

Paperless Teaching Environment Using Cloud Computing Facilities: A Proposed Model

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Abstract. A Collaborative Teaching Environment model and functional requirements are presented. Software tools utilized and best practices are discussed. An application case and its results are shown. Prevention measures are proposed in order to insure success on the implementation of the model. Costs of the application case, model implementation alternatives available in the Internet, and a simple provider evaluation method are introduced.

Keywords: Cloud computing, collaborative environment, paperless teaching environment, student teacher electronic communication, collaborative learning environment.

1. Introduction.

Internet offers a great variety of tools to support team work in a collaborative environment, most of them available at affordable prices. Previous applications have shown the advantages that may be obtained from using this type of environment in research and academic work, a good discussion is presented by (Taufer, Teller, Kerstens, and Romero, 2006) another study (Douglas, Schaffer, Nowicki, and Butler, 2003).

Teaching and training are activities which require an effective and secure communication, as recommended in (Black ,2004) the teacher has to communicate with his students in order to deliver notes, presentations, examples, computer software and even books. On the other hand students have to deliver to their teacher assignments, midterm exams, project reports, and laboratory results. There are a large number of papers dedicated to discuss virtual teaching and training, this paper focus on the application of collaborative environment tools and cloud computing facilities available in the internet to traditional teaching and training. Today's teachers as well as students are familiar with the tools available in the cloud computing, using them in the classroom is the natural next step in the learning process. (Bronson, and Dentith, 2005) have found that this type of collaboration not only apply to students but also teachers as a team.

It is very important to distinguish between tools such as USB Flash Memories, CD or any other hardware devices and the cloud computing facilities referred here, which are totally software based and widely available in the Internet at very low costs as shown by (Jacobi, and Larkin 2006).

The hypothesis of this work can be established as follows: It is possible to define a simple model in which students and teachers do not have to interchange papers; instead, they can interchange computer files in a secure and easy way, in such a manner that printing and paper costs are totally eliminated, as well as devices and special hardware costs, using exclusively one personal computer connected to the Internet.

The hypothesis has proven applying the proposed environment model to five computer sciences courses attended to almost one hundred students.

2. Paperless teaching environment requirements.

(Koufman-Frederick, Lillie, Pattison-Gordon, Watt, and Carter, 1999: 7) present the following definition of electronic collaboration:

“connects individuals electronically via the Internet using tools such as email, or through access to sites on the World Wide Web. This Internet-based work allows collaborators to communicate anytime, from anywhere to any place. People from different parts of a building, state, country, or continent can exchange information, collaborate on shared documents and ideas, study together, or reflect on their own practices.”

According to their methodology, in order to establish a teaching environment the first step is to define the requirements. This is the first task that our study had to face, so, the requirements for a paperless teaching environment can be grouped as follows:

1. - Communications and file transfers
2. - File sharing capabilities
3. - File Security
4. - Support and documentation.

1. - **Communications and file transfers.** Students and teacher need to send and receive different types of information.

- Messages
- Computer files
- Computer Software

Messages can be sent and received by using the regular email services. On the other hand, computer files are not recommended to be sent by mail due to security issues, size restrictions, and performance of the mail servers; instead, they can be transferred to a file server which students and teacher may access. The same strategy may also be applied to computer software.

2. - **File sharing capabilities.** Team members (students, teachers and teacher's assistants) require to access a repository of files, considering also the possibility of download such files or simply view and play them (in the case of sound and video files). Special care has to be taken about copyright issues (Talab, and Butler, 2007: 14) present an excellent analysis and recommendations about copyright of materials used in the classroom. The following are their recommendations:

“Assume that a work is copyrighted unless it states it is not.

Read the terms of use , or similar sections, for each file-sharing site.

Link to files whenever is possible.

Always provide attribution for all downloaded files used in the classroom.

Do not download files with phone numbers, addresses or other private information.”

3. - **File Security.** Access to shared files and other services have to be controlled and secured. File transfer need to be done under strict security protocols in order to insure integrity and avoid illegal access to data. Some teachers need time to accept new technologies even though they do transfers of money and payments using their bank's Internet services, they refuse to manipulate their grades by using the same technology. There is no question that improving security will allow them a quicker adjustment and acceptance of the new environment.

4. - **Support and documentation.** The use of the system as a whole has to be easy enough to avoid confusion and usability has to be guaranteed in every operation such as download and upload files, view and play files, send and receive messages and so on. This requirement is a key issue to obtain the acceptance and approval of the students.

In order to conduct a proper analysis of the model, it is necessary classify the types of files involved in a traditional learning environment. The following types of files are regularly used and transferred:

- Assignments, and assignment specifications.
- Exams and exam specifications
- Laboratory Reports
- Computer Programs written by students
- Computer Programs written by the teacher
- Different types of documents: texts, workbooks, and more.
- Presentations
- Drawings and images
- Video and sound files

The flow of these files allows establishing the requirements of the model expressed in terms of services provide by the cloud computing to implement the model.

Table 2.1 shows the flow of the files, the operation performed by the students and the teacher team.

Type	Direction of the flow	Teacher & Teacher Assistants Operations	Student Operations
Assignments	Students to teacher	Read	Read & Write within a rank of dates by the author
Exams	Students to teacher	Read	Read & Write within a rank of dates by the author
Laboratory Reports	Students to teacher	Read	Read & Write within a rank of dates by the team
Computer Programs	Students to teacher	Read & write	Read & Write within a rank of dates by the author
Documents	Students to teacher	Read & Write	Read & Copy only by all the students
Presentations	Students to teacher	Read & Write	Read & Copy by all the students
Drawings and images	Students to teacher	Read & Write	Read & Copy by all the students
Video and sound files	Students to teacher	Read & Write	Read & Copy by all the students
Assignment Specifications	Teacher to students	Read & Write	Read only by all the students
Exam Specifications	Teacher to students	Read & Write	Read by all the students within a rank of date and time.
Computer Programs	Teacher to students	Read & Write	Read & Copy by all the students
Documents	Teacher to students	Read & Write	Read & Copy by all the students
Presentations	Teacher to students	Read & Write	Read & Copy by all the students
Drawings and images	Teacher to students	Read & Write	Read & Copy by all the students
Video and sound files	Teacher to students	Read & Write	Read & Copy by all the students

Table 2.1. File Flow.

3. Minimal cloud computing facilities required for the collaborative teaching environment.

Attending table 2.1 and the regular operations of a traditional college course, the minimal set of operations to be supported by the model are:

- 1. - Lecture:** The teacher views and plays some files using the materials in the teacher's on line space and a projector to show them to the class. On the other hand students download the shared materials from the teacher's on line space.
- 2. - Assignment or Laboratory:** The teacher explains the assignment or laboratory specifications, including due date and so on. Students download from the shared materials the file for the assignment or laboratory specifications, later on once they do the assignment students will hand in the assignment or laboratory report by using the drop box of the course, it may be a single file or several files compressed in only one file.
- 3. - Exam or quiz:** The teacher gives instructions and asks students to download from the teacher's on line space shared materials, once all the students have a copy of the compressed encrypted file, the teacher publishes the password to expand and decrypt the file. Once the students finish the exam they will hand in their work by using the Drop Box of the course.

Considering the operations above, the minimal set of facilities required to implement the model are the following:

- 1. - Access using a user/password.** In order to establish user profile: student or teacher team, due to the fact that students and teacher's team are able to perform different type of operations.
- 2. - Drop Boxes with password,** only the teacher's team can browse on them. Students use Drop Boxes to hand in their files. This is the way in which students transfer their files to the teacher's team.
- 3. - E-mail communications.** Teachers and students need to send each other written messages; e-mail is the instrument to be used for this purpose. Notice that no files are transferred using this tool.
- 4. - File sharing facilities using passwords.** Teacher's team has to be able to share information with students, each student needs to have access to the shared material, and password is needed to avoid public access in the Internet. More details about file sharing can be found in (Volda, Edwards, Newman, Grinter, and Ducheneaut, 2006).
- 5. - File encryption using a password.** Some shared materials by the teacher's team, such as exams and quizzes will be released at a given time by the teacher, they will be delivered encrypted and the teacher will release the password to decrypt them at a given time in the classroom.

The construction of the environment can be described as follows:

Teacher's team will have the privilege to build folders using teacher on line access space, the following folders are built:

1. - **Drop Boxes**, this folder will be used to receive all the files handed in by students; there will be a sub folder for each course.
2. - **Exclusive**, this folder will be used to store any file belonging to the teacher or any teacher's assistant, meaning that this space is used to hold information regarding to the course but it should not be seen by the students. This folder has also one subfolder for each course. It can be seen as a online working folder to be shared only by the teacher and the teacher's assistants.
3. - **Public**, finally this folder will hold all the files which are released to the class, there will be one subfolder for each course.

The main folder structure is shown in figure 3.1

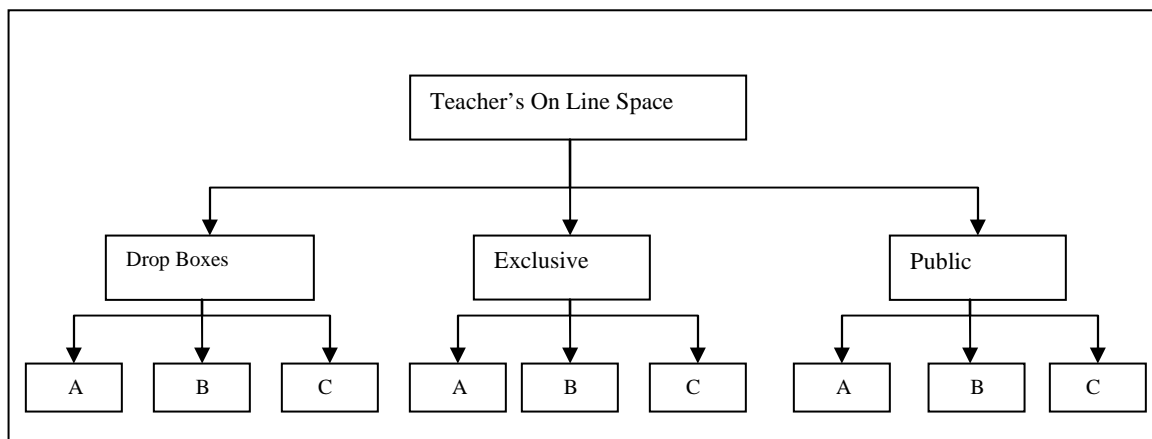


Figure 3.1 Main structure of the teacher's on line space.

In the figure 3.1 A, B and C are three courses of the same teacher.

Each course folder has a different structure according to the parent folder. For instance sub folder under **Drop Boxes** folder will have no structure at all; instead, files will be classified by the naming convention. Since Drop Boxes will hold the files coming from students to the teacher team, files have to be identified by looking at his name. The recommended naming convention is as follows:

File name description: XNNNNNN##.EXT

Where

- First letter X will be “A” is a constant for assignments, “E” for exams,, “R” stands for reports, “P” stands for programs, “D” stands for drawings, “V” stands for video files, “S” stands for r sound files, and “W” stands for presentations
- NNNNNNNN student id number
- ## Control number defined by the teacher for each event
- .EXT extension depending of the type of file, for example .zip, .doc, .txt, and .java. When the student needs to hand in more than one file a zip file can be used to hand in a compressed folder.

This naming standard has to be well known by the students and its use must be strictly enforced since failure to follow it will cause lost assignments and exams.

This standard will allow to group files and sort them quickly and easily in order to grade and review them. Students can not see the content of this folder; they are only allowed to hand in files in to the drop box of the course that they are taken.

Te structure under the **Exclusive** folder is totally free and each member of the teacher team can organize them as his convenience. The Exclusive folder can not be seen by students at all because they contain assignments and exams in process to be prepared by the teacher’s team.

Figure 3.2 shows the recommended structure for each sub folder of Public directory.

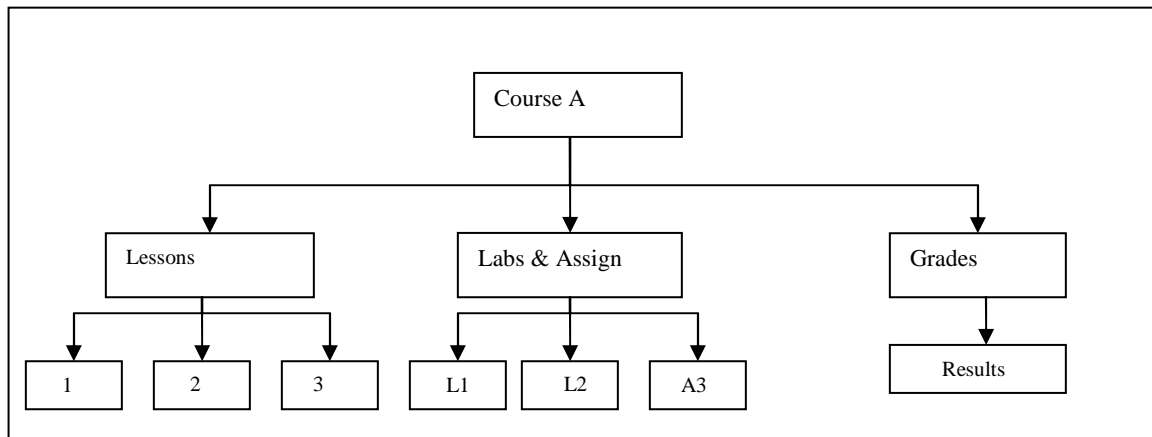


Figure 3.2 Structure of the subfolder under Public directory..

4. Cloud computing provider evaluation.

There are a wide options and facilities available as shown by (Notess, 2006) and also by (Jacobi, and Larkin, 2006). In order to implement the operations and the structure described above it is necessary to set up the boundaries to the problem this will be done by defining the functions which are required by the teacher's team:

Authority and capability to:

- Generate Folders and sub folders in the teacher online space.
- Share folders and sub folders specifying a password and the sharing mode: read and write or read only.
- Create Drop Boxes specifying a password to let users hand in a file.
- Use Secure FTP transfer.
- Download a file and complete folders.
- Upload a file and complete folders.
- Erase and rename files and folders.
- Keep an email list of contacts.
- View and play common file formats.
- Send messages and files using email.
- Copy on line space assigned to the teacher's team (Backup).
- Recover selected files or folders from a backup copy (Recovery).

Any server providing the above functionality may be used to implement the teacher environment along with the student's requirements. A simple method to evaluate a provider will be to review if the provider delivers all the above services and capabilities. Additionally it will be very important to measure the quality of the services such as: percentage of time online, number of software failures presented per unit of time, and number of interruptions of the services as well as simplicity and usability of the site.

5. Teaching environment operation.

(Marjanovic, 1999: 131) classifies the learning systems attending to their operation in two main types:

“Asynchronous collaborative technologies enable ‘any-time, any-place’ collaboration providing freedom of time (so learners participate when and if they choose), opportunities to research and backup assertions, more time for

reflection, more time to phrase the intervention. While asynchronous collaborative systems have been more dominant in recent times, especially Internet-based conferencing tools and news groups, they may be more suitable for distance learning than for the face-to-face classroom environment due to their asynchronous character.

Synchronous collaborative technologies enable ‘same-time, same-place’ or ‘same time, any-place’ collaboration providing immediacy, faster planning, problem solving, scheduling and decision making processes. However, the majority of synchronous collaborative tools enable communication (such as text-based chat systems or video teleconferencing) rather than computer-mediated collaboration.”

According to this classification the model discussed here is a Synchronous model since it is a “same time” and “same place” using the traditional classroom model.

Therefore we will proceed to explain the rest of the operation beginning by setting up the environment:

- To build the folders and subfolders required as described in figures 3.1 and 3.2.
- To share the Public folder by using a password to access it.
- To create the Drop Boxes required using the folders under the directory Drop Boxes, assigning a password to allow the user to hand in a file.
- To build the email list for each course.
- To populate with the course teaching materials and exercises the Public directory building one sub folder for each lesson or lecture depending on the teacher preferences.

Daily operation will be as follows:

- Teacher lectures and uses the shared material in the Public directory; students get a copy of the materials and presentation.
- Teacher publishes assignments in the Public directory sub folder dedicated to assignments and laboratories exercises. Specifying the control number for such assignment or exercise. Exams are treated as another assignment but they can be compressed and encrypted, liberating the password on the day of the exam.
- Students hand in assignments, laboratory reports and exams by using the drop boxes.
- Teacher’s team grades students work and write results in a worksheet which is published in the Grades directory under Results subfolder, in order to support the grades corrected exams, laboratory reports and assignments showing the grading policies are attached in the same subfolder; they may be compressed to allow students download the files and review them.

- Teacher’s team sends messages to students list in order to remain them about new assignments or laboratory exercises.

Special care is required to apply exams, to be able to apply exams the classroom has to have one personal computer for each student and computers must have a good high quality Internet connection. On the other hand lectures can be delivered in a classroom with a projector and a personal computer for the teacher.

When the course ends at the end of the term:

- Teacher gets a full compressed copy of the whole site.
- Teacher cleans up the space.

6. Applications of the model and results.

The first step to build the Teacher’s on line space was to evaluate and choose one provider, in order to do so the evaluation form of the figure 6.1 was used. This form is only a list of the main features required by the model a weight was arbitrarily assigned to each row depending on the importance of it. There were five sites evaluated but we only show three of them.

Feature	Weight	Filesanywhere	Result	4sahred	Result	Anonymous	Result
Create Drop Boxes with password.	12	1	12	1	12	0	0
Use FTP transfer.	8	1	8	1	8	1	8
Download files and folders	15	1	15	1	15	1	15
Upload files and folders.	15	1	15	1	15	1	15
Erase and rename files and folders	10	1	10	1	10	1	10
Keep email lists of contacts	5	1	5	1	5	1	5
View and play common file formats	5	1	5	1	5	1	5
Send messages and files using email.	10	1	10	1	10	1	10
Copy on line space assigned (Backup).	10	1	10	1	10	0	0
Recover of selected data form backup	10	1	10	1	10	0	0
Total	100		100		100		68
		1.- Provider offers this feature					
		0.- Provider does not offer this feature					

Figure 6.1 Evaluation Form

The provider selected was www.filesanywhere.com, even though www.4shared.com has also a perfect score, the anonymous provider was far away to fulfill the requirements, his name has been omitted, the other two got similar scores to the anonymous provider. It is not difficult to find a good provider which supplies the requirements of the model, Filesanywhere.com was selected due to the fact that it supplies all the requirements

discussed above. With the experience of using their services we can say that quality was outstanding as it is shown in the results of the student's survey presented in the results section.

The implementation was used to attend five computer sciences courses which need to share software packages and other large files such as electronic books. No paper was used in any exam, assignment or laboratory exercise. Grading was communicated using the site. About 100 students participated in the courses and an average of ten assignments per course were done. In these courses there are three exams for each course for each student. So we have a total of 1000 assignments and 300 exams.

A very simple survey was used in order to evaluate student satisfaction, potential problems and opportunity areas. The results are shown in figure 6.2.

Questions						Total
How often do you use the course's online materials?	Always	Very Often	Some times	Almost never	Never	
	22	13	4	0	0	39
	Percentage	56.41	33.33	10.26	0.00	0.00
Your opinion about the tools used to share materials	Excelent	Very Good	Good	Regular	Bad	
	Responses	17	16	5	1	0
	Percentage	43.59	41.03	12.82	2.56	0.00
How many files have you lost in the Drop Box?	None	One	More Than one			
	Responses	39	0	0		39
	Percentage	100.00	0.00	0.00	0.00	0.00
How many exams have you lost in the Drop Box?	None	One	More Than one			
	Responses	39	0	0		39
	Percentage	100.00	0.00	0.00	0.00	0.00
How many times had you tried to connect to the site unsuccessfully	None	One	Two	More	Too many	
	Responses	31	8	0		39
	Percentage	79.49	20.51	0.00	0.00	0.00
If you compare this system with others that you know...	This is te best	It the same	This is the worst			
	Responses	31	8	0		39
	Percentage	79.49	20.51	0.00	0.00	0.00
Your opinion about the organization of the shared materials	Excelent	Very Good	Regular	Bad		
	Responses	9	27	3	0	39
	Percentage	23.08	69.23	7.69	0.00	0.00
Your opinion of how the exams are applied	Excelent	Very Good	Regular	Bad		
	Responses	19	19	1	0	39
	Percentage	48.72	48.72	2.56	0.00	0.00
Your opinion about how to hand in reports and assignments	Excelent	Very Good	Regular	Bad		
	Responses	20	18	1	0	39
	Percentage	51.28	46.15	2.56	0.00	0.00

Figure 6.2 Survey results.

The results can be resumed to the following statements:

There were none lost files.

The site was online 99.9% of the time.

The shared materials were heavily used.
User satisfaction is over the average.
There are opportunity areas on the organization of the material.

7. Costs.

Costs of this type of services in the Internet have been low since 2006 as presented by (Dwyer, and Malani, 2006). An average of 100 MB space per course was used giving a total of 600 MB actually used by the five courses. The total online space assigned to the teacher was 1 GB. No limit in the size of the files to be transfer to or from the file server was established. The annual cost of the complete service was \$29.50 US dollars. To this cost it is important to add the cost of the classroom equipped with a computer for each student, even though this classroom is used only to apply the exams.

A rent of \$100 US dollars per event is estimated for the use of the classroom with 25 personal computers connected to Internet since there are 3 exams per course and there are five courses we have a total of 15 events which gives a total rent of \$1,500 US Dollars. In this case the university has the classroom already equipped and rent was not paid.

8. Best Practices.

Perhaps the most important issue to take care of is to insure that student's files are properly handed in. In order to do that the following procedure was used during exams:

At the end of the exam and after each student handed in his exam the teacher review in the presence of each student that his exam was actually received in the Drop Box folder for the correspondent file, along with any other relevant material for grading the exam; such as reports and assignments. As it is recommended in the naming convention in section 3, the teacher also reviewed that the student id number is correctly written in the name of each file. This is almost the same procedure used to receive paper exams in traditional courses.

Once all the students handed in their exams the teacher made a copy of the Drop Box.

Another important issue to avoid communication among the students during exams is done by inhibiting chat and email tools.

A serious problem is the fact that the internet address of shared files and drop boxes are normally provided as a sequence of letters and numbers very difficult to remember and type, to solve this problem is recommended to register a internet www domain for instance www.instructor.com and to use addresses such as www.instructor.com/programming-I where a very simple index can show the links of shared files and drop boxes, as it is shown

in figure 8.1. In such a way that addresses are hidden in the HTML code of the index, students never have to write the addresses down, they will only need to remember the teacher internet domain.

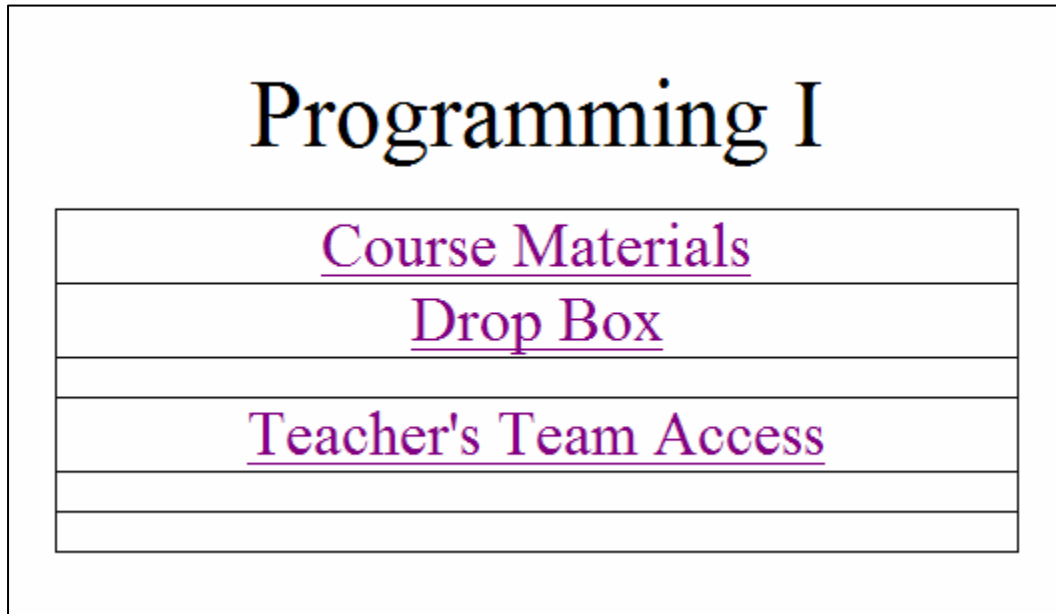


Figure 8.1 Example of a course index.

9. Conclusions.

Results show the effectiveness and low cost of the model. Future studies point to achieve automatic grading of test and quizzes by integrating low cost evaluating tools according to the course available in the cloud computing.

Other promising field would be to expand the application of collaborative environment to allow team work on activities such as software design this is encouraged by the results reported on engineering design by (Jin, Levitt, 1996) and (Rosenthal, and Finger, 2006).

Collaboration environments has been expanded into research activities as described in (Olson, Hofer, Bos, Zimmerman, Olson, Cooney, and Faniel, 2008) research projects are also candidates to use this type of environment, as well as, preparing courses, shared materials, and exercises will help teachers to communicate and work in groups more effectively.

The fact that learning is a communication process illustrates the need of a fast and reliable interchange of information among students and teacher therefore the better than communication is achieved the more effective learning process is performed.

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