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Patrick Jermann, Pierre Dillenbourg, Jean-Christophe Brouze
TECFA (unit of Educational Technology),
School of Psychology and Education Sciences
University of Geneva, Switzerland

Abstract

This contribution is an attempt to systematise our approach to the design of a virtual campus. Activities in the recently started TECFA virtual campus rely on Internet tools, but they concern both distance teaching and presential interactions. Designing learning activities is relatively easy when the learning goal is an activity in itself. In this contribution, we explain how we extend the “learning by doing” approach to the acquisition of declarative knowledge. After fulfilling a pseudo-task, the activities we describe lead students to interpret a graphical representation of their performance. This happens during a debriefing session where the teacher turns students’ experiential knowledge into academic knowledge. The target knowledge, i.e. the concept or theory we want them to understand, is acquired through the effort students make to understand differences that appear in the representation of pseudo-task performances. The representations produced by the system were successful in triggering intense discussions.

Keywords: Declarative knowledge acquisition, virtual campus, collaboration and collaborative tools, collective representations.

1. Introduction: What's in a virtual campus ?

What is the difference between a virtual campus and any genuine Web site for training? The most salient difference is that the information space is rendered by a spatial metaphor. A second difference is that a campus is supposed to be broader than a course, i.e. that a virtual campus should cover rather broad curricula. This requires some homogeneity across courses, both at the pedagogical level and at the management level (e.g. student tracking tools). In this contribution, we suggest a third difference: to restrict the label 'virtual campus' to environments which offer learning activities, rather than simply provide information. The evolution of the Web shows itself the limits of the "teaching as transmitting information" paradigm: we have the technology to provide learners with a huge amount of information, but the learners cannot turn it into personal knowledge simply by reading Web pages. We see the virtual campus paradigm as a move away from information sites towards learning sites, from providing (multimedia) documents towards involving the user in learning activities. This additional item in the definition of a virtual campus does not reflect its current use in the community, we propose it here for adoption.

However, when training university teachers to use Internet, we observed that, although they mostly accept this constructivist approach at the discourse level, they do complain about the difficulty to apply it to their own teaching ("I like what you do but it would not work for my course!"). Designing learning activities is relatively easy when the learning goal is an activity in itself. For instance, learning a programming language naturally relies on programming exercises. In a similar way, when teaching software design, the most natural method is project-based, the learners being asked to design a piece of software. In other words, the design of activities is rather natural for procedural and heuristic knowledge. It is harder for declarative knowledge, teachers object that activities are not useful for teaching theories. Hence, this contribution addresses the design of Web-based activities for learning declarative knowledge. Since the goal is not a task in itself, the learning activity is hereafter referred to as a pseudo-task, i.e. a task which is artificially introduced for making learners aware of some features.

TECFA virtual campus includes a variety of learning activities. We present three of them (section 3) because they share some design features (section 4), which can be generalised to other learning objectives. We do however not propose any recipe, the design of learning activities remains a complex engineering process, based on the deep analysis of the knowledge or skills to be acquired. Our contribution suggests some solutions which can be chosen during this design process. These solutions will have to be adapted to other contexts than ours (section 2), according to the number and level of students, to the balance of presential versus distance learning activities, and so forth.

This contribution does not include AI components, as the scope of this conference has been broadened to interactive learning systems. It is based on standard tools for generating dynamically Web pages from a database. However, the activities illustrated in this paper and other activities in the virtual campus share many technical aspects. We hence suggest to develop higher order tools which produce this kind of environments with reduced costs.

2. Teaching context

The TECFA virtual campus relies on design principles drawn from our five-years experience in teaching with Internet. We used it for a master degree in educational technology. Its organisation combines distance with presential periods: students attend courses for one week at the University and then work remotely for 5 to 7 weeks using a combination of available media (e-mail, discussion groups, MOOs, phone, ...). Combining presence and distance has proved to be a very robust formula. Some weaknesses of electronic communication can be repaired through face-to-face meetings (and vice-versa). For instance, e-mail is not appropriate for the initial phase of a project, when goals have to be defined (Hansen et al, 1998): Brainstorming and negotiation are more efficiently conducted through face-to-face meetings. Paradoxically, we observed a bias in our evolution: since students spend a short time in presence, we tended to teach as much theory possible and neglected interactive sessions. The actual state of TECFA virtual campus results from the solutions we found to these various problems.

2.1. Designing principles

The design of the activities illustrated in section 3, reflect general principles:

Principle #1: *Less text, more activity.* We do not claim that a web site should not include any documents but that resources and activities must be differentiated at the technical and conceptual levels. The resources are the documents, images, movies,... The activities are the tasks that students are asked to perform in order to process the encountered information. In general, the Web sites include an implicit activity: please consult the information (read/watch/listen). We suggest to use activities in which the learner has a more active role to play, where he is in charge of constructing his knowledge.

Principle #2: *Design activities for presence*. The usage of Internet tools is not restricted to distance interactions, they can also be used in presential teaching. One could even argue that the real challenge is to use the Web in presential teaching: when students are far away, providing information is per se a good thing, whatever the pedagogical quality; at the opposite, if students are present, one has to justify in which way Web-based activities offer any extra added value compared to other ways of teaching. Of course, we have the same interest for distance activities, but those presented here are used with students being present in the room.

Principle #3: *Integrate communication into activities*. Providing communication tools (e-mail, forums,...) does not imply that students actually use them for content-rich interactions ("conversational learning"). Our experience in Internet-based teaching is that e-mail is mostly used for management issues (appointments, assignments, ...), while discussion groups are more frequently used to handle technical problems than for knowledge intensive argumentation. This statement is rather trivial: Students do not communicate just for the sake of communication, but because they need to communicate with respect to some task. Communication should not be an extra-task, it should be part of the task. Namely, the main vector for communication in our examples are shared spaces, i.e. interfaces by which learners act on the same objects.

Principle #5: *Structure groupwork with scenarios*. Beyond collaborative learning, we observed that involving the whole class of students at some stages produced very dynamic interactions. We later refer to this phase as being 'collective'. Most of our learning activities rely on the group of learners. However, as we know from research on collaboration (Dillenbourg et al, 1995), group interactions are not guaranteed to produce learning. To increase the probability of productive interactions, we design scenarios which specify which learner must do what and at which time. This scenario is encompassed in the interface: the scenario phases are represented as virtual rooms, the environments functionalities determine how learners interact, ...

3. Three examples of activities

The activities we present in this section are represented as buildings inside the TECFA virtual campus. A building corresponds to a pedagogical scenario, and each phase is matched with a room. The examples below share two aspects: they all include a pseudo-task, i.e. a task which is apparentely not related to the pedgagoical goals, and this pseudo-task is followed by debriefing activities during which emergent knowledge is structured by the teacher.

3.1. Ergonomics laboratory

This activity belongs to a course on human-computer interaction. Its objective is to introduce the SSOA model (Schneiderman, 1992). Students compare the effectiveness of different interaction styles and relate these styles to different types of users' knowledge taken from the SSOA model. The difference between styles is not taught but experienced by the students themselves as they use different versions of the same application in a pseudo-task.

Pseudo-task. We ask students to use six versions of an application in order to produce railway tickets. Each student composes 4 tickets with each version. Students have to fulfil the wishes of an imaginary passenger who chooses the destination, the type of seat, the class, return or not, etc... They get a verbal description of the tickets to produce. Each version of the application is based on different "interaction styles": command languages, pull-down or pop-up menus, direct manipulation (drag & drop or click) and forms. They get a verbal description of the tickets to produce. Once the student has completed the 24 tickets, log data is collected by the application and sent to a central device.

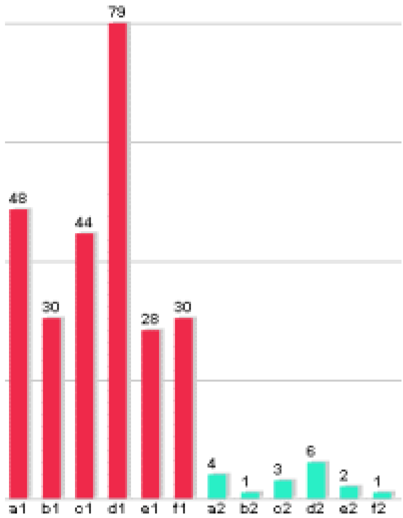

Figure 1: Histogram of mean response time in seconds (bars a1..f1) and number of errors (bars a2..f2) across the different interaction styles: (a) command language, (b) pop-up menus, (c) pull- down menus, (d) forms, (e) direct manipulation by click, (f) direct manipulation by drag & drop

Representation and debriefing. Several parameters are stored during task completion: the response time, the number of errors and the number of help requests. On demand, by moving to the next phase, the system generates representations of the parameters measured for each interaction style. A general histogram (Figure 1) shows the mean of parameters across the interaction styles. The students comment these data by explaining why they were slow or fast with different versions, why they did mistakes, they clarify which system features are responsible for their behaviour. The role of the teacher is to synthesise both these numeric data and the experiential comments and to articulate them with a theoretical framework, in this case Schneiderman's SSOA model.

Experiment. This activity took two hours to be completed. It was effective in the sense that students produced a very rich list of pros and cons with respect to each interaction style and related them to the target type of user (Schneiderman). Students tend to use their experiential knowledge more than the statistical summary during the debriefing. This summary is more useful for the teacher to draw a synthesis.

3.2. Defects of multiple-choice questionnaires

This activity is intended to teach the common defects of multiple-choice questionnaires, i.e. to provide students with an operational understanding of the validity of this educational measurement tool.

Pseudo-task. Students answer two questionnaires in pairs: the first about performances of belgian athletes, the second about capitals in western Europe. Before they answer the questionnaires, they are asked to evaluate their level of competence in each of the domains on a 5 point scale. The questionnaires are built in such a way that the questions related to the domain more familiar to the students (capitals of western Europe) is hard to answer. Conversely, the questions for the less familiar domain (performances of belgian athletes) are built in such a manner that one can guess the correct answer. Completing each questionnaire leads to a score to be compared with the self-evaluation the students gave at the beginning of the activity.

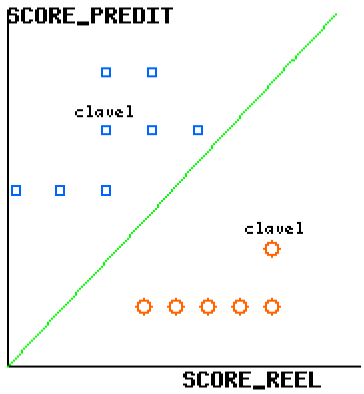

Figure 2: Graph of evaluated and real scores for the two questionnaires. (Real scores on the X-axis and predicted scores on the Y- axis). Because some pairs had the same scores, several squares and circles are superimposed. The squares above the diagonal are responses to the questionnaire on capitals of western Europe (familiar topic). Students over-evaluated their competence. Conversely, the circles below the diagonal represent scores to the questionnaire on performances of belgian athletes (unfamiliar topic). Students under-estimated their competence.

Representation and debriefing. In the next phase, the system plots a graph (Figure 2) with the students' position indicated by his name. In addition to the scores graph, the system provides several statistics: the distribution of answers to each question, a list of defects and ways to avoid them. During the debriefing, the teacher reviews questions one per one, the students explain how they produced their answers and identify defects of the questionnaires. Finally, the teacher generalises the observed defects of the questionnaires from a docimological viewpoint. During the debriefing, the negative correlation between predicted and real scores is not interpreted as reflecting bad metacognitive skills, but the low validity of the questionnaire.

Experiment. This activity lasted 2 hours. It appeared to be effective for inducing the defects of MCQuestionnaires, especially for the second questionnaire: since students were upset by their bad scores they were eagerly trying to attribute their errors to defects of the questionnaires.

3.3. Argue Graph

The goal of this activity is to make students aware of learning theories (e.g. constructivism, behaviourism, ...) underlying design choices in courseware development. In the past, this course was given as a standard lecture with less convincing outcomes.

Pseudo-task. The scenario includes the following steps: Students twice fill in the same online questionnaire about design principles in courseware development. Here is an example of the questions they had to answer: What is the best way to motivate students? a) show them what the learning objective is; b) show them a funny animation at each correct response; c) include the score they get for the course evaluation.

The first time they answer to the questionnaire alone and the second time in pairs. When answering, they are invited to give a written argument to support each of their choice. The choices the students make are transformed into two scores reflecting whether they privilege system- vs. user-driven interactions and a discovery vs. teaching based pedagogy. A scatterplot is created on the basis of these scores representing each student's position along the two dimensions of courseware design. In a second phase we let students work in pairs. These pairs are formed as to maximise the differences between students based on their answers to the individual questionnaire. When working in pairs, the students see the arguments they gave to support their answers in the individual phase. They have to agree on a common answer and provide a common argument.

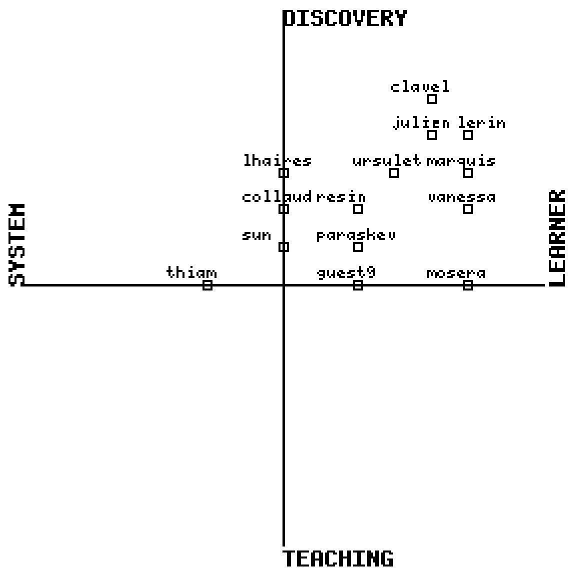

Figure 3: Scatterplot of solo answers. Each square corresponds to a student’s opinion. The horizontal axis opposes system vs. learner driven interaction. The vertical axis opposes discovery based learning vs. teaching.

Representation and debriefing. The system draws two scatterplots. After students answered alone, they can see their position along the dimensions we just described (Figure 3). Then, after students answered in pairs, the scatterplot represents the “migration” of each student from his initial position to the common position. In addition to the scatterplots, the system lists all the arguments given for each question and draws a piechart with the distribution of answers. Finally, a brief statement presents the underlying theories to the options the student can select in a question. The teacher debriefs the class on the basis of this information.

Experiments. This activity took 4 hours to complete. We ran two pre-experiments, respectively with 15 students in 1997 and 17 students in 1998, after which the system was improved with regard to various functionalities. The experiment reported here was run with on October 22nd 1998. Most students where located in the same quarter of the graph (Figure 3). This phenomenon is probably due to the fact that the questions did too clearly reflect the pedagogical values sponsored at TECFA and did not take into account the technical or financial dimensions. A preliminary data analysis shows that the pairing method is efficient for triggering argumentation. In 49% of the questions, the members of the pair had to answer a question for which the individuals previously gave different answers. There is some relation between the distance in the graph and the frequency of conflict (the five pairs with a distance of 1 have a disagreement rate of 38%, while the pairs with a larger distance have a rate of disagreement of 52.5%), but the size of the sample is not sufficient to compute a correlation rate. For each AB pair, we counted the number of times that AB’s joint answer corresponded A’s previous solo answer versus the times it corresponded to B’s previous solo answer. We thereby observed that pairs were rather symmetrical, the difference ranging between 0 and 2, with the exception of 2 pairs.

4. Generalizing the approach: dialectic collective activities

The learning activities we described in section 3 follow a similar scenario: students first complete a task not directly related to the target knowledge to be learned. The system then uses the students' answers to produce a synthetic representation of their performance. Finally, the teacher uses this representation to debrief the class. i.e. to turn their experiential knowledge into academic knowledge, to put labels on new concepts, to structure the outcome.

As stated in the introduction, designing learning activities is relatively easy when the learning goal is an activity in itself. When acquiring declarative knowledge (principles, theories, laws, concepts, ...) the learning task cannot simply be derived from the target task. Therefore, we introduce the notion of pseudo-task to refer to a task which is not the skill to be mastered, but which produces learning by experience.

The target knowledge results from the effort to understand differences that appear in the representation of pseudo-task performances. These representations always present an aspect of differentiation, either cognitive, metacognitive or social. While the students have accomplished the pseudo-task either alone or in pairs, the synthesis produced by the system represents the students as a collectivity. "Collective" differs from "collaborative" due to the fact that it does not necessarily imply rich interactions among students. Simply, the system collects individual productions or data and makes them available for the whole group. Collective representations bring the social plane into the frame of reference used during the debriefing session.

In other words, the underlying principle is to play with various types of differences in such a way that the explanation of observed differences produces the information which is then structured by the teacher during the debriefing.

Table 1 summarises design parameters we used to set up the activities. The question which remains open is whether a particular type of competence, type of difference and type of representation match better.

Table 1: Design parameters

	Ergonomics laboratory	***MCQuestionnaires***	***Argue graph***
Target knowledge	SSOA model: understanding the usability of different interaction styles	validity criteria for multiple choice questionnaires	learning theories underlying design choices in courseware
Pseudo-task	produce railway tickets with six different interfaces	answer two badly designed questionnaires	answer a questionnaire about design choices
Type of competence in the pseudo-task	tool specific knowledge	domain specific knowledge	opinions
One correct response	yes (ticket matches the needs of passenger)	yes (only one answer is correct)	no (opinions)
Debriefing	clarify differences between interaction styles with respect to a theoretical model	clarify the concept of validity	link opinions about courseware development with learning theories
Representation used in debriefing	graph represents mean performance for each interface	graph represents self-evaluation and score obtained	graph represents people's opinions
Differentiation level	cognitive (performance: time, errors)	metacognitive (mismatch between self-evaluation and effective score)	social (difference between opinion scores)
Mode of representation	anonymous	individual compared to an anonymous group	individual compared to individuals

5. How to get a demo

TECFA virtual campus is located at http://tecfa.unige.ch/campus/infospace/index.php. In order to have full access to the facilities of the campus, users have to log in. Ten guest accounts are available for testing purpose. Use “guest1” (or “guest2” ... “guest10”) as login and password. The “ergonomics laboratory” is located in building 1201 of zone 12. The “defects of multiple-choice questionnaires” activity is in building 1603 of zone 16. Finally, the “argue graph” can be found in building 1601 of zone 16.

6. Conclusion

This contribution is an attempt to systematise our approach to the design of a virtual campus. We have presented three learning activities for declarative knowledge acquisition. After fulfilling a pseudo-task, these activities lead students to interpret a graphical representation of their performance. This happens during a debriefing session where the teacher turns students’ experiential knowledge into academic knowledge. The target knowledge, i.e. the concept or theory we want them to understand, is acquired through the effort students make to understand differences that appear in the representation of pseudo-task performances. The representations produced by the system were successful in triggering intense discussions.

We have just started the TECFA virtual campus and it remains under construction. New developments are planned in the near future. For example, the extension of the existing navigation tool with 2D maps should allow us to use distances between buildings to represent thematic relationships. We also intend to build personal maps which can then be used by students as spatially organised bookmarks.

7. Acknowledgments

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8. References

Dillenbourg, P., Jermann, P., Schneider, D., Traum, D. and Buiu, C. (1997) - The design of MOO agents: Implications from a study on multi-modal collaborative problem solving. In Proceedings of AI&EDí97 Conference. B. du Boulay and R. Mizoguchi (Eds.). IOS Press.

Dillenbourg, P., Baker, M., Blaye, A. & O'Malley, C. (1995) - The evolution of research on collaborative learning. In E. Spada & P. Reiman (Eds) Learning in Humans and Machine: Towards an interdisciplinary learning science. (Pp. 189-211) Oxford: Elsevier.

Hansen, D., Dirckinck-Holmfeld, L., Lewis, R. and Rugeli, J. (1998) - Using Telematics for Collaborative Knowledge Construction. In Collaborative Learning: Cognitive and Computational Approaches. Elsevier Science Publishers: Amsterdam.

Rouet, J.-F. (1994) - Question answering and learning with hypertext. In R. Lewis & P. Mendelsohn (Eds) - Lessons from learning. IFIP Transactions A-46.

Schneiderman, B.(1992) - Designing the user interface. Reading, MA: Addison-Wesley.