, S., Yamg, Y., & Zhao, X. (2008). Design on collaborative virtual learning community and learning process visualization. *Lecture notes in computer science*, *5145*, 424-433. doi: 10.1007/978-3-540-85033-5_42.

Tapper, J., & Gruba, P. (2000). Using a Conference Model to Teach Communication skills in a communication across the curriculum program. *Language and Learning Across the Disciplines*, 4, 55-65.