Web 2.0 Technologies Applied to Collaborative Learning

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Abstract:

Collaborative learning has been used extensively in higher education. But true collaborative learning has several elements and restrictions that make it very difficult to implement in synchronous distance learning environments. In this article we propose that some collaborative learning characteristics can indeed only be implemented using Web 2.0 technology, the social Web, for synchronous collaborative distance learning environments.

1 Introduction

Collaborative Learning is a learning theory or technique that aims to create a learning scaffold by using social interaction. Just as this type of learning environments starts to spread globally in just about every learning environment, a revolution is beginning to brew. This revolution is not driven by psychology or neurology that is by learning more about how our brain works, but rather by technology. Just as Internet technology is revolutionizing learning, we can be sure that the new generation of tools, languages and protocols that are called "Web 2.0" will present new challenges and changes in the way we teach and learn. Specifically, Web 2.0 is being called the Social, Collaborative Web, thus the association with collaborative learning seems natural. In this article, we present a framework that can help to drive the new revolution and to determine that the new technologies will play in modern Interactive Computer Aided Learning environments.

2 Collaborative Learning

We start by using a common definition of Collaborative Learning (CL): "involved joint intellectual effort by students or students and teachers. Groups of students work together in searching for understanding, meaning, solutions or in creating a product" [1].

One of the most important principles in collaborative learning is "**Positive Interdependence**". Positive interdependence is "the degrees to which participants perceive they are interdependent in that they share a mutual fate and that their success is mutually caused" [2]. Although there are other important aspects of collaborative learning, positive interdependence stands out because is not only encourages knowledge and skills acquisition, but it also encourages the practice of certain attitudes and values such as respect, responsibility to others, personal accountability, self-evaluation, etc. [3, 4].

2.1 Elements of Collaborative Learning

There are five elements of collaborative learning [2]:

1. **Clearly Perceived Positive Interdependence**. In collaborative learning the success of one person is bound up with the success of others. There are many ways to ensure positive interdependence. Goal sharing is one way. This might include shared subject matter, a particular assessment, joint problem solving or creating and discovering something of value. Another way is role sharing. This occurs when each group member is given a specific role that gives a person specific responsibilities. The role describes what group activities that person might take and the contribution to the overall task. Also, resource information contributes to positive interdependence and exists when each group member has only part of the information, cases, material or other resources necessary for the group to achieve its task. Finally, task interdependence is structured by creating a division of labor so that the actions of one group member have to be completed before the next member can complete their tasks.

2. **Interaction**. Individual students are encouraged to assist others in the group to complete tasks in order to reach the group's goals. In other words there is an expectation that students will help each other so that common goals can be achieved. Help may be resources, advice, provision of feedback and challenging conclusions.

3. **Individual Accountability and Personal Responsibility**. Everyone is expected to do their fair share of work and it is important for all group members to know that they cannot 'free ride.' Fair sharing of work can be achieved by:

    a. Keeping the group small: the smaller the group, the greater the individual accountability
    b. Testing every student
    c. Observing the group and recording the frequency with which each member contributes to the group's work
    d. Ask one group member to check the work of others through use of reasoning
    e. Having students teach what they have learned to someone else

4. **Small Group Skills**. Interpersonal skills are important. In order to achieve these goals students must

    a. Get to know and trust each other
    b. Communicate clearly
    c. Provide and accept support
    d. Resolve conflict constructively

5. **Group Processing**. Group work is effective when group participants reflect on how well they function as a group. This reflection assists members to maintain good working relationships. Reflection may focus on such things as relationships between people, facilitation of collaborative skills, rewarding of positive behavior and the celebration of success.

2.2 Skills Developed Using Collaborative Learning

Been a social constructivist technique, collaborative learning has many advantages mostly related to social skills, empowerment and information processing, but also related to information coding and problem solving. A list with most of those skills, compiled from many sources, follows:

1. Time Administration
2. Decision making
3. Satisfaction with self learning experience
4. Oral communication skills
5. Written communication skills
6. Social interaction skills
7. Leadership
8. Team approach to problem solving while maintaining individual accountability
9. Use discussion and debate to clarify ideas
10. Negotiation skills
11. Organizing, clarifying and classifying information
12. Interpreting and discarding information
13. Diversity understanding
14. Personal responsibility for learning
15. Responsibility for each other
16. Critical thinking
17. Self management skills
18. Project management skills
19. Student assessment techniques
20. Criticize ideas, not people (respect and tolerance for diversity)
21. Encourage participation
22. Empathy
23. Understand learning style differences among students

This provides with a tool to evaluate how effective a CL environment is. We perform such evaluation in the following manner; first, we ensure that the entire learning environment, with information technology (IT) supported and no IT supported parts taken into consideration, complies with the five elements of collaborative learning. This is a minimum setup. Secondly, we use the previous list to measure how broadly the environment supports congnitive and metacognitive skills. Which and how the items in the previous list will be evaluated is left to be determined by each educational institution or program.

2.3 Collaborative Activity Models

CL Technique	Description	Procedures
Jigsaw	Complex problem/task that can be easily divided into sections or independent sub-problems	Each participant studies or work around a particular sub-problem. The participants of different groups that study the same problem meet in an Expert Group for exchanging ideas. At last, participants of each Jigsaw group meet to contribute with their expertise in order to solve the whole problem
Pyramid (Snow Ball)	A problem whose resolution implies the achievement of gradual consensus among all the participants	Each individual participant studies the problem and proposes a solution. Groups of participants compare and discuss their proposals and, finally, propose a new shared solution. Those groups join in larger groups in order to generate new agreed proposal. At the end, all the participants must propose a final and agreed solution
Coop-Coop	Complex problem/task that can be easily divided into sections or independent sub-problems	Each participant studies a sub-problem that particularly interests her. The student explains why the item interests her. Students form expert groups to research the sub-problem with task division and deadlines. participants of each group meet to contribute with their expertise in order to solve the whole problem

Table 1. A Summary of Common CL Techniques

To ensure positive interdependence and interaction, CL is normally carried out using predefined activity models such as Jigsaw, Coop-coop, Pyramid, etc. Table 1 shows a brief description of some CL techniques [5].

3 Tools for Collaborative Learning

CL was born long before IT became widely available for education. Thus, true CL does not need IT. Nevertheless, the use of IT has benefited CL in the following manners:

1. To reduce costs by allowing products and procedures to be replicated and thoroughly spread.
2. To widen the reach of the benefits of high quality education even to those that by reason of their geographic isolation, their family/social situation or they economic constraints cannot have access to it.
3. To eliminate space and time barriers.
4. To improve the efficiency of the learning process in such a way that education can take place in a shorter amount of time, be effective over a longer period of time and be available to a larger amount of people.
5. To improve the efficacy of the learning process in such a way that what students learn will transfer smoothly to real life, that is, that learned knowledge and skills will be used immediately.
6. And in general, to promote the information society which by means of information technology, aims to create a better society where goods and services reach equally all.

As pointed out by Kortemeyer and Bauer [6], “We are now on the threshold of the ability to use the emerging computing and communication technologies in education to mediate and augment interactions among teachers and learners.” There are many IT tools that allow us to implement advanced learning environments that redefine the roles of teachers and educators just as collaborative learning has predicted [7].

3.1 First Generation Collaborative Tools

First generation collaborative IT tools support, out of the five minimum elements, interaction and positive interdependence.

They support interaction by different means. For example, synchronous interaction can use messaging and chat systems (MS Messenger, Jabber, ICQ), voice over IP systems (skype and Netmeeting) and video conferencing systems. Asynchronous communication can be use e-mail and bulletin boards systems and discussion forums.

Positive interdependence is supported in different ways:

a. **Goal sharing**. Students use group and team portals to share information and resources that point to common goal, such as the used in dotLRN and Moodle.
b. **Task sharing**. An effective way to confront difficult tasks is to divide the problems in sub-problems and assign different tasks to different students. Project management and workflow tools can help do that.
c. **Resource sharing**. Resources such as information, software and products can be shared between team members by using white boards, content repositories and virtual portfolios.
d. ***Role sharing***. In role sharing, different students become experts in some part of the fabric of the functioning team. Different roles can be: coordinator, informer, speakers, secretary,

counselor, integrator, conciliator, etc. Nevertheless, only state of the art applications such as the Beehive, CSILE, CaMILE and Belvédère and support role sharing [8, 9, 10].

State of the Art Collaborative Tools (Generation 1.5)

These state-of-the-art first-generation tools are integrated software environments in which most of what is needed to carry out collaborative activities are accessible within a single interface. They are often called Computer Supported Collaborative Learning (CSCL) tools. Those tools give the following support [10]:

- Promote inquiry and sense-making
- Facilitate knowledge building by providing a forum for collaboratively presenting arguments, raising learning issues, and reaching consensus on new knowledge
- Allow students to take different roles
- Record-keeping and/or external memory functions
- Enable communication with distant communities
- Promote reflection of alternative perspectives, solutions, and critiques
- Aid in teacher planning and implementation of collaborative activities

As an example, we present University of Sidney's Beehive project which is a synchronous collaborative tool. Figures 1 and 2, and Table 2 are about Beehive. In Fig. 1 we show how the tool is used to plan a collaborative session. In Table 2 we show the different types of collaborative activity models that supported and in Fig. 2 we show the different roles that can be taken by teachers and students. Later on, when the next generation of CSCL tools is presented, the reader can use the figures to make contrasts between the tools.

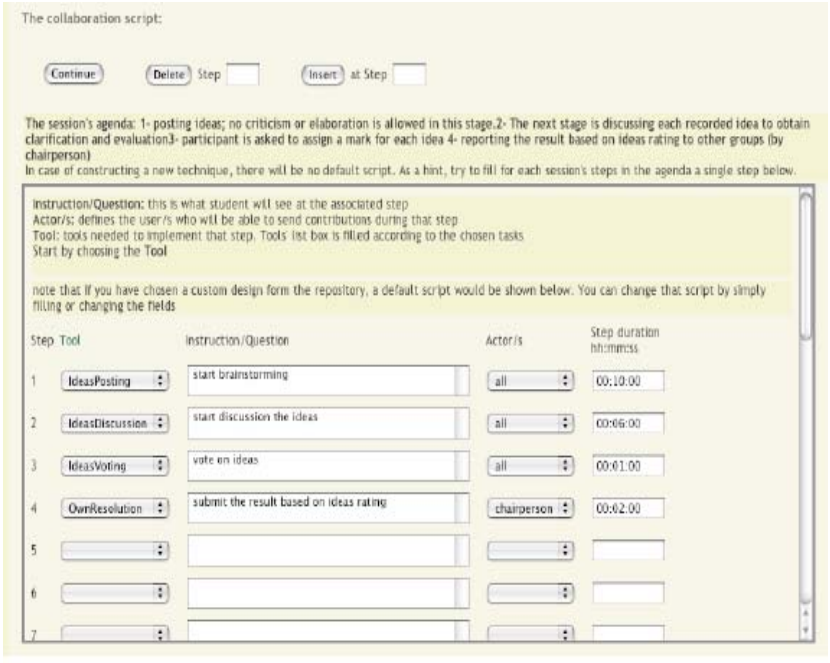

Figure 1. Beehive session planning

Pattern information	Uses
Brainstorm	Ideas creation in a short period
Buzz Group	A topic group discussion for a short period to gather potential solutions to a problem
Case Studies	Helping participants to develop skills in identifying concerns, analyzing problems, and solutions
Debate	A controversial topic clarification or decision making
Debate -Three Person Team Debate Format	
Debate -Two Person Team Debate Format	
Debate -A typical Oxford format	
Debate - Modified Oxford format	
Debate - A typical Cambridge format	
Group Discussion	Knowledge sharing
Group Nomination technique	Creating and choosing the best ideas/solutions
Jigsaw	Complex Problem solving
Online Presentation -V 1	
Presentation	Content that requires presentation
Pro/Contra	Understanding and presenting different sides views
Problem Based Learning PBL	to actively involve with problems coming from real practice
Pyramid	Content that requires individual reflection and then group discussion and explanation
Role Playing	Training/ Understanding the different aspects of a topic
Round Table discussion	Knowledge sharing with a balanced participation
Team Pair Solo	Content that requires group discussion, peer explanation, and finally individual reflection
Think Pair Share	Content that requires individual reflection, peer discussion and groups solutions sharing

Table 2. Beehive Types of Collaborative Activities

Figure 2. Roles Taken by Students and Teachers in Beehive

So first generation CL tools have come a long way from just discussion boards. And more is yet to come. Carry on to the next section.

4 Second Generation Collaborative Tools

As can be observed from Figs. 1 and 2 and Table 2, the complexity of the state of the art first generation tools is increasing. And out of five elements of CL they only support two: interaction and positive interdependence.

Next generation collaborative tools will support:

- Individual accountability and personal responsibility
- Use of the relevant interpersonal and small group skills, such as offer and accept support, conflict resolution, measure trust
- Frequent and regular group processing of current functioning to improve the group's future effectiveness, evaluate a community

This all considered to be Web 2.0 technology!

Although at first it might seem possible that the learning environment complexity will increase as more elements of CL are supported, in fact Web 2.0 technology signals that the complexity might even decrease. Surely, Web 2.0 will be under the hood more complex than Web 1.0. But the complexity that teachers, instructors and students will face may be lower.

5 Web 2.0 and Education

5.1 Web 2.0, a Definition

Web 2.0 is actually a collection of ideas coming into fruition upon the present Web infrastructure all together. For example, Wikipedia defines Web 2.0 as follows "a second generation of services available on the World Wide Web that lets people **collaborate and share information** online". Tim O'Reilley [11] defines it as "the **network as platform**, spanning all connected devices; Web 2.0 applications are those that make the most of the intrinsic advantages of that platform: delivering software as a **continually-updated service** that gets better the more people use it, consuming and remixing data from multiple sources, including individual users, while providing their own data and services in a form that allows remixing by others, creating network effects through an '**architecture of participation**,' and going beyond the page metaphor of Web 1.0 to deliver **rich user experiences**".

Thus Web 2.0 is a platform that is:

- Dynamic
- Interactive
- Personalized
- Syndicated

In other words, it's a social semantic platform. Table 3 shows the differences between Web 1.0 and Web 2.0.

This revolution in which the Web becomes a gigantic desktop where users and computers collaborate combining information into new services and where Web applications behave like desktop applications will not come easy. It involves changes in architecture and infrastructure, protocols, languages, techniques, and applications. Some of those elements are shown in Fig. 3. This figure tries to illustrate the fact that while human-application interaction will become ever simpler because it will be ubiquitous to all humanity not just an elite, the underlying supporting infrastructure will be quite complex. Users will only see a tip of the iceberg disguised as Web 2.0 applications such as blogs, wikis, folksonomies, virtual communities, mash ups and other applications.

Web 1.0 (1993-2003)		Web 2.0 (2003- beyond)
Pretty much HTML pages viewed through a browser		Web pages, plus a lot of other "content" shared over the web, with more interactivity; more like an application than a "page"
"Read"	Mode	"Write" & Contribute
"Page"	Primary Unit of content	"Post / Record"
"Static"	State	"Dynamic"
Web browser	Viewed through...	Browsers, RSS Readers, anything
"Client Server"	Architecture	"Web Services"
Web Coders	Content Created by...	Everyone
"Geeks"	Domain of...	"Mass amatuerization"

Table 3. Differences between Web 1.0 and Web 2.0

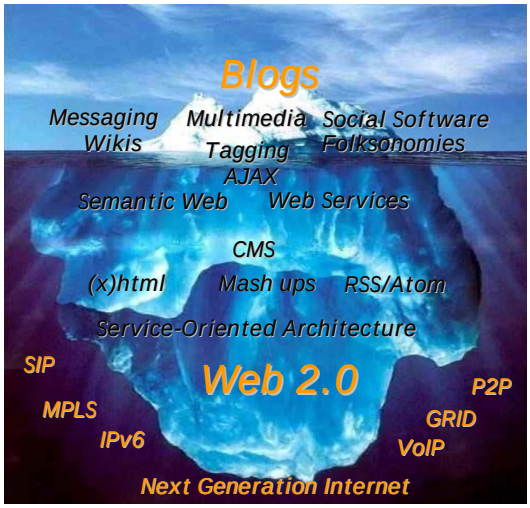

Figure 3. Web 2.0 applications are only the tip of the iceberg. Most of the underlying technology will be invisible to users.

The Top 10 most visited sites that represent this evolving change in platform are:

1. Yahoo!
2. Google
3. MySpace
4. MSN
5. E-Bay
6. Amazon
7. YouTube
8. Craiglist
9. Wikipedia
10. CNN

Fig. 4 shows MySpace, Fig. 5 shows YouTube, Fig. 6 shows Amazon and Fig. 8 shows Google.

Figure 4. MySpace. A social networking site.

Figure 5. YouTube. A video sharing site.

Figure 6. Amazon. A commerce site where user generated content determines sales.

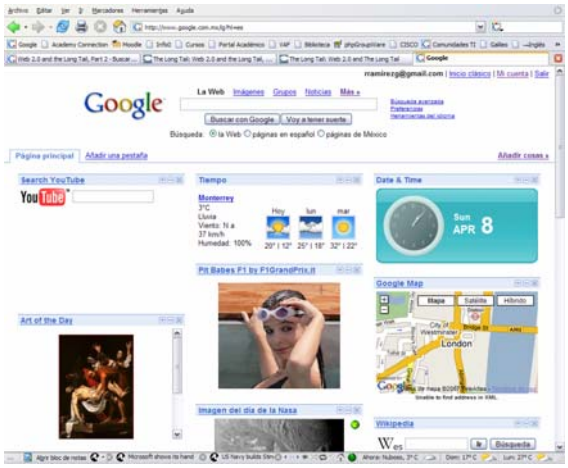

Figure 7. Google. An information organization site the uses Rich Internet Applications and Mashups.

5.2 The Web as Learning Platform

At first it seems that the whole concept of using the Web as platform and abandoning our well-known desktop environments seems odd. The truth is that the change that Web 2.0 brings into academic computing is radical. As you might have noticed, it is hard to see how most of the top 10 Web 2.0 applications can be used for learning. It is easy to see how at least two of them can be used in education. Blogs are similar to student journals and folksonomies seem not too different to groupware. But the astonishing fact is that the Web 2.0 revolution of education goes much deeper than that. Web 2.0 will influence education in the following ways:

1. Web 2.0 technologies contribute to the **overall student experience**, not just improve teaching (although hopefully it would do that as well!). That is Blogs, Wikis, virtual communities, Jabber and other services become part of the learning process. We are witnessing the **birth of a new era of academic computing**. One that it's involved **not only on student learning but in student's life**.
2. Students will contribute their **own materials** for learning. And these contributions will necessarily be original. We are witnessing the **death of plagiarism** and other types of academic dishonesty.
3. Learning materials will be constructed by **pulling information sources from all over the world and building from those sources**. Learning materials will be public and world-available. We are witnessing the birth of **free quality education for all**.

These characteristics produce positive interdependence on a global scale.

And not only positive interdependence benefits from the new technology. Interaction also improves. The new technology will improve the following types of interaction:

- **Teacher-Student interaction**. Students will be able to reach teachers and tutors from anywhere any time.
- **School-Student interaction**. Schools will be able to poll student's attitudes, concerns and progress with greater accuracy and speed.
- **Student-Student Interaction**. Students will collaborate with their teams, classes, cohorts and the world in sharing academic and life experiences, creating content and helping others.

Again we are witnessing the birth of something new: the **birth of real-time learning**.

But not only interaction and positive interdependence benefit from the new technology. We have already said that individual accountability and personal responsibility, use of relevant interpersonal and small group skills, and group processing can only be fully supported by Web 2.0 technology. In Table 4 we show how different Web 2.0 applications relate to those elements of CL. For each CL element, several sites have been chosen, but each site appears in only one CL element. This is for illustration purposes as several sites support all CL elements.

CL Element	Web 2.0 Site / Application	Explanation
Individual Accountability and Personal Responsibility	e-Bay, YouTube	This is called the "Long Tail" (not all members contribute equally). Permanence of members depends on frequency and quality of contributions. All contributions are tagged, annotated and evaluated
Interpersonal and small group skills	MySpace, Blogs	In these sites, people offer and accept support, help and advice. People establish trust relationships and there are instruments to solve conflicts
Group Processing	Wikipedia, Flicker, del.icio.us, Sourceforge	In these sites, different groups work in different projects. Differences of opinions often arise and teams do self evaluation to improve effectiveness. The entire group or community can go through an evaluation process (determine progress and quality metrics)

Table 4. Web 2.0 Sites and CL Elements

Specific Academic Web 2.0 Applications

Even as it is obvious how the previously mentioned Web 2.0 applications can improve the academic experience, there are specific Web 2.0 applications for learning. Just to mention a few:

1. **Edline**. A K-12 portal that allows parents to be involved in classroom activities, follow students progress and communicate with teachers (Fig. 8)
2. **myExperiment and Taverna Workbench**. Social networks for reusable science experiments (Fig. 9)

Figure 8. Edline. K-12 communities and portals

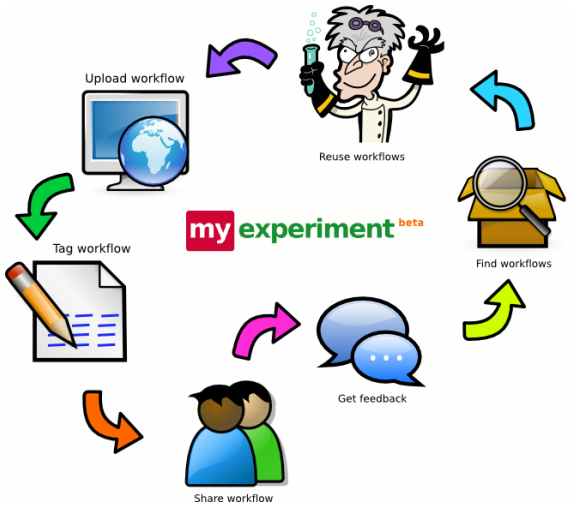

Figure 9. myExperiment. Reusable scientific experiments

5.3 RedWiki and Learning Communities

In order to get started in the academic Web 2.0 revolution, two projects were started at Tecnologico de Monterrey:

1. **Redwiki**. This project aims to create a computer networks encyclopedia. For that, mediaWiki, the same software that uses Wikipedia was installed in http://redhat.mty.itesm.mx/data/redwiki. Instead of having students send over e-mail, upload to a learning platform or simply turn in printed essays and homework, students contribute original articles on the wiki. In this way, the article benefits many people and will not be discarded after some time by the teacher or tutor. One added benefit is that plagiarism tends to disappear, since all articles are public. Also, when articles are developed by more than one person, work must be divided and coordinated, group performance must be measured and differences in opinions must be resolved. mediaWiki provides tools to do all that (Fig. 10).
2. **Virtual Communities**. Students have different interests. Some whish to establish a small company right after graduation, some are interested un computer modeling and animation, some are interested in video and photography, some are interested in Linux, etc. Several

virtual communities have been setup (you can find most following the link http://redhat.mty.itesm.mx/comunidades.htm). The software used was Drupal, Mambo and PHP-Nuke. Those are all Content Management Systems (CMS). In these communities members contribute content in the form of articles, reviews, tutorials, software, useful data such as models, templates, etc. All contributions are tagged, annotated and rated. These communities are not specific to any course in particular and participation is voluntary (Fig. 11).

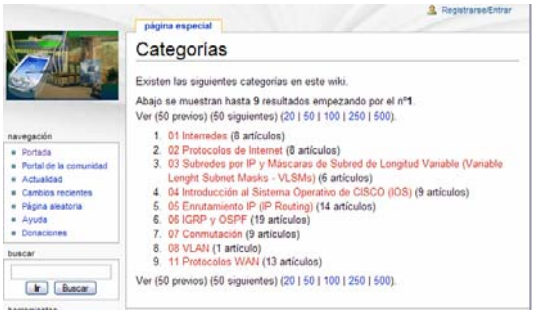

Figure 10. RedWiki. A networking encyclopedia

Figure 11. Virtual Communities. Content Management Systems where students volunteer content according to interests

6 Conclusions

Although the benefits in improved academic achievement or improved motivation and satisfaction that the Web 2.0 revolution can achieve are yet to be determined, there is strong evidence that the impact will be important. Collaboration between students seems to increase. Critical thinking, which is used when a student must review and improve an existing article also seems to have improved. Plagiarism between the institution seems have decreased. There is no way to measure out side plagiarism, but it seems that eventually all information will be public thus determining if a contribution has been plagiarized will be as simple as a Google search. We use well-known CL activity models to design and develop some of the wiki contributions, thus CL elements are kept, although this is not a direct consequence of Web 2.0 technology.

Other ideas on the use of existing and future Web 2.0 technology are the following:

- Build student virtual associations (and a Federation) not only based on place of origin or academic program, but in particular combinations of personal interests and attitudes.
- Build a learning object sharing community for teachers
    - With a few key strokes teachers can find resources for any academic subject, but often times, it is more difficult to find learning materials form colleagues that work on the same building. Teachers should be examples of collaboration.
    - This is more than just a content repository. We mean to establish a complete Web 2.0 experience where individual contributions can be annotated, commented, tested, evaluated and collaboratively improved.

- Support more student interaction (for example peer to peer is often prohibited as is e-mail servers). This has to change. IT is now part of student's life and should be supported.
- Allow public evaluation of courses and students (students are doing it anyway behind our backs). Academic institutions evaluate programs and teachers just as they evaluate students. But these results are not public. Nevertheless, students know us and can pin point strengths and weaknesses of both teachers and institutions. Let this information be fairly presented and public. Not only that, let society participate in the process.

References:

[1] http://en.wikipedia.org/wiki/Collaborative_learning
[2] Johnson, D. W., & Johnson, R. T. "Positive Interdependence: Key to Effective Cooperation". In R. H. Herz-Lazarowitz, & N. Miller (Eds.), Interaction in Cooperative Groups: The Theoretical Anatomy of Group Learning, pp. 174 – 199. Cambridge University Press, 1991.
[3] Barkley, E., Cross, P. and Major, C. H. "Collaborative Learning Techniques: A Handbook for College Faculty" (Chapter 1). Jossey-Bass, 2004.
[4] Dale, V. H. M., Nasir, L. and Sullivan, M. "Evaluation of Student Attitudes to Cooperative Learning in Undergraduate Veterinary Medicine". Journal of Veterinary Medical Education, Vol 32, Issue 4, 511-516, 2005.
[5] Hernandez, D., Asensio, J. I., and Dimitriadis, Y. A. "Collaborative Learning Strategies and Scenario-based Activities for Understanding Network Protocols". ASEE/IEEE Frontiers in Education Conference, October, 2006, San Diego, U. S. A.
[6] Kortemeyew, G., and W. Bauer, "Multimedia Collaborative Content Creation (mc): The MSU Lecture Online System," Journal of Engineering Education, vol. 88, no. 4,1999, pp. 421-427.
[7] Evans, R.M. et al., "Effectiveness of an Internet-Based Graduate Engineering Management Course," Journal of Engineering Education, vol. 89, no.1,2000, pp.63-71.
[8] Turani, A and Calvo, R. A. "Beehive: A Software Application for Synchronous Collaborative Learning". Campus Wide Information Systems, 23, 3, 196-209, 2006.
[9] Turani, A and Calvo, R. A. "Sharing Synchronous Collaborative Learning Structures using IMS Learning Design". International Conference on Information Technology Based Higher Education & Training, pp. 119-129, Sydney, 2006.
[10] J. M. van Bruggen, P. A. Kischner and W. Jochems. "External representation of argumentation in CSCL and the management of cognitive load". Learning and Instruction, 12, p. 121-138, 2002.
[11] O'Reilly, T. "Web 2.0: Compact Definition?" http://radar.oreilly.com/archives/2005/10/web_20_compact_definition.html

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