SCRIPTING STRATEGIES IN COMPUTER SUPPORTED COLLABORATIVE LEARNING ENVIRONMENTS

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FAPSE, Université de Genève

Michele Notari micheno@hotmail.com

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Jury:
Advisor: **Daniel K. Schneider**

Mireille Bétrancourt
Barbara Class

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Preface

This report is a master's thesis presented in order to obtain a DES in "Sciences et Technologies de l'Apprentissage et de la Formation" (Master of Science) at the University of Geneva. The work was performed from November 2002 to September 2003 in Berne, Liestal, and Geneva, and the thesis topic is related to the author's job as a high school teacher. We would like to mention that a part of this research is presented in the 'Second International Conference on Multimedia and Information & Communication Technologies in Education[1] (m-ICTE 2003) in Badajoz, Spain.

This thesis is directed toward teachers that are interested in getting involved in constructivist learning with ICT, but also presents a more research-based component where different scriptings are compared. Teachers would tend to be more interested in different scripting methods, while the pedagogical engineering part, including the evaluation of the tests and the questionnaires, may be more appealing to researchers.

This paper is an attempt to implement action-based learning in the classroom. We hope to motivate teachers to try out described techniques or to invent new ones. Scripting is firmly bound to a specific learning situation, and therefore needs to be adapted for each new educational scenario. Nevertheless, we hope that some general scripting concepts can be applied to a variety of learning set-ups.

Please note the rather hypertext-type structure of this document. We tried to work with many small chapters connected to a specific subject, and to permit a non-linear reading we had to repeat some facts in different chapters. We set up our text in the style of the conducted research about constructing hypertexts. Once the text is online we will link all the different chapters.

Since this document is my first attempt at writing in English, I apologize for any mistakes!

I wish a merry reading and some useful new insights in this field of research.

Michele Notari – micheno@hotmail.com

Berne, October 2003

[1] http://www.formatex.org/micte2003/micte2003.htm

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Sorry to my sons Luca and Che (my sons), for the time I could not spend with you two because I was sitting in front of the computer.

Abstract

Free and unstructured collaboration tasks do not systematically produce effective learning. One way to enhance the effectiveness of collaborative learning is to structure interactions by engaging students in well-defined, computer-supported pedagogical scripts. A script (some authors use the term scenario) is a “story” that the students and tutors have to “play”, as actors would play a movie script. We conducted a study using three different learning units that are currently embedded in regular high school biology curricula, and focused on the students’ learning processes and results. We constructed these collaborative, hypertext-based pedagogical scripts based on the following formula: (1) A first phase where there is the production of a critical mass of information into the system i.e. a hypertext accessible to all members of the learning community. (2) A second step where students are encouraged to link similar concepts. (3) A third phase where students should sustain the important consideration of the work produced by other members of the community. These strategies lead to a deeper immersion in the treated subject, better subjective perception of efficiency, and a somewhat increased learning progression.

We focused on the performance of two classes exposed to the same educational concepts but in different scenarios. A regular high school class accomplished their tasks in a conventional learning unit, while a vocational high school class utilized a collaborative hypertext (Swiki). The two groups showed a similar increase in factual knowledge, which clearly shows an experimentation effect. Given the elective Swiss school system, regular high school students would be expected to show a better academic performance than the vocational students, in a comparable learning situation. The vocational class produced a longer and more complex hypertext than the regular class. However, the regular class produced summaries about a wider variety of subjects and showed a better confidence in their knowledge about the subjects. We called our scenarios: **A**ction **Ba**sed, **H**ypertext-**Co**nstructive, **Co**mputer **Su**pported **Co**llaborative **L**earning units (**ABAHCOCOSUCOL**) and found numerous possibilities for applying the scripting elements combined with the additional tool to all sorts of learning environments. This may include a face to face learning environment, but also blended learning (with adolescent and adult students), and learning that integrates different subjects.

“The teacher is not in the school to impose certain ideas or to form certain habits in the child, but is there as a member of the community to select the influences which shall affect the child and to assist him in properly responding to these influences.”

“I believe that the social life of the child is the basis of concentration, or correlation, in all his training or growth. The social life gives the unconscious unity and the background of all his efforts and of all his attainments.”

John Dewey's famous declaration concerning education. First published in January 16, 1897

1 Introduction

How do teachers direct their students to use computers and the Internet?

The use of computers for classroom education has become more and more ubiquitous. When we started our work we wondered how most of the teachers already use this tool in their lessons. We carried out a little research and found results for the United States. The following statistical analysis has been done by The National Center for Educational Statistics[2].

Sixty-six percent of public school teachers reported using computers or the Internet for instruction during class time[3] (table 1). Forty-one percent of teachers reported assigning students work that involved computer applications such as word processing and spreadsheets to a moderate or large extent; 31 percent of teachers reported assigning practice drills and 30 percent reported assigning research using the Internet to a moderate or large extent.

The ways teachers direct students to use computers or the Internet varied by instructional level. Elementary school teachers were more likely than secondary school teachers to assign students practice drills using computers (39 vs. 12 percent) and to have their students use computers or the Internet to solve problems (31 vs. 20 percent). Secondary school teachers, however, were more likely to assign research using the Internet (41 vs. 25 percent).

School and teacher characteristics	Teacher uses for classroom instruction	Computer application e.g. word processing	Practice drills	Research using the Internet	Solve problems and analyse Data	Research using CD-ROM	Produce multimedia reports	Demonstrations / simulations	Correspond with others
All public school teachers with acces to computers or internet at school	**66**	**41**	**31**	**30**	**27**	**27**	**24**	**17**	**7**
School instructional level:									
Elementary school	**68**	**41**	**39**	**25**	**31**	**27**	**22**	**15**	**7**
Secondary school	**60**	**42**	**12**	**41**	**29**	**27**	**27**	**21**	**7**

table 1: Percent of teachers reporting using computers or the Internet for instruction and the percent assigning various uses to students to a moderate or large extent[4]:

Another international analysis of the use of the computer of 15 years old pupils in Europe in spring 2000 has shown the following results (Pisa Studie[5]). About 60% of the pupils use computers at

[2] http://nces.ed.gov/
[3] http://nces.ed.gov/pubs2000/quarterly/summer/3elem/q3-2.html
[4] http://nces.ed.gov/pubs2000/quarterly/summer/3elem/q3-2.html

home and 36% at school. 50% of the pupils use a computer for information research, 43% for e-mail, and about 30% for learning activities[6]. In this study no detailed information about the type of learning activity is shown.

Our main concern is to show that it is also possible to use the computer for something other than simple exercises, information research, e-mail or word processing in classroom education. It is also important for us to bring out that there is no bad or good use of any tool or strategy. Depending on the pedagogical goal of the teacher a drill unit can be ideal but in another case a collaborative unit would be much more useful.

The following theoretical chapter, which contains an overview of learning models, will substantiate more activity-centred approaches for the use of computers in education. We hope to give an overview of the possibilities and maybe convince teachers to use these models for appropriate pedagogical settings.

[5] http://www.mpib-berlin.mpg.de/pisa/PISA_im_Ueberblick.pdf (in German)
[6] http://www.statistik.admin.ch/stat_ch/ber20/indic-soc-info/pdf/ind30404d_v1.pdf

1.1 Learning theories / learning models

"All learning theories address real problems
All pedagogical models have their usefulness
but ...
Computer-based instruction (CBT)
- what is sold as "e-learning" today -
gets too much attention !
Rich activity-based educational designs do not "

Citation from a Speech of Schneider D. in Goteborg (2003)
According to this citation and the statistical survey about the use of the internet for pedagogical purposes we will shortly describe two learning models: the first is an 'information transmission model' and the second a constructivist or activity-based model. The research emerging from this paper is based upon a constructive pedagogy; for this reason a much wider description of the theoretical background is given.

1.2 Learning models based on instructional pedagogy

Briefly this important and very often adopted model for teaching will be described. Learning consists basically in transfer of information from teacher(s) or computer(s) to student (s).
This approach has been described by "The Thomas B. Fordham Foundation7":
"Variously called "direct instruction," "mastery learning," "explicit teaching," or "precision teaching," these classroom strategies have key points in common. Teachers who use them are specific about what students are expected to learn, and they communicate these expectations clearly to their pupils; Virtually all school time and energy are focused on the desired learning; testing provides frequent feedback on progress, success is rewarded and failure is not accepted, and effort continues until the goals are attained."
So learning material is prepared by the teacher and presented to the learners. To ensure that students have learned what was intended, evaluation takes place after each learning unit and especially in mastery learning students are not allowed to continue before mastering the unit.
Three phases of instructional pedagogy can be pointed out:
a) Information transfer
b) Evaluation
c) Feedback
The cycle of the three phases can be very short as in classical behaviourist approaches where learning is based on very short instructions and immediate (positive or negative) reinforcement or the cycles can be longer as e.g. proposed in typical mastery learning pedagogies.

[7]The Thomas B. Fordham Foundation:1627 K Street, NW, Suite 600 Washington, DC 20006: http://www.edexcellence.net/library/epciv.html

Instructivist theories have been criticised for years. Many controversial opinions have been formulated about learning efficiency, modest long term learning effects, failure in understanding complex concepts, bad transfer capacity and so on and so forth.

1.3 Learning models based on a constructive pedagogy

We will introduce some theoretical assets, basic concepts of constructivism and show the characteristic of constructivist learning environments. Our text is based on a summary about learning theories written by Jy Wana Daphne Lin Hsiao (1996).

1.3.1 Constructivism

In essence, constructivism views that knowledge is not 'about' the world, but rather 'constitutive' of the world. Knowledge is not a fixed object, it is constructed by an individual through his or her own experience of that object. Constructivist approach to learning emphasizes authentic, challenging projects that include students, teachers and sometimes experts in the learning community. **Its goal is to create learning communities that are more closely related to the collaborative practice of the real world**. In an authentic environment, **learners assume the responsibilities** of their own learning, they have to develop metacognitive abilities to monitor and direct their own learning and performance. When people work collaboratively in an authentic activity, they bring their own framework and perspectives to the activity. They can see a problem from different perspectives, and **are able to negotiate and generate meanings and solution through shared understanding**. The constructivist paradigm has led us to understand how learning can be facilitated through certain types of engaging, constructive activities. **This model of learning emphasizes meaning-making through active participation**. A crucial element of active participation is dialog in shared experiences, through which situated collaborative activities, such as modelling, discourse and decision making, are necessary to support the negotiation and creation of meaning and understanding.
“In sum, the contemporary constructivist theory of learning acknowledges that individuals are active agents, they engage in their own knowledge construction by integrating new information into their schema, and by associating and representing it into a meaningful way” (Jy Wana Daphne Lin Hsiao, 1996) Constructivists argue that it is impractical for teachers to make all the current decisions and dump the information onto students without involving students in the decision process and assessing students' abilities to construct knowledge. In other words, guided instruction is suggested that puts **students at the centre of learning process**, and provides guidance and concrete teaching whenever necessary. Perkins (1991) indicates that students may easily get lost in management without any experience to guide them through the information jungle. This student-centred guided learning environment is considered, however, more appropriate for ill-structured domains or higher-level learning (CTGV, 1991; Cognition & Technology Group at Vanderb ilt) (Jy Wana Daphne Lin Hsiao, 1996).

1.3.1.1 Distributed Cognition[8]

The relationship between social interactions and individual cognition issue lies at the very heart of the "social versus individual" debate that concerns the nature of cognition. One can discriminate three theoretical positions with respect to this issue. Piaget and the socio-constructivist approach (Doise and Mugny, 1984) are often presented as the defender of the individual position while Vygotsky and the socio-cultural approach are viewed as the instigator of the social approach. As Butterworth (1982) pointed out, their opposition has been exaggerated. Both authors acknowledge the intertwined social and individual aspects of development, but they attribute the primacy to the individual or to the social environment. This project is inscribed within a third approach, hereafter referred as 'distributed cognition'. **In this approach, the similarities between the individual and the social planes of cognition receive more attention than their differences**. They view cognition as fundamentally 'shared' or 'distributed' over individuals. Defenders of this approach question the very discrimination between what is social and what is individual: "... research paradigms built on supposedly clear distinctions between what is social and what is cognitive will have an inherent weakness, because the causality of social and cognitive processes is, at the very least, circular and is perhaps even more complex" (Perret-Clermont et al., 1991, p. 50). The distributed cognition approach is closer to the Vygotskyan position than to the Piagetian view since it considers the group rather than individual as the primary unit of analysis (Resnick, 1991). By its focus on social structure, distributed cognition is deeply intertwined with the **'situated cognition'** theory (Lave, 1988).

1.3.1.2 Situated Cognition[9]

It is not possible to separate cognitive tasks from social tasks, because all cognitive tasks have a social component (Perret-Clermont, 1993). Constructivists view cognition as situation-bound and distributed rather than decontextualized tools and product of minds (Lave, 1988; Pea, 1994). Thinking is both physically and socially situated that problem tasks can be significantly shaped and changed by the tools made available and the social interactions that take place during problem solving. Situated cognition, a new paradigm of learning, emphasizes apprenticeship, coaching, collaboration, multiple practice, articulation of learning skills, stories, and technology (Brown, Collins & Duguid, 1989). "Community of practice," a concept emerging from situated cognition, emphasizes sharing and doing, construct meaning in a social unit (Roschelle, 1995). **Situated learning occurs when students work on authentic tasks that take place in real-world setting** (Winn, 1993). However, the very difference between the metacognition approach to learning and the situated belief of learning is that situated learning is usually unintentional rather than purposeful. These ideas are what Lave & Wenger (1991) call the process of "legitimate peripheral participation."

As Lave (1991) states that learning **is a function of the activity, context and culture in which it occurs, which contrasts with most classroom learning which is abstract and out of context**

[8] (By TECFA, Dillenbourg see for references: http://tecfa.unige.ch/tecfa/research/cscps/proposal.html)
[9] http://www.edb.utexas.edu/csclstudent/Dhsiao/theories.html#vygot

(see also chapter about ‘Activity theory’ further more in this paper).Education can apply the two basic principles of situated cognition into classroom practice: 1. present in an authentic context, 2. encourage social interaction and collaboration. **It is believed that rich contexts can reflect students' interpretation of the real world and improve the knowledge being transferred to them in different situations**. Collaboration can lead to the articulation of strategies that can then be discussed, which in turn can enhance the process of generalizing that is grounded in students' situated understanding.

1.3.1.3 Cognitive Flexibility Theory

Spiro, et al., (1988) suggested that **people acquire knowledge in ill-structured domains by constructing multiple representations and linkages among knowledge units**. This can be achieved by designing hypermedia documents that present multiple cases where similar concepts are linked across cases. Learners revisit, the same case or concept information in a variety of different contexts.

Spiro's Cognitive flexibility theory addresses important issue in transfer, how general knowledge is transferred in ill-structured domains. They suggest a mixture of well- and ill- structuredness in the early stages, to familiar learners with grounded knowledge yet avoid establishing rigid presentation. Intermediate course of cases were selected to seek a balance between continuity and discontinuity; a partial overlapping across cases rather than from any single perspective that running through many cases, this will strengthen the interconnectedness of the cases (Jy Wana Daphne Lin Hsiao, 1996).

1.3.1.4 Cognitive Apprenticeship

Cognitive apprenticeship is a term for **the instructional process that teachers provide and support students with scaffolds as the students develop cognitive strategies**. Wilson and Cole (1994) describe the core characteristics of a cognitive apprenticeship model: heuristic content, situated learning, modelling, coaching, articulation, reflection, exploration, and order in increasing complexity. **Cognitive apprenticeship is a culture that permits peers to learn through their interactions, to build stories about common experiences, and to share the knowledge building experiences with the group** (Collins et al, 1989).

The cognitive apprenticeship model is directly related to situated cognition. In situated approaches, students collaborate with one another and their instructor toward some shared understanding. Instructors who advocate such approaches believe there is a “culture” of learning that can be cultivated. In other words, students can process concepts and information more thoroughly when multiple opinions, perspectives, or beliefs must be accounted for across a group. Think of this in the context of “freedom of speech.” We learn nothing new by supressing differing viewpoints and opinions, but if we allow these ideas to be expressed openly and attempt to evaluate their value or lack our understanding of the concept or issue will be strengthened.

(Brown et al., 1989, p. 33).

Cognitive apprenticeship stages:

- teacher considers complex strategies involved in a task
- teacher designs scaffolds that encourage students to apply the strategies
- the activities should be situated or geared toward a relevant outcome
- teacher models strategies and coaches students to apply them[10]

1.3.1.5 Self-Regulated Learning / Metacognition

Flavell (1976) first named the term metacognition. **He defined metacognition as one's knowledge regarding one's own cognition as well as controlling and monitoring one's own cognition**. The terms self-regulated learning and metacognition are interchangeable in the current discussion.

A self-regulated learner is aware when he or she knows a fact or has a skill and when he or she does not. He or she views acquisition as a systematic and controllable process, and he or she accepts greater responsibility for his or her achievement. In other words, he or she is the initiator of the learning process. “Self-regulated learning has played a part in behavioural theory, cognitive theory, social cognitive theory, and constructivism theory. In behavioural theory, regulation is through external reinforcement. In cognition theory, self-regulation is equivalent to metacognition, knowing about and regulating cognition.” (Davidson, K., 1995).

Self-regulation plays a crucial role in all phases of learning. Schönfeld (1987) states that self-regulation has the potential to increase the meaningfulness of students' classroom learning, and the creation of a "mathematics culture "in the classroom best fosters metacognition. He showed that many problem-solving errors are due to metacognitive failure rather than lack of basic mathematics knowledge. He further insists that all metacognitive strategies are illustrated in action, should be developed by students, not declared by the teachers. Study metacognitive strategies are important as well in reading to learn and can be applied to enhance text processing.

“To teach students to become active, motivated, self-regulated learners is a continuing issue in education. Authentic and meaningful classroom activities that are relevant to real-life situations are likely to engender students' cognitive activity and conceptual change (transfer). Scaffolding, dual instructions (verbal persuasion and modelling), and teaching appropriate cognitive strategies are believed to have positive impact on increasing students' efficacy.

Teachers or instructors can help students set achievable goals and provide feedback highlighting progress toward goals. Linking students' success and failure with cause, is a highly persuasive source of efficacy. Ensure appropriate leaner control in the task that requires students to become self-directed learners. It is assumed that students can be taught to become more self-regulated learners by acquiring effective strategies and by enhancing perceptions of self-efficacy. Poor learners can benefit from reciprocal teaching through processes of modelling, guiding, and collaborative learning” Schönfeld (1987).

The major responsibility of teachers is not to dispense knowledge, and no single teacher can teach students everything they need to know in their entire lifetime. Equipping students with self-regulated strategies will provide them with necessary techniques for becoming independent thinkers and lifelong learners. Dede and Palumbo, (1991) indicate that developing constructive

[10] http://www.edtech.vt.edu/edtech/id/models/powerpoint/cog.pdf

instructional systems should be grounded in the psychology of learning and transfer rather than in the human factors and technological design issues. They further claim that the development of constructive systems should support metacognition and problem-solving skills development.
A good description of the elements of constructive learning environments according to the theoretical assets mentioned above is given by Wilson. In his polyhedron (see figure1) the edges constitute the characteristics, and the connections point out the importance of the integration of these characteristics to build such a scenario.

1.3.2 Constructivist learning Environments[11]

How will we know if we are engaging students in meaningful learning?
The following characteristics of meaningful learning provide guidelines for designing constructivist learning environments.

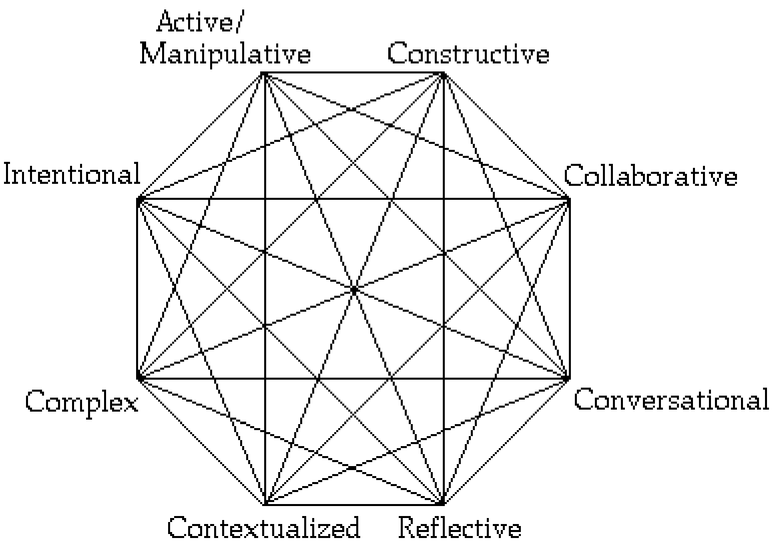


Figure 1: Qualities of constructive learning environments (Wilson, B.G., 1996)

When we apply Wilson's model to computer supported education then technology could be an engine to help to keep students active, constructive, collaborative, intentional, complex, contextual, conversational, and reflective. A short description of these characteristics will clear up what he means by these adjectives.

- "Active: Learners are engaged by the learning process in mindful processing of information where they are responsible for the result. In natural learning situations, learners and performers of all ages, without the intervention of formal instruction, can acquire sophisticated skills and advanced knowledge about what they are learning. In all of these situations, learners are actively manipulating the objects and tools of the trade and learning by reflecting on what they have done.

[11] Wilson, B.G. (1996). Designing constructivist learning environments. Englewood Cliffs, NJ: Educational Technology Publications http://tiger.coe.missouri.edu/~jonassen/courses/CLE/main.html

- Constructive: Learners integrate new ideas with prior knowledge in order to make sense or make meaning or reconcile a discrepancy, curiosity, or puzzlement. They construct their own meaning for different phenomena. The models that they build to explain things are simple and unsophisticated at first, but with experience, support, and reflection, they become increasingly complex.

- Collaborative: Learners naturally work in learning and knowledge building communities, exploiting each others skills while providing social support and modelling and observing the contributions of each member.

- Intentional: All human behaviour is goal directed (Schank, 1995). That is, everything that we do is intended to fulfil some goal. That goal may be simple, like satiating hunger or getting more comfortable, or it may be more complex, like developing new career skills. When learners are actively and wilfully trying to achieve a cognitive goal, they think and learn more. Learning environments need to support learners in articulating what their goals are in any learning situation.

- Complex: The greatest intellectual sin that we teachers commit is to oversimplify most ideas in order to make them more easily transmittable to learners. In addition to stripping ideas out of their normal contexts, we distil ideas to their simplest form so that students will more readily learn them. But what are they learning: that the world is a reliable and simple place. However, the world is not a reliable and simple place. Problems are multiple components and multiple perspectives and cannot be solved in predictable ways. We need to engage students in solving complex and ill-structured problems as well as simple problems. Unless learners are required to engage in higher order thinking, they will develop oversimplified views of the world.

- Contextual: A great deal of recent research has shown that learning tasks that are situated in some meaningful real world task or simulated in some case-based or problem based learning environment are not only better understood, but also are more consistently transferred to new situations. Rather than abstracting ideas in rules that are memorized and then applied to other canned problems, we need to teach knowledge and skills in real life, useful contexts and providing new and different contexts for learners to practice using those ideas.
- Conversational: Learning is inherently a social, dialogical process (Duffy & Cunningham, 1996). That is, given a problem or task, people naturally seek out opinions and ideas form others. Technologies can support this conversational process by connecting learners across town or across the world. When learners become part of knowledge building communities both in class and outside of school, they learn that there are multiple ways of viewing the world and multiple solutions to most of life's problems.

- Reflective: Learners should be required by technology-based learning to articulate what they are doing, the decisions they make, the strategies the use, and the answers that they found. When they articulate what they have learned and reflect on the processes and decisions that were entailed by the process, they understand more and are better able to use the knowledge that they have constructed in new situations." (Wilson 1996)

In Wilson's description the use of computer and internet is not a precondition but can be helpful. A concrete computer supported learning environment based on constructivist theory is the so called CSCL.

1.3.3 Computer-Supported Collaborative Learning (CSCL)

First, a definition about what could be meant by collaborative learning:
"Collaboration is a situation that involves two or more persons carrying out a joint activity."
The broadest (but unsatisfactory) definition of 'collaborative learning' is that it is a situation in which two or more people learn or attempt to learn something together. Each element of this definition can be interpreted in different ways:

- "two or more" may be interpreted as a pair, a small group (3-5 subjects), a class (20-30 subjects), a community (a few hundreds or thousands of people), a society (several thousands or millions of people) and all intermediate levels.
- "learn something" may be interpreted as "follow a course", "study course material", "perform learning activities such as problem solving", "learn from lifelong work practice",
- "together" may be interpreted as different forms of interaction: face-to-face or computer mediated, synchronous or not, frequent in time or not, whether it is a truly joint effort or whether the labour is divided in a systematic way (Dillenbourg, 1999).

A further three features to characterise a collaborative situation:

- Collaborating peers passed almost the same level, so they can show almost equal performances in collaborative activity.
- Common goals and common interests lead to interaction.
- There is a division of labour among the participants.

Collaboration also concerns the interactions which take place between the participants. **First, a collaborative activity implies interactivity.** That does not mean that what matters is the amount of interaction. In fact, the extent to which the interactions between group members influence the participants' **cognitive processes is a more accurate criterion to define the degree of interactivity**.
Roschelle and Teasley (1995) describe **collaboration as a problem-solving task**:

> "collaboration is a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem".
> They also propose the notion of joint problem space to explain what is going on during collaboration:
> "(…) Social interactions in the context of problem solving activity occur in relation to a Joint Problem Space (JPS). The JPS is a shared knowledge structure that supports problem solving activity by integrating:
> (a) goals
> (b) descriptions of the current problem state,
> (c) awareness of available problem solving actions, and

(d) associations that relate goals, features of the current problem state, and available actions."

Hence, collaboration is a process of solving a problem and maintaining a shared conception of the situation (the JPS) by integrating information during the task. This understanding of the task is continually shaped and reshaped during the course of the interaction.

1.4 Action- based pedagogy

Some authors refer to action-based pedagogy as activity pedagogy (e.g.Schneider 2003: p.6). Some examples of activities are described as the following:

- Gathering and distribution of information
- Creation of collaborative documents
- Discussion and commentaries around productions
- Project management related activities.

We call such activities ‘actions’ because of the differentiation of these terms used in the activity theory approach (see chapter 1.4.1). In this approach, an ‘activity’ occurs on a motivational level while an ‘action’ occurs on a lower level connected to a specific goal. We presume that what we intend by ‘action’ rather exists on a ‘goal level’ (see table 2).

We consider action to be the basic ‘driving engine’ of learning in an action-based pedagogy. The main role of action is to implement the described learning models. Learning (through actions) takes place within a community and within a context. Through mutual stimulation members make better progress in learning. Because contextual learning is complex the goals cannot be reached alone, therefore distributed cognition concepts have to be adopted. A cognitive flexibility approach is fruitful when parts of the community begin to connect their work and link different concepts. Learning also takes place through cognitive apprenticeship when learners work in small groups..

Activity theory is a relatively long-standing theoretical approach upon which most of the aforementioned models are based, or at least from which they have integrated some of their key elements., is. In fact it is not a theory based on hypothetical constructs for validation or falsification. It simply describes some basic concepts of activity, action, and operation that could be related to a context, an artefact, and a community.

1.4.1 Activity theory:

The following chapter shows the narrow bond between activity theory and socio constructivist pedagogy was fundamentally shaped by Lev Vigotsky.

Most of the information has been collected from Bonnie A. Nardi (1996): “Context and consciousness” and Engeström Y. (1999): ”Learning by expanding: An activity-theoretical approach to developmental research”.

The origins of the concept of activity lies in German philosophy, in which Kant, Fichte, and Hegel emphasized the role of mental activity (Tätigkeit) in constituting the relationship between subject and object. This was nevertheless an idealistic-subjective interpretation. The concept of activity was brought into materialistic philosophy by Feuerbach, who emphasized the primary role of objective reality but only as an object of contemplation. The activity concept of Marx was developed as ‘practical-critical’ activity, the central aspect in activity being the transforming of material objects (gegenständliche Tätigkeit) (Klaus and Buhr 1987, pp 1203-1207).

Further on Karl Marx (1848) in the theses on Feuerbach he characterised the two pitfalls of social theory: “The chief defect of all previous materialism ... is that the thing, reality, sensuousness, is conceived only in the form of the *object* or of *contemplation*, but not as *sensuous human activity, practice*, not subjectively." And on the other hand: “Hence in opposition to materialism the *active* side was developed abstractly by idealism, which of course does not know real sensuous activity as such."

After this sociological approach the theory has been initiated by Russian revolutionary psychologists in the 1920s and 1930s, who wanted to create a new approach to understand and transform human life. The basic approach was formulated by Lev Vygotsky, A.R. Luria and A.N. Leont’ev, who formulated a completely new theoretical concept to transcend the situation: “A human individual never reacts directly (or merely with inborn reflects) to environment. The relationship between human agent and objects of environment is mediated by cultural means, tools and signs. Human action has a tripartite structure. A human individual never reacts directly (or merely with inborn reflects) to environment. The relationship between human agent and objects of environment is mediated by cultural means, tools and signs. Human action has a tripartite structure.” (Vygotsky, 1978, p. 40).

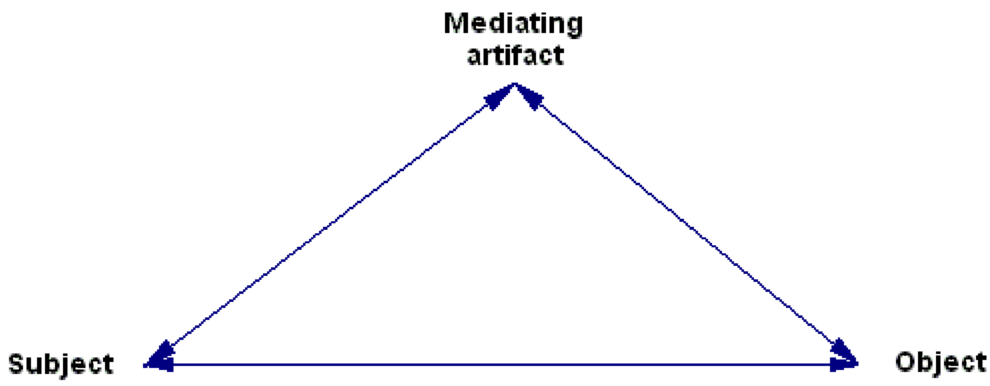


figure 2: Vigotsky’s reformulation of the model of mediated action[12]

Alexander Leont’ev expanded Vigotsky’s triangular model and introduced a distinction between collective activity and individual action. This step was achieved by means of reconstruction the emergence of division of labour as a fundamental historical process behind the evolution of mental functions. Leont’ev (1978) gives an example about primitive hunters who, in order to catch game, separate in two groups: catchers and bush beaters. Bush beaters frighten the game toward the catchers. When compared with the goal of hunting – to catch the game, for food and clothing – the

[12] http://www.edu.helsinki.fi/activity/pages/chatanddwr/chat/

action of the bush beaters in themselves are irrational; they can be understood only as part of the larger system of the hunting activity.

The uppermost level of collective activity is driven by an object-related motive; the middle level of individual (or group) action is driven by a conscious goal, and the bottom level of automatic operations is driven by the conditions and tools of the action at hand.

Engeström (1987) depicted Leont'ev's model of collective activity:

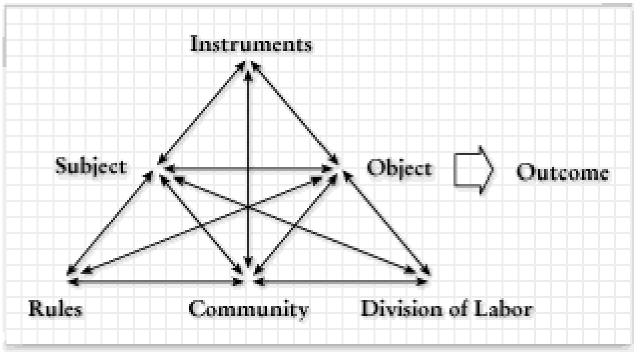


figure 3: Collective activity model[6]

This model may be better illustrated by means of an example. Consider the work activity of a physician at a primary care clinic. The object of his work is the patients with their health problems and illnesses. The outcomes include intended recoveries and improvements in health, as well as unintended outcomes such as possible dissatisfaction, non-compliance and low continuity of care. The instruments include such powerful tools as X-rays, laboratory, and medical records - as well as partially internalised diagnostic and treatment-related concepts and methods. The community consists of the staff of the clinic, distinguished from other competing or collaborating clinics and hospitals. The division of labour determines the tasks and decision-making powers of the physician, the nurse, the nurse's aide, and other employee categories. Finally, the rules regulate the use of time, the measurement of outcomes, and the criteria for rewards.

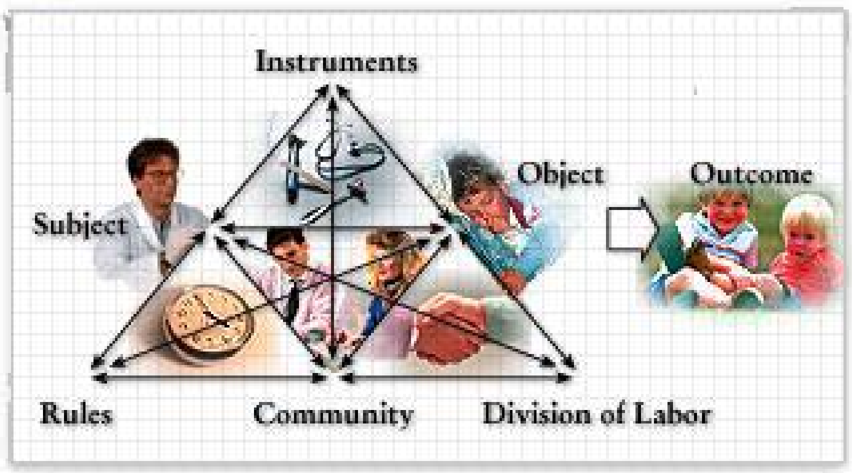


figure 4: The work activity of a primary care physician[6]

Below the collective activity and individual action, there is the level of automatic operations. Operations are dependent on the conditions in which the action is performed. Leont'ev (1978, p. 66) gives an example from learning to drive a car.

"Initially every operation, such as shifting gears, is formed as an action subordinated specifically to this goal and has its own conscious 'orientation basis'. Subsequently this action is included in another action, for example, changing the speed of the car. Now shifting gears becomes one of the methods for attaining the goal, the operation that effects the change in speed, and shifting gears now ceases to be accomplished as a specific goal-oriented process: Its goal is not isolated. For the consciousness of the driver, shifting gears in normal circumstances is as if it did not exist. He does something else: He moves the car from a place, climbs steep grades, drives the car fast, stops at a given place, etc. Actually this operation [of shifting gears] may, as is known, be removed entirely from the activity of the driver and be carried out automatically. Generally, the fate of the operation sooner or later becomes the function of the machine."

The three levels of an activity can be summarised as:

Activity	Motive
Action	Goal
Operation	Conditions

Activity level	Building a house	Completing a software project	Carrying our research into a topic
Action level	Fixing the roofing, transporting bricks by truck	Programming a module, arranging a meeting	Searching for references, participating in a conference, writing a report
Operation level	Hammering, changing gears when driving	Using operating system commands, Selecting appropriate programming language constructs	Using logical syllogisms, selecting appropriate wording

table 2: Examples of Activities, actions and operations (Nardi 1996, p: 33)

It is impossible to make a general classification of what an activity or an action is because the definition is totally dependent on what the subject or object in a particular real situation is.

Activities and information technologies

The relationship between activities and information technologies is according to Leont'ev (1978) the fact that in principle all operations can be automated. Information technology is no exception; the major driving force in the development of the first computers was the need to automate human calculating operations, and one of the forces behind expansion of IT has been the need to automate administrative data manipulation operations. Information can support actions in various ways. IT can serve as a tool in manipulative and transformative actions directed at an object or at part of it – as with different editors and other symbol-manipulation tools. IT can also help in actions that are directed toward sense making.

The tool used for our research acts at the level of operation and action; formulating and defending points of view can be seen as a 'action' while succeeding in the final test would correspond to an activity. Learning (with the help of the tool) consists in first achieving basic capacities (changing actions into operation level) while comparing and commenting on activities of the learning community, the interesting part of learning, is related to activities of the community.

In his further publications Leont'ev (1981) points out that computer tools could be understood as functional organs. Such organs are fully integrated, goal orientated configurations of internal and external resources. External tools support and complement natural human abilities in building up a more efficient system that can lead to higher accomplishments. For example, scissors elevate the human hand to an efficient cutting organ, eyeglasses improve human vision, and notebooks enhance memory. The external tools integrated into functional organs are experienced as a property of the individual, while the same things not integrated into the structure of a functional organ (for example, during the early phases of learning how to use the tool) are conceived of as belonging to the outer world. Nardi (1996) tries to show the connection between computer tools and internal plane actions (IPA):

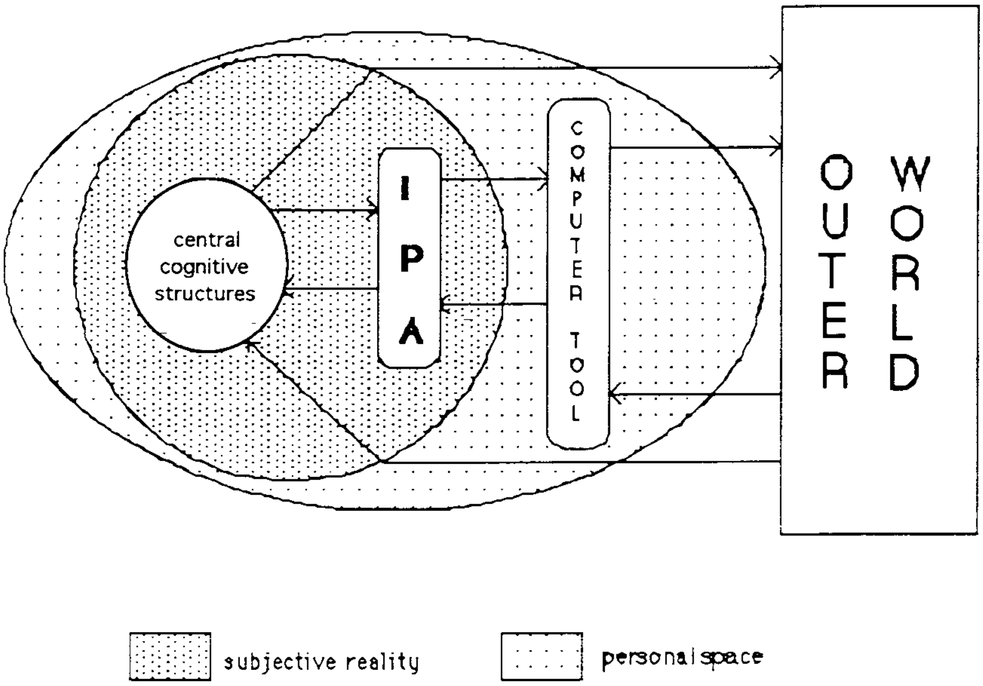


figure 5: Computer tool as an extension of the internal plane actions (IPA): Nardi (1996, p:52)

The model of internalisation of computer tools as personal organs can even be applied to computer-supported group activities or activities of an organisation. An analysis along the general lines of activity theory can lead to: finding motives, discovering goals and conditions of the activity, identifying structural components of the subject's interaction with reality (individual activities, actions and operations) as well as tools mediating the activity; and tracing developmental changes of the activity. Such a group centred and computer mediated process is shown in figure 6.

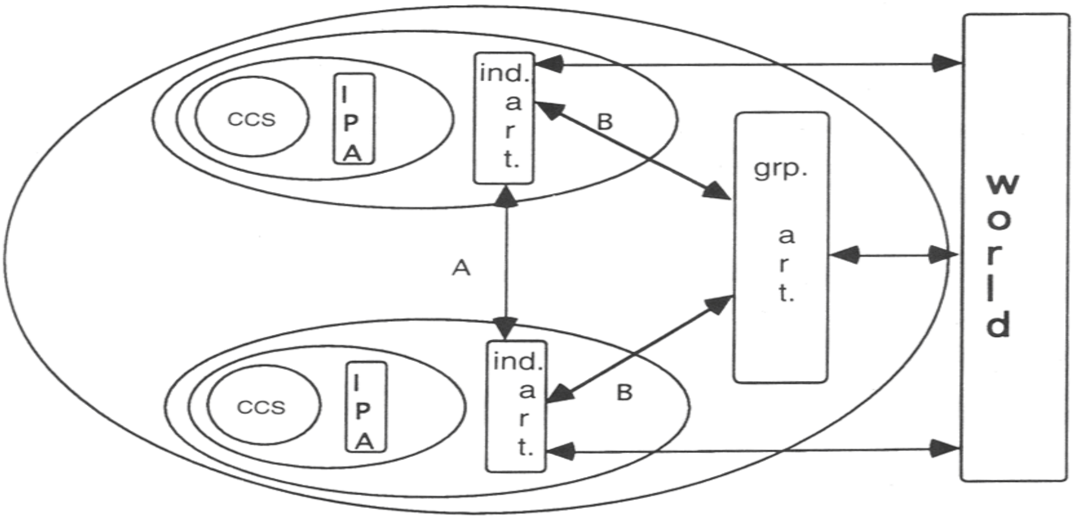


figure 6: Computer-mediated group activities. CCS = central cognitive structures; IPA = internal plane of actions; ind. Art. = Individual artefact; grp. Art. = group artefact. (Nardi (1996, p: 58)

“The notion of computer tools as extensions of IPA can be applied to collective agents, too. In this case the components of group activity can be presented as shown in figure 6. Shared virtual workspace is an extension of the group IPA, and the pattern of various links relating the components of the model represent the way computer-mediated communication, non-computer communication, interpersonal communication mediated by references to a virtual common object, and individual human-computer interactions are integrated within the collective computer-mediated activity.” (Leont’ev 1981 in Nardi 1996)

1.4.2 Activity theory and learning

Learning activity differs from other kinds of activity in that it aims, above all, at psychic transformations of the subject itself (Davydov, 1988a; El'konin, 1989; Lompscher, 1988). Other kinds of activity (play, labour, everyday, communication, etc.) may have learning results too, but they are not consciously aimed for by the subject (although possibly by other persons, e.g. teachers). The problem is that these learning actions necessary to reach certain goals are often not yet available to the learner or are available only at an insufficient level. At first, they have to be formed systematically; only then can they serve as essential means for learning. Another contradiction arises. It is impossible to learn the appropriate learning actions first and then to learn the material itself. The actions' content, structure, and course are determined by the object; there is no content- or objective-free formal action to be transferred to different material.

The teaching strategy that leads to learning activity is based on the joint activity of teacher and students focusing on the production of new personal meanings by constructing new personal texts in the interaction between canonical (scientific) texts and subjective text (Davidov, 1988).
In the present research we tried to apply such a learning strategy which leads students from scientific information (concepts, abstracts, general textual information) to subjective texts as summaries and concept definitions written by themselves and evaluated by other members of the leaning community (teacher and students). Such a learning activity is strictly bound to the learning subject and can not be performed and evaluated without this context.

Impact of activity theory and pedagogical / psychological research

“Many psychological studies use human action as the unit of analysis. This makes it relatively easy to design laboratory experiments, but the use of isolated actions in analysing real-life situations outside a laboratory is much less fruitful. The reason is that the actions are always situated into a context, and they are impossible to understand without this context (e. g. Suchmann 1987). The solution offered by activity theory is that a minimum meaningful context for individual action must be included in the unit of analysis. This Unit is called Activity.” (Nardi 1996. p: 25)
Following the citation of Nardi (1996), research about such learning activity needs to be performed in a concrete learning context as it is given in classroom education. According to these settings we constructed our learning scenarios embedded in ‘normal’ lessons at school. Within these settings we tried to consider the concepts of constructivism as cognitive flexibility, cognitive apprenticeship, and self-regulated learning. Of course, the results of such research cannot be compared with those of an experimental setting. A so-called pedagogical engineering approach has been chosen, where some settings had to be changed while the work was ongoing but other parameters were kept constant to get some comparable results. The changed settings have been logged and will be discussed further in this paper.
According to both this theoretical background and the theory of Wilson (2000), common denominators of socio-constructivist pedagogies:

- Provide access to rich sources of information.
- Encourage meaningful interactions with content.
- Bring people together to challenge, support, or respond to each other.

We set up several learning scenarios. To ensure a successful degree of participation and efficient learning, these settings needed to be orchestrated and supported through the use of technology. We have chosen different strategies of support and preparations for the chosen scenarios, to be able to stress the differences and to find out ways of enhancing the quality of learning.

2 Two important factors for learning success in CSCL

2.1 Scripting

2.1.1 What is Scripting?

Some authors use the term 'scenario',to refer to what is now more commonly called a script or 'scripting' to refer to the analysis, by the student, of the log file of their own interactions (Zumbach et al., 2002). For our work we will use the definition formulated by Dillenbourg, which differs from the cited one:

“A collaboration script (O'Donnell & Dansereau, 1992) is a set of instructions regarding to how the group members should interact, how they should collaborate and how they should solve the problem. When a teacher engages students in collaborative learning, he or she usually provides them with global instructions such as "do this task in groups of three". These instructions usually come with implicit expectations with respect to the way students should work together. The teacher's way of grading collaborative work strengthens this implicit contract. A script is a more detailed and more explicit didactic contract between the teacher and the group of students regarding to their mode of collaboration. (Hoppe and Zumbach (2002) call this sort of script ‘orchestration’, while others refer to it as ‘story-boarding’: comment of the author)
Regulating collaborative learning is a subtle art. The tutor has to provide prompts or cues without interfering with the social dynamics of the group.
Scripts enhance the effectiveness of collaborative learning activities, scripts integrate these activities within more traditional instructional sessions:

- Scripts enable integration of activities that were often separated: individual, cooperative, collaborative and collective activities.
- Scripts enable integration of co-present activities and computer-mediated activities.
- Scripts often include an important role for the tutor.
- Scripts introduce a time frame in distance education where students often lack landmarks for their time management.”(Dillenbourg 2002)

Dillenbourg (2002) describes **the syntax** of script the following way:

“A script is a story or scenario that the students and tutors have to play as actors play a movie script. Most scripts are sequential: students go through a linear sequence of phases. Some scripts are defined in an iterative way, but from the student’s point of view, they are run as a linear sequence.”
Each phase of the script specifies how students should collaborate and solve the problem. This requires five attributes: the task that students have to perform, the composition of the group, the way that the task is distributed within and among groups, the mode of interaction and the timing of the phase. These five attributes are now analysed one by one. The third attribute, the distribution of the task over the group, does not require a specific slot as it will be expressed by the syntax of the task and group descriptions.
A large number of scripts can be built from the combination of a limited number of components, in the same way that a language is made of words and grammatical rules. This analysis provides the bases for such a formal grammar.”
The elements and rules of a possible grammar can be informally specified in order to be eventually turned into a formal notational scheme like XML or EML. Another new approach for a markup language called ‘learning design’ (LD) developed for educational purposes has been proposed by Koper (2003). It does have the potential to describe very rich and diverse pedagogical situations. However, it is not yet known if industry or an academic consortium will provide a full implementation.

Example for the described Script:

Script = [phase 1 phase 2 phase 3 …]

Phase = [Task Group Mode Timing]
Task = [input activity output]

In the present work scripting was not formalised the way Dillenbourg proposes. Instead we tried to formulate the different possible scripting methods in teaching units with different pedagogical goals. In particular the subtle input given by the teacher before and during the working process is described. In these units we tried to blend two pedagogical traditions: collaborative learning and traditional instructional design. **It is a challenge for a teacher to specify pedagogical goals that students adopt as their own goals. The more the script segments collaboration into sub-processes, the more it is difficult for the collaborating team to adopt/choose shared goals and organise themselves.**

2.1.2 Scripting strategies

What is the idea behind the script? What are the pedagogical values? Is the script 'playable' by the students? Is the script specific to the content to which it is applied?
In this more theoretical part of the paper we will show more general statements about scripting strategies. In the results section, more concrete strategic thoughts will be discussed and possible generalisations made for other learning situations.

The Idea behind the script is related to **the pedagogical goal(s) of the learning unit as:**

- Concept building
- Deep understanding
- Getting an overview
- Grounding
- Combination of mentioned goals

Of course, different strategies must be adopted following the aim of the lessons. It is essential that every teacher be aware of the pedagogical goal of the unit. For each goal or combination of goals, a set of other parameters can influence the strategy.
Some (main?) interacting factors can be mentioned:

- Type of education
  - traditional classroom
  - blended education
  - distant education
- Students experience
  - in collaboration
  - by working in groups
  - with the learning themes (novices or experts)
  - with the learning materials (books, media...)

- learning environment or tool (ex. C3MS (Community, Content and Collaboration Management Systems (Schneier 2002) literacy for distant education)

- Students grade level (primary, secondary, high school, university)
- Amount of time and time distribution
  - Full-time project
  - distributed lessons over a certain period
- Size of the learning community and number of available teachers and tutors
- Type of motivation of the learners
  - obligatory unit with final evaluation
  - voluntary unit
  - self organised group with common goals (scripting may merge as product of gathered experiences within the learning community to manage information flow)
- The structure of the script itself
  (Students and tutors have to understand the script, i.e. to know what they have to do, without additional difficulty or cognitive overload. Moreover, to claim that actors have adopted the script, they should play the script more or less as the designer intended it to be played: Dillenbourg 2002)

2.1.3 Preparation phases for the script

Some authors relate phases of scripting mainly to the ongoing project (->learning unit) process (Engeli 2001). The following chapter will describe scripting preparation before the unit is running, and while students are working on it. This view leads to three phases of scripting:
First the preparation of the unit, followed by a moderation phase and finally the evaluation. Moderation and evaluation can happen at the same time (when students are working or after the work is done) while preparation should happen before of the start of the unit. The three phases depend on the adopted strategy and their influencing factors.
Starting from a multidimensional matrix of factors a teacher has to choose the appropriate fields to arrange the course. Some fields of the matrix can be set in advance, others have to be changed or set while the unit is running. The ‘right’ choice of the matrix fields and the correct setting of them constitute one of the major challenges of teaching and provide the best learning environment.

2.1.3.1 Preparation of learning unit

Depending on the complexity and the extent of the learning unit one or more preparation phases has to be set up. Larger units may contain different pedagogical goals and according to this different preparation is demanded for each goal or subunit. The main difference from teaching based on an instructional design theory is the fact that students should have the sensation of choosing **their** subjects and working strategies and formulating **their** goals. Furthermore, the importance of metacognitive activities has to be pointed out and considered in each scripting decision. It is very difficult and not desirable to predict the detailed development of the unit. The teacher should prepare and master a certain number of path breaking inputs and advice according to the needs of the learners. These rather retroactive inputs also differ from the more proactive strategy of the instructional design approach. The disposition and modality of inputs **sustain learner's activity** and should not necessarily be understood as a directive but as **advice**. The tone for all presented documents (and inputs during the unit) should consider that.

Normally the goal of the teaching unit is given by the students' learning curriculum. In some cases the learner can either choose the subject or even the goal. In such cases a part of the script of this unit consists in the **preparation of choice strategies**. Such scripting units can also be used further on for individual decisions.

After that the learning unit has to be **embedded in a 'real life situation'** or an occurring problem. It is not necessary to set up the unit as a problem based project à la Freinet. The relation to the actual life situation of the learner helps to integrate the unit into a cognitive frame. So it may be sufficient to formulate a **main issue** for the unit.

A hypothetical framework of core mechanism(s) has to be set up to foster the pedagogical goal of every sub unit.

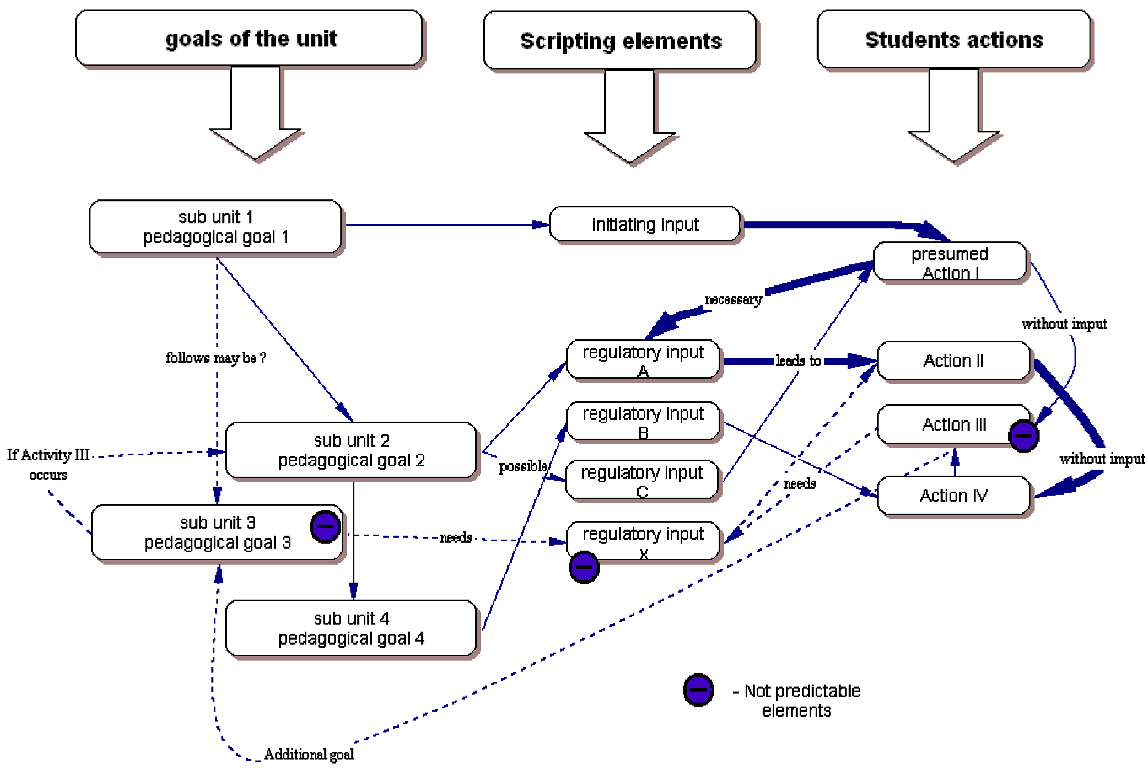


figure 7: preparation of scripting elements

Legend:

Actions: all types of work produced by the students (e.g. discussion, summary,..)

Inputs: Advice and documents produced by the tutor and teacher

---- Elements connected by dashed line: not predictable. Actions can lead to changes in regulatory inputs and even create new pedagogical goals: these elements must be set up while the unit is running
(According to Activity theory we call students work to produce 'Actions' even if sometimes it is difficult to make a clear difference of the two terms in a script: some as 'action' interpreted work may be an 'activity' for the students. Some Authors just use the term 'activity' for students' work.)

Figure 7 shows a possible framework of elements the teacher should prepare before the unit is running. Pedagogical goals and scripting elements can be prepared while the student's actions can just be presumed. The thick line shows a possible sequence of students' actions and the teacher input. Some transition from one to another action needs no regulatory input (e.g. from action III to action IV).

Students may not carry out the expected actions. In such cases new regulatory inputs must be generated while the unit is running (e.g. action III in figure 7). These actions may lead to new pedagogical goals, and when this happens it may be difficult to achieve the main goal of the unit.

It seems important to us to stress that the regulatory inputs have to be understood not just as corrective feedback but also as 'giving a new task' or initiating a new action, and the regulatory inputs should be formulated as advice and not as directives. The relationship between the pedagogical goals and the regulatory inputs is supposed to be a reminder for the teacher, as students do not need to know them. Students' actions can be repeated. Such a 'loop' is sometimes helpful; in a best case scenario students notice themselves that a task has been done well enough or the same action has to be done with other settings. No exit arrow is visible in figure 7. It does not mean that the learning unit lasts forever but that not every group stops at the same action and finishes the unit. In another preparation script a common ending action is scheduled, and such a scripting figure would show a final regulatory input and a final student's action.

Not every regulatory input must be realised: the regulatory input 3 is prepared by the teacher but may not be implemented in the unit.

2.1.3.2 Moderation of learners, phases, tasks and working process (regulatory inputs -> fig. 7)

A so-called regulatory input is described by Dillenbourg (2002) as a part of a 'phase' and he allocates five attributes to a phase: the task that students have to perform, the composition of the group, the way that the task is distributed within and among groups, the mode of interaction and the timing of the phase. A regulatory input can contain all five elements but can also consist in a single part of it. If learners pass from one presumed activity (or action) to the next, no input is necessary. Regulation is a subtle and individual intervention and needs to be adapted to every single learner. It is one of the most important guiding tools. In classical classroom teaching where the teacher knows his students the regulatory input can be coordinated to personal characteristics of the student. Such short inputs can range from encouragement to delimitation for the same observed situation.

The following table shows possible categorisation of a typology of tasks, audience, mode timing of a regulatory input in a classroom education unit:

Task type	**Group**	**Mode**	**Timing**
Informational / new or addition (specification)	Class	Written / through collaboration tool	Start / new work phase /
Methodological	Class /group / individual	Oral /written if complex	If general method / start (of phase) else on demand
Motivational	Individual	Oral	Depending on perception of teacher (of who needs their motivation sustained)
Guiding	Group / individual rarely to class	Most oral / rarely written	Best case : on demand but normally depending on perception of teacher
Systemic (computational support)	All categories	If to class ->written else oral	

table 3: type, goal and audience of a regulatory input

2.1.3.3 Evaluation

The evaluation part of scripting is not meant to be a classical evaluation at the end of the unit. Of course such an evaluation type must also be prepared in a curriculum, but for the scripting strategy in a collaborative unit another evaluation also needs to be set up. The work (-'visible' part of actions) produced by the learning community activities should be evaluated (compared, commented,..) by all participants, learners, and teachers. **It is crucial to design the way such comments and criticism should take place during the unit.**

It is possible to implement a subunit where students learn how to give feedbacks to other learners. As we will elaborate on later, we realize that it is an ambitious task to implement a good feedback culture within a learning community. Therefore, it is important to integrate it in the script.

2.2 The additional tool

While teachers can regulate and orchestrate complex scenarios with very little technology, the effort can soon become cumbersome. In addition, more advanced functionalities like visualizations of student actions or the possibility of comparing ongoing work within the whole community is difficult without the help of technology. In other words, we needed educational software less to deliver courseware, but rather to support students to solve more complex and open-ended tasks. We were looking for an easy editing tool permitting a direct access to the published text. A lot of software exists to manage text and interactions like virtual classrooms, CMS or C3MS. Many of these systems are quite complex and not easy to manage. **A fruitful attempt to reduce technical difficulties while enhancing the possibility of students' (publication) activity and group interaction are Wikis.**

Wikis were exactly what we needed for our research: a simple tool without many technical features which we could use without a long introduction and preparation. Students should be able to edit quickly content and to compare immediately the work of the other members of the learning community.

2.2.1 The Wiki Concept[13]

A glossary of Hawaiian words gives this definition:

Wikiwiki (stative verb). Fast, speedy; to hurry, hasten; quick, fast, swift.

"The WikiWikiWeb server concept, most often called simply ' a Wiki', originated with Ward Cunningham. A Wiki is a freely expandable collection of interlinked Web 'pages', a hypertext system for storing and modifying information – a database, where each page is easily editable by any user with a form-capable Web browser client." (Loef, 2001)

At the functional level, which is what the user sees, the essence of Wiki can be summarized by these statements:

- A Wiki invites all users to edit any page or to create new pages within the Wiki Web site, using only a plain Web browser without any extra add-ons.
- Wiki promotes meaningful topic associations between different pages by making page link creation almost intuitively easy and by showing whether an intended target page exists or not.
- A Wiki allows the reconstruction of older versions of a document through saving each produced version in the database
- A Wiki is not a carefully crafted site for casual visitors. Instead, it seeks to involve the visitor in an ongoing process of creation and collaboration that constantly changes the Web site landscape.

2.2.2 Wiki Basics

There are just few things you can do in a Wiki, either read a page or follow a link. If the link points to a page that does not yet exist, following it lets you immediately enter content and create that page. Because these few activities are what people mostly want to do, restricting the Wiki choices to them gives simplicity of interface and operation. Furthermore, the absolute bottom line when

[13] The Wiki Way, quick collaboration on the Web: Bo Leuf, Ward Cunningham (2001)

entering Wiki content is ‘just write’ – essentially, you can use the same, now ubiquitous, conventions that you would when writing an e-mail. These are functionalities of the basic web edition. More sophisticated possibilities are offered by Wiki clones developed for specific functions. A list of all activities which can be performed by users in comparison to other web applications is shown below:

Activity	**Wiki**	**Static Page**	**Database**
Content publishing	Anyone or member of specific groups	Web master or delegated FTP/ publishing	Database contributors
Updating material	Anyone (group), anytime	Scheduled or when there is time by person with access	Database updaters
Browsing	Free-form structure, topics, search, backlinks	Site structure and navigation as defined by Web master(s)	Query transactions or generated site structure
Following site links, cross- references	Anyone who can edit can also create cross-links and create topic pages for searches	Difficult to do effectively, hard to change or update, ‘linkrot’ (broken links due to change) a problem	Depends on query and serving engine, often only search is possible
Commenting or reviewing	Anyone or any member or specific group, on any (open) page	By way of e-mail, feedback form, or ‘guestbook’ page	Only if comment pages / fields implemented

table 4: Overview of user activities in different Web applications (Leuf, B. Cunningham, W.b. 2001, p: 33)

2.2.3 Wiki Clones

Many implementations of the Wiki concept have been made. There are also numerous Wiki-like applications, and the categories of clones and Wiki-like applications overlap somewhat, since it can be difficult from the user’s point of view to decide how much ‘Wiki’ is in a particular functionality. A list of some clones is shown in the table below:

Wiki Type	Language, Technology	Comments
Wiki,	Perl CGI script	The ‘original’ flavour based on Ward

many clones	Apache server, IIS/PWS, or stand-alone	Cunningham's Wiki
TWiki	Perl, with extensions	TWiki is aimed to corporate use and integrates many features for this user group: revision control, templates, category tables, automatic e-mail notification of changes, file attachments, more. Professional and powerful. Mainly for *nix, and depends on some UNIX tools, so Windows users need ports of these
Squeek Wiki, Swiki, CoWeb	Squeak, Smalltalk	**Will be described further more** Runs in Squeak Virtual Machine environment and with Squeak Web server. Integrated Smalltalk environment. Campus wiki Highly extensible because of access to Squeak code modules in 'open' OS and server. Maps to numbered pages rather than named files
Python wiki, Py Wiki, Pyki, Pyle	Python	Use a more structured language, easier for many to understand code. Popular in Germany Japan, Australia and New Zealand.
Ruby Wiki RWiki	Ruby	Uses 'RD syntax' rather than WikiWords. Based on the relatively new language Ruby, which combines many attractive features from Perl, Python, and others. Main activity in Japan
Zwiki	Python and Zope, XML	Zope ('z object publishing environment') is a collaborative open-source Web application server (UNIX and Windows), written in Python, so that when Python Wiki runs on top of Zope it can leverage many powerful features. Other discussion tools also exist as Zope 'plug-ins'
JOSWiki, Kehei Wiki	Java, JOS	JOS is a free and open Java operating system. Many extensions possible, good as Web management tool
PhpWiki	PHP	PhpWiki is opensource; licence: GNU, available in English, German and Spanish[14]. Close to the original Wiki. Also exists as PostNuke module
tikiwiki	PHP	Portal built on wiki principels[15]

[14] http://sourceforge.net/projects/phpwiki/
[15] http://tikiwiki.org/

table 5: List of some Wiki Clones (Loef 2001, P: 26)

For our research we used a Swiki or Squeak Wiki. Squeak[16] is based on Smalltalk, a platform-independent virtual machine with totally open architecture. It was introduced as a 'modern implementation of Smalltalk-80', developed by a team that included members of the original Xerox PARC team and Alan Key[17]. Squeak is essentially a multi-media internet-supporting system to build micro-worlds for children[18].
Squeak is open source, and the current versions of this environment are distributed with Swiki components included – both the pluggable Web server and the Swiki application. This means an out-of-the box system, where you start the virtual machine appropriate for your system, start the Swiki from inside Squeak, and point your browser client to it. Most production Swiki sites now generally run on newer Comanche servers, rather than on pluggable Web servers, and they are therefore called ComSwiki sites.
Swiki servers are found extensively within the academic environment, because Swiki technology dovetails nicely with computer science studies and collaborative class work. (Loef, 2001)

2.2.4 Swiki and education

An area where open collaboration and exchange of ideas is both natural and important is education. One of the pioneers in this domain is Mark Guzdial, Associate Professor in the College of Computing at Georgia Institute of Technology and leader of Collaborative Software Lab[19]. In November 1997 he wrote the first **CoWeb server (short for collaborative Website, but then and often still just known as Squeak Wiki, or Swiki; in this chapter the term CoWeb is used to distinguish from other Wikis**) on top of his pluggable Web server module. After some developmental changes of the structure in 1999 almost 1000 students used the CoWeb. Since then the growth of the CoWeb at has been enormous (Spring 2000: 120 CoWebs running on 10 Servers at Georgia Tech). The major use of these CoWebs was course support activities (Loef, 2001).
Differences between CoWeb and Wiki:

- CoWeb can be used on virtually any server platform available (due to the fact that it is implemented in Squeak, **a cross-platform and open-source freeware** version of Smalltalk).
- The underlying engine is different in that the openness of the Squeak environment it runs on allows **considerably more extensions and functionalities** that would be more difficult to set up using Perl and a traditional Web server.
- Links between **pages are created by referencing pages within the same site by name** – the CoWeb syntax (*Page Name*) means that any word or phrase can be used as a

[16] http://www.squeak.org
[17] http://minnow.cc.gatech.edu/squeak/378
[18] http://www.squeak.org
[19] http://coweb.cc.gatech.edu/csl/1

'page name link', unlike the traditional WikiWord text patterns. Pages are for this reason mapped to numbered rather than named files in the database.

- The original Wiki provided a simple text notation without raw HTML source, CoWeb by default supports both, **simple text notation and HTML**. There are pros and cons with this freedom (some students try to mix up both notation possibilities and easily lose a lot of time in formatting their inputs)
- Unlike the more freewheeling discussion-based context of Wiki, the use of CoWeb is aimed to **encourage the treatment of more specific contexts**.
- While CoWeb gives **equal power to all users**, there is generally someone 'in charge' (teacher or teaching assistant), whose words carry more weight than those of others, even if that person has no more capabilities than other users.
- CoWeb is **easy adaptable**. Many CoWebs contain extra features that were designed for those specific sites; for instance, code sharing, uploads or 'hot spots' at the top of every page.

(Leuf, B. Cunningham, W.2001)

2.2.4.1 Security and user behaviour in CoWebs related to education

Surprising to most, security has not been a problem in either the original Wiki or in CoWeb, despite the wide-open authoring policy. Admittedly, each implementation has backup mechanisms in place that can be used for recovery from damage, whether malicious or accidental, but little malicious damage occurs (Leuf, B. Cunningham, W.2001).
Possible reasons for the behaviour in a CoWeb context:

- The public nature, where anyone with a browser can visit, may cause users to be more aware of their audience.
- The persistent nature of the CoWeb is unlike a newsgroup in that CoWeb pages are frequently revisited. **This may cause users to think of them as community property.**

Though malicious damage to CoWeb pages is infrequent, accidental damage proves more common**. A frequent cause is users overwriting another's changes during heated contributions to a single page**. It is in fact a weak point of the system when it is used in conventional classroom education. Students normally work all at the same time on the subject And edition conflicts occur quite often. More information about how this fact has been handled in the current research can be read in the chapter results.

2.2.4.2 CoWeb Usage

The Georgia Tech team proposes four general categories for uses of the CoWeb:

- **Collaborative artefact creation**
  The artefact created is sometimes the Web site itself, with pages offering essays or

particular information created collaboratively by students. In other cases the artefact is an analysis of a report or even a poem, which is collaboratively marked up and commented upon by the class. In still other cases students work on external artefacts (for example, multi-media presentations) and use the CoWeb for coordination, planning, and distributing versions.

- **Review activities**
  The reviewers may be internal (peers, students, teachers) or external users.
- **Case library creation**
  'knowledge and example' basis for courses
- **Distributing information**
  Within the classes, teachers to students and teachers and tutors

(Leuf, B. Cunningham, W.2001 P: 350)

The above-mentioned applications of CoWeb can be compared to the propositions of the TECFA seed catalogue of socioconstrucivist activities (working paper 2002[20]). There a classification of four categories of learning activities is proposed:

- Collection and distribution of information
- Creation of collaborative documents
- Discussion of comments and products
- Project management:
  Group formation, partitioning of tasks, planning work, managing time

These four categories are tailored for C3MS (Community, Content and Collaboration Management Systems) as an infrastructure. A phpWiki can be added as a module of the C3MS.

2.2.4.3 Supported CoWeb User Roles

The CoWeb development team recognized a variety of roles for users, where the user may not always be someone facing a human-computer interface. These users were detected as students adding content, teachers conducting an educational activity or a system administrator providing new pedagogical tools for the faculty he supports.

The development team attempted to provide features and new tools to address the concerns and activities of these users. Both roles are discussed by Guzdial (2000. 1).

Authors:

The main activity of a collaborative author is adding content. When the author creates the collaborative artefacts, case libraries, and submits materials for review, he or she seeks to:

- find places to add content
- make sure that content has been added
- find out where new content has been added

[20] Tecfa Seed Catalog: Daniel Schneider et al.
URL: http://tecfa.unige.ch/proj/seed/catalog/net/catalog-eng.pdf

- create links between content

Purpose Agents or teachers:

Teachers give a purpose, or context, to the various activities that occur on the CoWeb. They may not be the most active users, but their actions greatly affect the use. Most activities that occur on the CoWeb are encouraged, or at least approved, by the teacher. Usually, the teacher also uses the CoWeb to distribute class information to the students.

Central Users

Because of the unstructured nature of the CoWeb and given that each user may have their own opinion of what that structure should be, CoWebs may become disorganized fairly quickly. To solve this problem, there is often a user who manages the meta-concept of the structure. Their main interaction with the CoWeb is to guide the interaction of the authors to better structurally define the space. This role is sometimes filled by the teacher, although it is more often done by others, such as teaching assistants or active students. In our scenarios one or two students acted as central users. They took this role without active allocation by the teacher.

Peripheral Users

Two roles that emerged on the CoWeb over time were those of viewers (i.e., visitors who were just viewing material but not contributing) and reviewers, who were often external persons. In one of our implemented scenario we created two pages designated to external users: a ‘guest book’ for parents and friends of the students and a page where students could put questions to an expert.

A table grouping all mentioned roles and supporting tools or features existing in the CoWeb is proposed by Leuf, B. Cunningham, W.(2001) (Notice: not all roles were described above)

Role	**Central Concerns and Activities**	**Supporting Features or Tools**
Authors	Add material, find new material, connect related material, manage the accessibility of that material	Monitoring features, support for composition and reclamation
Purpose Agents	Encourage proper usage and specify the usage context	Navigational support
Central Users	Structure the space	Re-classifying material
Peripheral Users	Contribute easily	Notification and annotation support
Site Designers	Change the end-user interface’s “look and feel”	Templates and customisation support
Developers	Apply the technology to new applications and easily add new	Powerful language, easy to use API (Application Programmer Interface)

	features	
Administrators	Administer the site without knowing the technical details	On-line administration utilities
Support Staff	Support the maintenance and robustness of several servers	Monitoring and upgrade supports

table 6: Roles and supporting features or tools in a CoWeb environment (Leuf, B. Cunningham, W.2001)

2.2.4.4 The importance of structure

What has made CoWeb successful in classes has been

- The ease of use for students
- The ease for teachers of structuring useful activities

"The least successful CoWebs are the ones where the teacher asked that a CoWeb be created for her class, announced it to the students on the first day of class, and never touched it. Part of the problem is just the lack of appropriate structure in the CoWeb. Students are surprisingly reticent to edit or create CoWeb pages and must be explicitly invited to participate in the coWeb in a structured Way" (Leuf, B. Cunningham, W.2001. P: 361). A good example of a Swiki with quite a complex structure for students of an applied University can be found under http://brainspace.hta-be.bfh.ch:8000/BrainSpace03 (German).

According to the previously mentioned theory about collaborative work (chapter 1) and the importance of scripting (chapter 2), the citation in connection with the major advantages of CoWeb suggests, the right strategy for the use of the tool can be determined as following:
A high degree of importance is given to the way teachers and tutors handle and orchestrate collaboration: a subtle job of supporting and directing students without suppressing collaboration and creativity.
In short:

An appropriate scripting strategy is the recipe for successful collaborative learning with a CoWeb!

3 The paradigm shift…

…from instruction-based towards construction-based teaching.

The title of this chapter has been chosen to emphasise the role of construction-based learning and teaching with new technologies. As described above today's most used learning scenarios are conceived on an instruction-based pedagogy. Our research tries to point out some receipts and methods to set up activity- and action-based scenarios. We hope that some teachers and instructors will grab these ideas and change there teaching methods whenever they find it appropriate.
We propose the following scenarios:
Students accomplish a task through collaboration. Work is centred on activity mediated by scripting and moderated by the teacher. **Self regulation and metacognitive skills are encouraged by creating and supporting critical interactions among students and the learning community**.
The theoretical base described in the preceding chapters is adopted for the learning units in order to provide a high quality education. Of course not every concept could be adopted in every learning situation.

Three different learning units were set up in the following research. The first unit is the creation of a collaborative dictionary, the second the publication of different summaries about human anatomy and the third unit treats human embryology. The first two units describe the handling of the collaboration tool and there the results will focus on the 'usability' of the software. The third and main unit will compare two classes: one using a collaboration tool and the other having a classical set up.
The whole research is led in a 'pedagogical engineering style', which means that pseudo-experiments are done with classes in real learning situations embedded in a normal curriculum. During the learning units sometimes changes in the set-up had to be made. All changes made while the learning units took place are reported and potential errors discussed.

3.1 General scope / delimitation

Much research about learning and collaboration or communication has been conducted in the last few years. Most of this happened in a laboratory environment. The results showed important parameters to focus on in order to improve the learning situation. A problem with the laboratory or test environment is the difficulty to map the results onto so-called normal curricular learning situations. In fact 'every-day-'s learning' depends on a vast number of factors. The apparently-identical lesson with the 'same' students at the same time of day can give a totally different score of efficiency or of satisfaction of the students just because their favourite soccer team lost the match the evening before. Two apparently similar classes with the same previous knowledge can react in a totally different way just because in one class a 'leader' shows enthusiasm about the set-up.

The divergences between an experimental situation and a ‘real word’ environment have been discussed in many different fields. In medicine, many clinical tests with animals have to be done, followed by other tests on humans and, finally tests in a ‘real world’ environment. The results of the tests with people under special conditions can never cover every situation of an application under normal circumstances. Many pharmaceuticals had to be recalled because of a failure during use by ‘normal’ ill people. This fact does not necessarily mean that the clinical or experimental set-ups were not well done. It means that all experimental set-ups have to be integrated in a more complex system, and within this system it is very difficult to predict the impact of single parameters. On the other hand, a prediction made in a ‘real world situation’ can not necessarily be mapped to another apparently ‘real world situation’ because of its complexity.

Our pedagogical engineering approach tries to describe the impact of a few parameters on specific situations and discusses some opportunity for improvement. Some may be applied to other more general learning environments, and others may not. Pedagogical engineering also means to adopt or change settings while the ‘experiment is running’ if the presumed settings do not show the expected outcome.

We tried to conduct different collaborative biology learning units of high school students. The parameters under focus were the scripting and, connected to scripting, the impact of the additional tool on the learning situations. The three observed units differed in their topic and pedagogical goals. Different classes had to accomplish different tasks under different constraints. So what conclusions can be drawn under such diverging situations? We tried to work on the similarities of the units and to distinguish and discuss aberrations between the units.

3.2 Principal questions

We formulate our research questions in three general ‘working hypotheses’:

- The use of a Swiki as collaborative editing tool causes no technical and comprehensive problems (after a short introduction) for high school students without experience in collaborative editing but with some knowledge of the use of a common text-editing software and the research of information in the Web.
- Scripting which induces students to compare and comment on the work of the whole learning community (using a collaborative editing tool) leads to better learning performance (as assessed by pre- and post-testing) than a script leading students to work without such a tool and with little advice or / and opportunity to make comments and compare their work with the learning community.
- The quality of the product of the working groups is better (longer and more detailed) when students are induced to compare and comment on their work (with a collaborative editing tool) during the learning unit.

Because of our pedagogical engineering approach we did not strictly formulate operational hypotheses, dependent and independent variables to analyse. Too many parameters can intervene in our learning units to permit an experimental set up. Instead of hypotheses we formulated general questions. To answer these questions we observed the ongoing lessons and worked with questionnaires and tests. Within the questionnaires and tests we defined variables and tried to compare different learning units. **The results of these tests and questionnaires, the experiences we have had during the work, and the text produced by the students gave us some possible answers to our principal questions.**

3.3 General method

The whole research took place in a normal curricular class environment. The classes were not aware of a special learning situation and a deeper evaluation of the output they produced. We tried to embed the scenarios in an absolutely everyday teaching situation and supposed students to have the same motivational state as in other lessons.
To collect data we used questionnaires, observed students while working, and for one set up we asked students to write three tests. Of course the students asked about the purposes of the tests. We tried to motivate them to perform as well as they could without telling them the real reason of the tests.

3.4 Evaluation of scenarios

The evaluation of our pedagogical engineering project was a mixture of description of observed so-called ‘weak’ parameters changing throughout the ongoing project, some subjective perceptions of the students via results from a questionnaire, the comparison of students’ products under different scripting, and the measurement of the increase of their factual knowledge before and after a learning unit. The next chapters will give a short overview of all our evaluation ‘parameters’.

3.4.1 Subjective evaluation (questionnaire)

After each of the three learning units students had to fill in a short multiple choice questionnaire about how comfortable they felt with the tool and their perception of the quality of the product. We wanted to find out whether students feel comfortable working with the tool, whether they were able to use the functionalities and whether they thought to work efficiently. Furthermore we wanted to know whether students discussed things together while work was ongoing, whether they learned from the inputs of the other members of the community and whether they liked to work with the computer. The goal of the subjective evaluation was to find out their perception of the unit.

3.4.2 Direct observation / self evaluation

The direct observation was mainly adopted to adapt scripting in the lesson and for the following ones. It was important not to create an ambience of control but rather the sensation of a ‘help-centre’. We answered questions not only by giving the correct answer but by showing, where the information they required could be found. This more passive and reactive behaviour permitted us to perceive their needs.

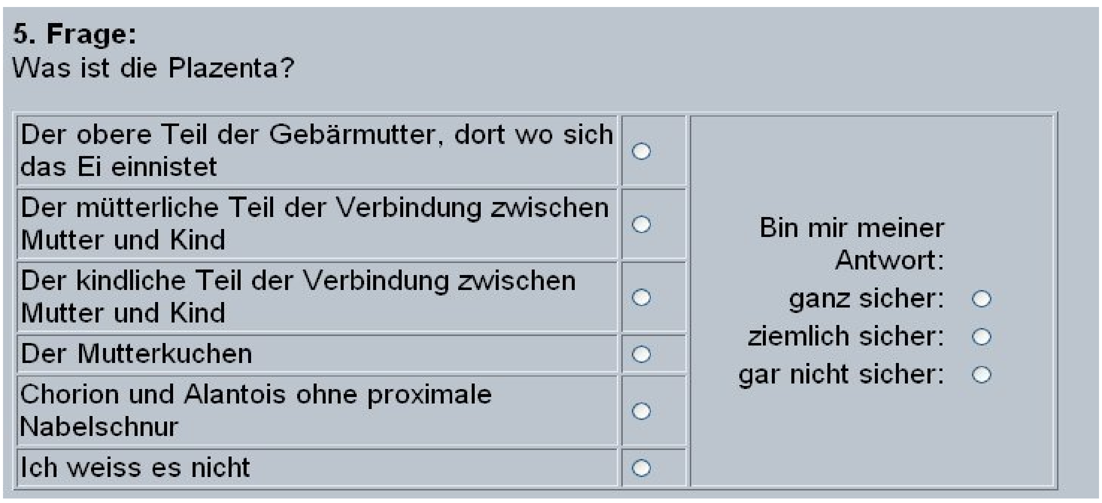
When several students had similar needs we quickly discussed the problem with the whole class.

3.4.3 Pre, Post and Final test

In one learning scenario (see chapter 3.7.3) we compared two classes, one class working in a conventional way and the other supported by a collaboration tool. In these classes, we tested the factual knowledge about the subject before the learning unit, after the learning unit, and six weeks later with a multiple choice test. We also wanted to know their degree of confidence in the answer they gave. Students also had the opportunity to say that they did not know the correct answer.

A question was composed of 4 distracters, the correct answer and the possibility to say ‘I don’t know the correct answer’ (see figure 8). The whole test consisted of 19 questions. The questions were quite difficult. We tested the questionnaire with some university students and a midwife. The university students did not have the same score as our students after the unit, and the midwife could answer all questions correctly. We produced a difficult test with similar answers to get big score differences between ‘good’ and ‘bad’ students. Another presumed effect of the difficulty was to motivate students after the pre test to learn things precisely. Of course students did not know that they had to do the same test also after the learning unit, but we hoped that they could get a feel for the required level.

The pre test was done just before or the at the start of the learning unit, the post test immediately after the unit, and the final test six weeks after the post test. Between post and final test students had their summer holidays. After the post test students had the opportunity to see the correct answers of the test on the screen.



5. Frage:
Was ist die Plazenta?

Der obere Teil der Gebärmutter, dort wo sich das Ei einnistet	○	Bin mir meiner Antwort:
Der mütterliche Teil der Verbindung zwischen Mutter und Kind	○	ganz sicher: ○
Der kindliche Teil der Verbindung zwischen Mutter und Kind	○	ziemlich sicher: ○
Der Mutterkuchen	○	gar nicht sicher: ○
Chorion und Alantois ohne proximale Nabelschnur	○	
Ich weiss es nicht	○	

figure 8: Questionnaire with 4 distracters the correct answer and the question about security of the correct answer (right side)

3.4.4 Evaluation of produced output

One of the great features of a Swiki based scenario is the fact that work produced is immediately visible to all involved participants. Most learning scenarios embedded in normal curricular classroom teaching last more than one single lesson. If students accomplish a longer task it is very difficult to see what they have done after one, two or three lessons. Normal teaching makes it possible to see the final result or intervene when students ask questions. Evaluation by the rest of the learning community is difficult especially to set up under such circumstances. **We tried to set up a scripting that reinforces comments and evaluations by the teacher <u>and</u> the learning community while work is ongoing**. Two effects were expected. First we hoped that students would get more involved with the work of the whole class, be aware of all contributions, and comment on them and link them to other concepts. Secondly we wanted them to think about the way they did their work. When other students ask questions of the type 'why' about their work, metacognitive capacities are invoked and supported. In the learning scenario about human embryology where we compared two classes we could also compare their final product. Of course we hoped that the final work produced with a collaboration tool would be better than the other. What does 'better' mean? The products of the group work were texts: summaries, definitions or explanations. Because of the open tasks, students could choose the subject they wanted to treat and no specifications were made about length, precision and diversity of themes. Two factors were analysed. First we considered the complexity and precision of the described subjects, and then the diversity and the number of different themes. In the scenario about human embryology we were especially able to compare these factors.

3.5 Material

Our research took place in normal classrooms of the Gymnasium Liestal. For the students the courses were not announced as special learning units. The Classrooms have 12 movable desks. As the rooms are used for biology lessons there is the possibility to work with microscopes, so each desk has a power outlet. For the different units, books, several models and additional brochures were brought to the course. In each classroom six I-mac computers were interlaced to a network with a connection to the Web and a recent standard browser. Students could print their work on a local printer and store their data in a class repository accessible from the whole school. Every student has an e-mail account and theoretically can access his or her data from everywhere. For our research it was not necessary to use either mail or a repository (except in one case). In every classroom, the teacher's computer is connected to the network and to a beamer, which permits the display of material to the whole class.

In one scenario students worked most of the time without computers. They used the Swiki just at home to publish their results. In the other scenarios some students spent their whole time with the computer (some took additional literature to the workplace) while others preferred to have two different workplaces, one sitting in front of the screen and the other elsewhere. No constraints were made concerning the place they had to accomplish their work. Many groups worked the whole time together, while some groups had a repartition of tasks. When we noticed that individuals in a group worked separately, we asked them to discuss their work with their partner. In figure 9 one of the classrooms with the 6 I-macs is shown. The computers are permanently installed and students normally do not pay attention to them anymore. When they were installed a couple of years ago we had to ask student to stop 'playing' with the computers at the beginning of each lesson. Now students have the opportunity to use computers in different rooms at school e.g. the cafeteria, the library or in a computer room with free access to all students whenever the school is open.

figure 9: Overview of the classroom with the connected computers

3.5.1 The unstructured collaboration tool

3.5.1.1 Swiki (CoWeb)

The possibilities of a Swiki are shown in chapter 2.2.1. In the present research we implemented a CoWeb server on a linux operating system of our school server[21]. Swiki servers can be implemented independently of the operating system. We first had the problem that the firewall of our provider locks the port :8888, so we had to get special permission to read and write on that port. The implementation of the Swiki took about half-an-hour of work. One of the scenarios ran on another server. It was the first one about evolution. This Swiki ran on the server of the University of

[21] http://idefix.gymliestal.ch:8888

Geneva at TECFA[22]. The administration of the single Swiki permits the denial of some features to certain users. For the current research we allowed all functions to everybody. Students could edit, create, delete, lock pages and upload images or files. Some pages were locked by the teacher. For all Swikis the same functional outfit was chosen (see figure 10).

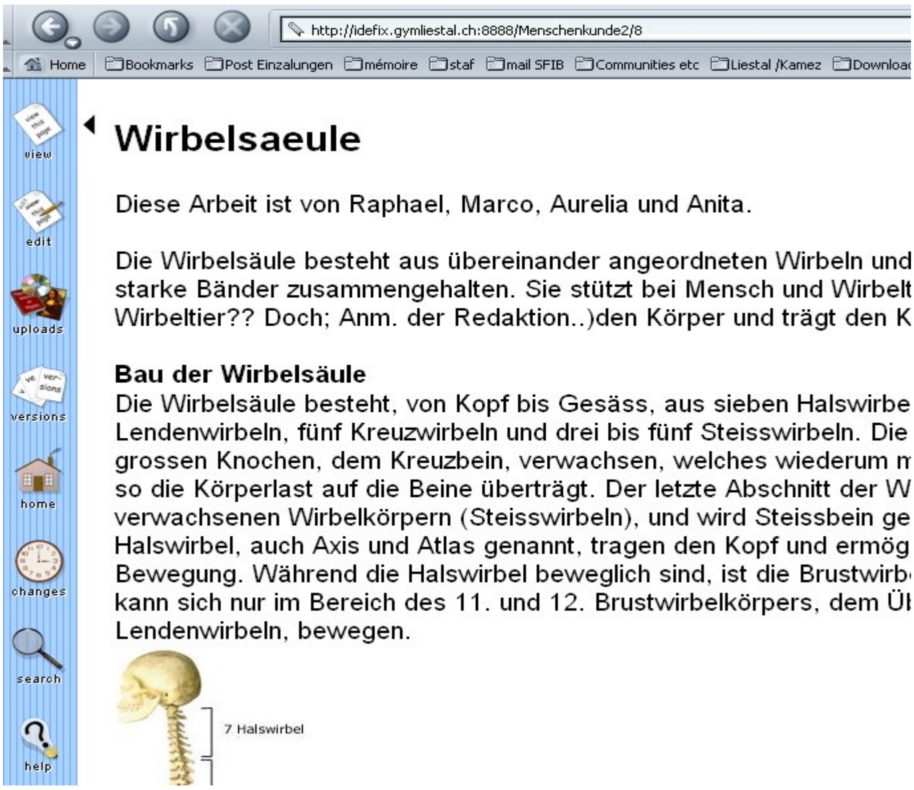


figure 10: screen-shot of a Swiki page used for human anatomy

The functionalities are visible on the left side of the screen. Students can 'view' the edited page, they can 'edit' a page, 'upload' pictures or files (like the picture at the bottom of the screen), and they can compare older versions of the page, since a direct link to the entry page leads 'home'; The 'changes' made can be tracked back; an internal 'search' function is provided and general 'help' pages can be accessed directly. For our purposes some help pages in German have been created by the teacher. The implemented help-page had no real importance. It would have been difficult to suppress the link, so we decided to let it be. The 'view' window covers the whole screen while the 'edit' window is smaller. The left bar remains visible in each circumstance and always allows access to these functionalities.

Figure 11 shows a screen shot of an 'edit' window. The 'Title' indicates the link name to this page. To create a link to this page it is enough to write the title in asterisks (e.g. *Wirbelsäule*-> leads to the page with this title). The 'last edited' section (underneath the title) shows who has changed the page and when the last change occurred. After every editing activity the page has to be saved with the 'save' button. It was possible for our Swikis to lock the pages individually. The administrator can unlock all locked pages.

[22] http://tecfa.unige.ch:8888/liestal1

An important feature for collaboration is the possibility of inserting text (~comments) without entering the edit mode. For this purpose a special comment option can be inserted into the text (see figure 12 and 13). Such an editing rectangle permits just to write text in the designated area of the Swiki page. It is even possible to add text when the page is locked.

We permitted the edition of plain text and of html formatted sections. Some students used for their work a mix of both, ‘plain’ and ‘html-text’.

figure 11: Screen shot of the editing window of a Swiki: (for same ‘view’ window see figure 10)

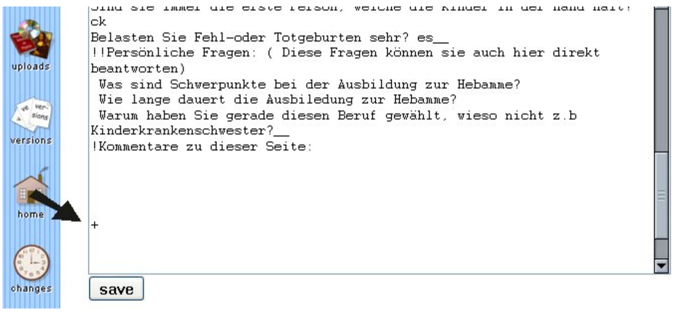


figure 12: Adding a ‘+’ sign at the beginning of a line (see arrow) creates a quick editing section in the page -> see figure 13.

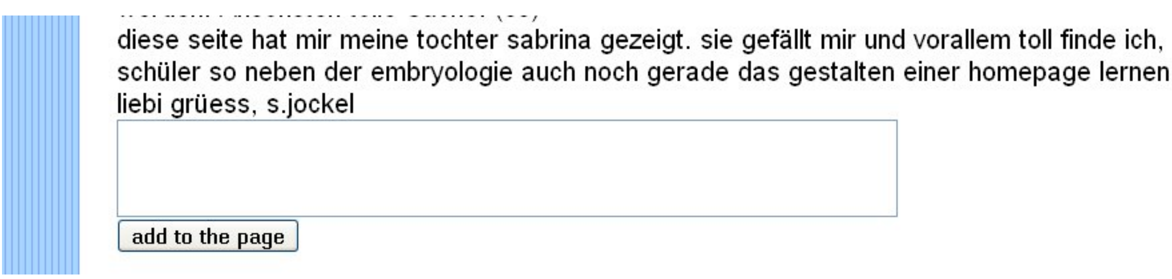


figure 13: The quick editing section in the 'view' window. A text can be written in the rectangle, with the button 'add to the page' this text is directly introduced into the page.

3.6 Participants

We worked with high school students. In Switzerland different types of high schools exist, 'normal' and vocational high school. Our participants belong to both school types.

'Normal' high school students of the 11th and 12th school year (age of 17 to 20) have two lessons of biology a week. One lesson is with the whole class, a so-called theoretical lesson, and for the other lesson the class is divided in two. In these lessons students are supposed to work in a more practical way: make little experiments, work with the microscope, and work in groups. The practical lessons are every two weeks for the students and last two lessons.

We also worked with a class of a vocational high school. These students have in their 11th year three lessons a week: one lesson with the whole class (theory) and two lessons with half of the class (more practical lessons).

The students of the vocational high school apply for a diploma which permits them to become an elementary school teacher or a nurse or to go to a university of applied sciences. Normally these students do not have the same capacities of abstraction as 'normal' high school students. They generally require a greater effort to understand difficult concepts. They usually show an inferior performance in exact sciences like physics, mathematics, chemistry and biology. In spite of that they usually have better level of social competence than 'normal' high school students.

A student of a normal high school can change to the vocational high school and continue the normal curriculum. A student from the vocational high school needs a good certification (average of all marks must be five; six is the best, one the worst mark, and the mean of a class is usually around 4.5) and has to repeat a year to be accepted. Therefore, we would expect a worse performance from these students. We hope to obtain a better learning effect through adequate scripting.

Division of Students and classes:

First scenario about **evolution**:

two classes of 'normal high school, 12th school year; 25 women and 5 men (not all students participated in the lessons)

Second scenario about **human anatomy**:

One class of 'normal' high school, 11th school year, 10 women and 6 men.

Third scenario about **human embryology**:

Two classes:
One ‘normal’ high school class of the 11th school year with 10 women and 6 men
One class of vocational high school of the 11th school year with 12 women and 9 men (only 16 students were always present at the courses).

3.7 Description of the three learning units

We carried out courses with three different learning scenarios. The first scenario is about evolution the second about human anatomy and the third about embryology. In the evolution unit two classes worked on the same collaborative hypertext, for the other units each class had their own. The major goal of the evolution scenario was to get an overview and understand different abstract concepts. In the human anatomy unit we wanted a deeper immersion in a specific subject. Students had to publish their results for the rest of the class. In this scenario the scripting strategy was of absolutely minimal intervention. The third scenario about human embryology was applied to two classes. We had two different scriptings for the classes. One class had an ordinary set up without the help of a hypertext; the other class published their results and comments in a Swiki.

3.7.1 The dictionary of evolution[23]

Evolution is part of the biology curriculum of high school students of the 11th year after starting school. Students already have a grounding in genetics, taxonomy and development of species but the concept of a scientific theory has never been mentioned. The abstract approach of the definition of a theory, based on a certain number of hypotheses which are retained until one of the hypothesis is proven to be false, seems to be difficult to understand. It is also difficult to separate the term 'theory' from faith.
Every student already had an idea about a possible origin of living organisms and the way genetic information is passed from one generation to the next one. So they can imagine how genetic information and through it life can survive through time.
This way of looking at the possibility of survival of genetic information from an organism through time - could lead to a hypothesis about evolution of organisms. We don't think that the students could imagine the impact of such a hypothesis on human society of the time when Darwin proposed it.

3.7.1.1 Participants

The two classes of high school students (18- 20 years old) were in the last month of their curriculum of biology. They were asked to construct a dictionary. In fact all the marks for their

[23] http://tecfa.unige.ch:8888/liestal1

school certificate had already been given. Normally it is quite difficult to motivate students to work at the end of their curriculum.

3.7.1.2 Time schedule, group building

The research was done in December 2002 and January 2003. The work lasted 4 lessons (180 minutes) for each class. Before the start of the unit about one-and-a-half lessons were spent in introducing the tool. They had two periods of two lessons time to do the work. Students worked in pairs; the composition of the groups changed quite often because many students were ill.

3.7.1.3 Specific goal

The global aim of the learning unit was to gain an overview of the different concepts and to get the students involved in the difficulties of formulating definitions about evolution.
The research goal was to find out how students could manage to work with the tool and whether they had difficulties creating the hypertext. For this purpose students had to fill in a questionnaire about their work.
We also wondered if the fact that both classes worked with the same Swiki and could edit or change pages written by 'foreigners' would increase malicious usage of the pages.

3.7.1.4 Scripting

Three phases of scripting were adopted:

1. Preparation phase:

In an initiation part students got an introduction to evolution. We spoke about the life of Darwin, his journey around the world and about how his theory has influenced the ideas of thousands of people in the last 150 years. They discussed the fact that there are different concepts and interpretations of the existence of all different species of organisms. Finally we read a very short text about how Lamarck (a 'rival' of Darwin) explained the fact that giraffes have such long necks.
After this more theoretical introduction we explained how publication into a collaborative hypertext could be done. First, we showed some existing Swikis and pointed out the possibilities of the system. After that we made some examples directly in their Swiki. The screen of a computer was drawn to a larger scale by the beamer. Afterwards the students could make their first essays with a special page in the Swiki (sandbox). We prepared the Swiki with a few definitions and some words without definition. For the words without definition a new page had already been created. We also added a text showing some facets of Darwin's character.
The home page of the Swiki was an introduction to the tool. Students could learn how to edit and create pages to make links and to upload pictures to the Swiki.

figure 14: prepared Swiki page for the dictionary of evolution. One term had already been defined, an initial article had been published, and a picture of the H.M.S. Beagle (her Majesty's Ship Beagle), the vessel on which Darwin sailed around the world and formulated his theory.

For the first impact students could use these words to define or immediately start with new ones. We asked them to insert new terms in alphabetic order into the list.

2. Start and moderation of the first lessons working with the tool

They were asked to search for terms concerning evolution. Then they had to write a comprehensive definition of the term and publish it on a Swiki. A second task was to search through definitions written by other students and find similar terms. These terms then had to be linked to their own definition. A third task was to group similar definitions (example: group all the researchers: Darwin, Lamarck, Cuvier, ..).

After the first contact with the tool students began to formulate definitions and create new pages. We tried to correct mistakes in the definitions. We were reading the texts of the students, giving advice and helping with the literature and the research on the Web. We also pointed out the problem of edition conflict. When more than one person edits the page with all the terms a problem arises. We tried to trigger this conflict through permitting the edition of this page only by one student. If someone wanted to add a concept he or she had to tell this person to add it in the front page.

We gave the advice to sign all inputs and to make references to the literature or the Web site they found their information. Students were advised to keep definitions short and concise.

We tried to encourage students to write their own definition; the goal of the dictionary was to create definitions adapted to their state of knowledge. Many definitions they found in the Web were too complicated and full of foreign words. At the beginning they just pasted definitions found

anywhere. After a while they tried more and more to adapt the definitions they found or at least to explain all foreign words and difficult sentences.
We pursued the following strategies over all lessons:
Reinforcing

- Production of content
- Awareness of other content and linking of concepts ->'communication' through the tool
- Creation of a personal structure of the produced concepts through repeated reading of evolving concepts.

3. Following phases of scripting /evaluation:
After the first two lessons of each class (this took two weeks of time) we had almost no more technical problems to solve. We had now to reinforce the linking of concepts. Students had the task of searching for similar words and definitions and trying to link them to other concepts. We also told them to complete definitions or to add definitions of terms when this would be necessary while they read the text.
We also tried to let the students group similar terms on the start page and build new categories of terms, like for instance to group all researchers.
At the end we gave them a paper questionnaire and asked them to introduce the answers in a personally created page in the Swiki. No special efforts were made to reinforce communication through the tool. Most discussions took place among working pairs orally.

3.7.2 Creation of a summary about human anatomy[24]

Knowledge of human anatomy is a part of the curriculum. For this the students worked in pairs and had four lessons to gather information about their bones and muscles. The class was divided in two; the lessons took place on different days for the two parts of the class.
.

3.7.2.1 Participants

In total we had a class of 17 high school students. The work accomplished was evaluated and had an impact on their final mark of their school certificate. Unfortunately only 9 students answered the final questionnaire. This fact had an impact on the statistical relevance of the results.

3.7.2.2 Specific goal

We wondered whether students without any specific introduction and scripting while they were using the tool can cope with the Swiki when they have a concrete task to accomplish. Students were just advised how to edit a page: go to the url of the Swiki and click on the 'edit' button, then at the end of editing click on the 'save' button. This explanation took us about 10 minutes of time. The same questionnaire used with the evolution-dictionary class was adopted. No special attention was

[24] http://idefix.gymliestal.ch:8888/Menschenkunde2

spent in this learning unit on collaboration among the learning community. The tasks they had to accomplish were done almost individually. Only the result could be seen by the whole class.
The summaries should lead students to a deep understanding of the treated subject. Each working pair had to write one definition of at least one page. Most of the work with the tool had to be done at home without additional support by the teacher.

3.7.2.3 Scripting

The students had no specific introduction to the tool. When the learning unit started they were advised to write their summary into the Swiki after having written it on paper. One computer was in the classroom, some students made their first steps with the Swiki, others did not touch it. The introduction of the summary into the Swiki was homework.
The tasks for the learning unit where:
Answer the questions about bones and muscles with additional help of models, microscopes, books and brochures. Choose a subject and write a summary including pictures. Put the summary on the Swiki and make it available for the whole class. The summaries produced were evaluated in the Swiki.

1. preparation phase

The task was formulated in a written introduction. There students had to accomplish 9 work items during the lessons. They used specific literature, models and microscopes. One of the items had to be chosen by each pair and a summary about the subject had to be composed. As we already mentioned almost no students worked with the computer and the tool. Most of them wrote their summary by hand and finished the work at home. There they filled it into the Swiki.
The Swiki entry page contained more structured help advice than the Swiki of evolution. We put the help advice not on the front page but built a link to a detailed page with a lot of editing and formatting examples. The titles of the summary have been introduced on top of the Swiki entry page.

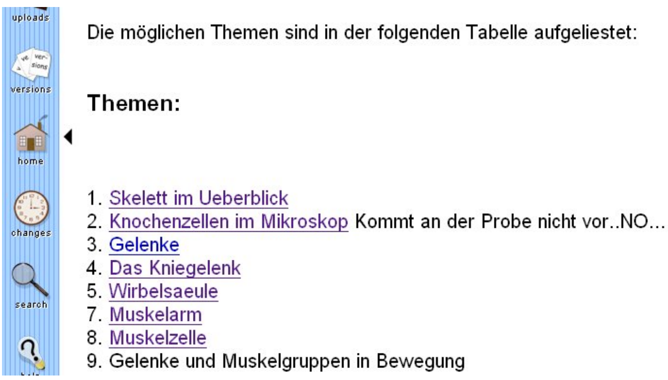


figure 15: Anatomy Swiki entry page with the possible summaries to select

Students had not much opportunity to change the themes to treat. Some groups chose the same subject to summarise. We gave the advice that they had to write summaries about different themes within the title; e.g. two groups wrote about the knee; one group wrote more about injuries of the articulation while the other group about the composition of it.

2. Start and moderation of the first lessons working with the tool and

3. Following phases of scripting /evaluation

No interaction or giving of advice took place while students were working on the Swiki. The final evaluation of the work was written directly into the Swiki after the unit. To let them answer questions about usability, a link to a questionnaire was made in the last lesson of the unit. They could directly access to it and enter data individually. The data were collected directly in a text file on the server.

After final marking some comments about accordance with the quality of the work and the mark set by the teacher were made.

3.7.3 Main research: human embryology[25]

3.7.3.1 Preface

Rarely, the computer is used for collaborative editing of content. From a constructivist point of view it is a tool to produce and compare concepts and opinions which supports and enhances learning effectiveness.

A tool which allows the comparison of the work before it is finished but allows input while concepts are created by the students is especially good for learning. Of course the scripting must force or at least suggest to students to compare their evolving work.

Students involved in 'conventional' group work often lack opportunities to compare the results of their work within the learning community (a class of students is divided in working groups which perform the group work; the class is defined as the learning community) while the work is in progress. Either their final work is presented in a text or a poster, distributed to all other members of the class, or they prepare a short talk for the other students or both. In such 'conventional teaching' it is difficult to show common or disjunctive conceptual understanding while work is in process. At the end of the learning sequence feedback is usually given by the teacher. Some times at the end of the cycle, there will be a discussion and (or) a comparison or the results. Even in such cases the comparison of the personal concepts and work among students is superficial. Of course grounding and mutual interactions **among working groups** takes place in conventional group learning. The lack of comparison described above is rather directed to that within the learning community.

The importance of mutual comparison and exchange is pre-eminent for a co-constructivist approach. Such mutual comparison while the work is running forces students to formulate and to defend their opinions. Contrasting interactions enhance the effectiveness of learning.

In this set-up students had to acquire some knowledge about fertilisation and the development of the embryo in the mother. They also had to know how a baby is born and be aware of potential dangers during pregnancy. The treatment of the subject took about one month of the curriculum.

[25] http://idefix.gymliestal.ch:8888/embryologie

This month consisted of four lessons of more-or-less individual practical work sustained by models, books and the teacher and about four theoretical lessons given by the teacher.

Curriculum of the two classes:

The activities of one class can be described as ‘conventional’, which means that they learned in pairs, produced summaries and compared them in a discussion. The second class was involved in the same work but worked with a tool which permitted and sustained interactions within the class. The activity of the two classes differed because of the different context. It is very difficult to compare the two different activities in an experimental way and as mentioned above not fruitful for real –life- learning situations. We tried to compare the two contexts and evaluate whether the class learning in a computer-aided context worked as efficiently as the ‘conventional’ class.

Didactical purposes of the Swiki:

- To use a Swiki for publishing the final results but also
- to allow the work in development, through adequate scripting and tutoring,
- to reinforce mutual comparison and judgement of statements and concepts.

This comparison and judgement within working groups **and** the learning community should increase learning efficiency if used in addition to appropriate scripting.

3.7.3.2 Participants

We utilized two classes of high school students (16 – 17 years old, ‘Gymnasium’: 17 students and ‘Diplommittelschule’ 21 students). The curriculum of the ‘Gymnasium’ leads to a high school degree permitting students to go to any university in Switzerland. The ‘Diplommittelschule’, a sort of vocational high school, leads to a diploma permitting students to become nurses, primary school teachers or to go to a university of applied research. In both curricula human embryology is an important part and students of both types of school have to know about the same things. Students attempting a high school degree normally treat subjects on a higher level. They are supposed to show a better pedagogical performance in a comparable learning set up. The students of the ‘Diplommittelschule’ worked with the Swiki while the students of ‘Gymnasium’ had conventional lessons.

3.7.3.3 Specific goal

Questions of interest:

Do vocational high school students (Class of the Diplommittelschule) induced to compare and comment on their work both in working pairs and within the learning community while it is in process, achieve a higher learning efficiency relative to a group which compares their concepts in working pairs while work is in process and with the rest of the learning community at the end of the work.

An additional question is whether a collaborative edition tool can support a group of high school students (again at the vocational high school = Diplommittelschule) and allow them to interact in the way previously mentioned within the learning community.

Comparison of the two groups:

Conventional group work	**Group work sustained by easy to manage publishing tool, which permits and reinforces mutual comparison and judgement of statements, opinions and concepts.**
Scripting without special reinforcement of mutual exchange within the learning community while work is in process	Adopted scripting reinforcing mutual exchange within working groups and learning community
Final discussion with comparison of results	Final and intermediate comparison and comment on work (reinforced by scripting and tutoring)
Tools: Web for research, literature, pictures, description of tasks to accomplish, text processing software	Tools: Web for research, literature, pictures, description of tasks to accomplish **+ Swiki** (collaborative editing tool)
Presumed learning performance: ‘good’	Presumed learning performance: ‘very good’

Table 7: comparing the two learning classes

3.7.3.4 Scripting

The following figure shows the comparison of scripting in both classes:

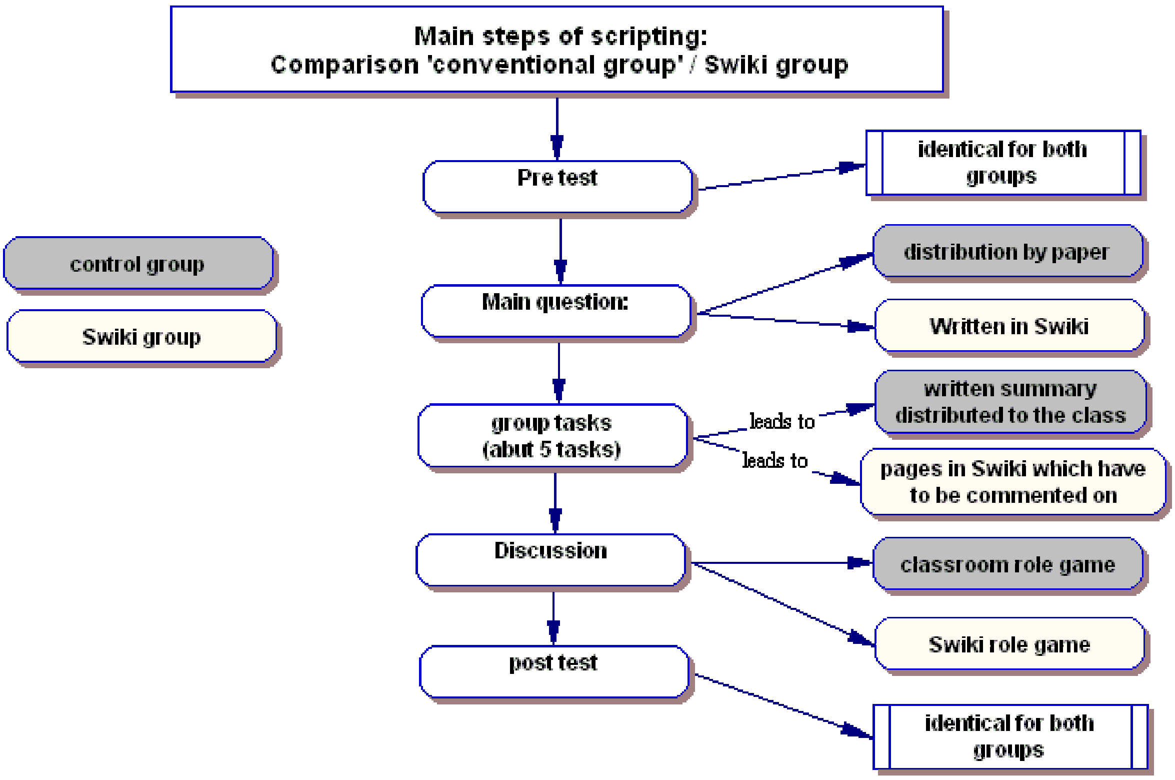


figure 16: Scripting overview for unit: human embryology

Both classes answered a multiple choice questionnaire with two text questions about the subject. They did not know the subject of the questionnaire and the right answers were not shown to the students. At the end of the unit the same questionnaire had to be done by both classes. We added some usability questions, the same as in the two preceding units (see the questionnaire in the appendix)

Conventional class:

We proceeded in this class in a similar way with human anatomy but without the Swiki. The students had to accomplish different tasks, chose a subject and write a summary about it. All items or tasks were described in several working papers. There we also prepared some figures concerning the specific themes. We told the students to use these figures to complete their summary. They had the task to know something about all items but then write about one. All summaries were copied for the whole class. We started from a main (see figure **16)** question about the law of legal abortion in Switzerland and why a woman has to abort within the first 12 weeks of pregnancy. To answer the question they had to know what happens within the whole pregnancy from the fertilisation to birth. They worked with literature, brochures, models and had the possibility to search for information on the Web. They had no access to the Swiki created by the other class. During the lessons we tried to sustain discussion among the working pairs. After the summaries had been done and read we had a classroom discussion about the pros and cons of abortion.

Swiki class:

1. Preparation phase

The introduction of the work with the Swiki was made in another learning unit. We spent an afternoon with the class talking about radioactivity and nuclear reactions. At the end of the lessons we asked all students to give a feedback on what they had learned. We spent about 30 minutes with it. For this purpose we used a Swiki. We prepared an entry page with a list of all names of the class and they answered to a few questions. On every page a comment-box (see figure 17) was placed so all members of the class were advised to comment on the entries of the others. In this Swiki we had the same help facilities as in the Swiki used for the embryology unit.

Most students used the tool to chat and to write silly things about the comments of the other members of the class. We just let them get on with it and commented on their first feedback. Some Students played around with formatting gadgets like moving text or different colours. Two pupils tried to erase the feedback of their peers and we had to reload older versions of the page. First we were afraid about malicious damage to the Swiki and were worried about further damage on the embryology Swiki but fortunately no serious damage happened.

The Swiki about embryology contained exactly the same information as the introduction paper of the conventional class. The figures had also been prepared and uploaded. We asked the students to sign first in into a special page and create personal acronyms, so they could sign every entry. We had learned in the evolution unit that students often forget to sign; so we decided to give more weight to the signature.

The home page of the Swiki contained a link to a help page with examples and to pages where the task was described. We also added the possibility to go directly to the summaries they had to write.

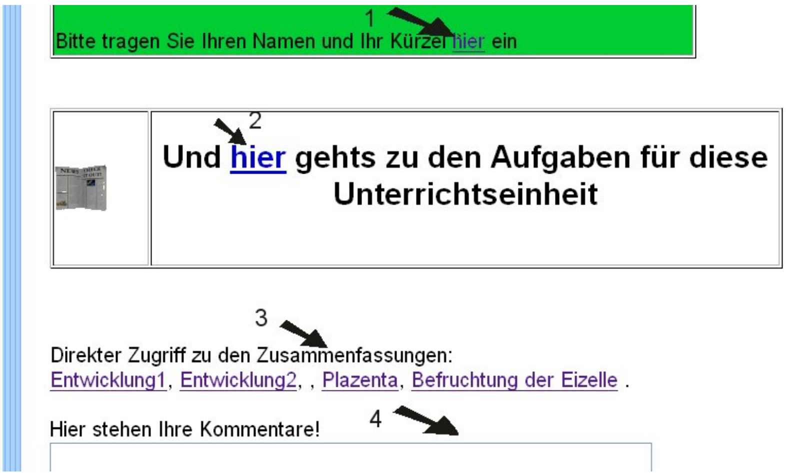


figure 17: Entry page of the embryology Swiki with the following elements

1. Link to the page with the signatures

2. Link to the task to accomplish

3. direct link to the summaries

4. Comment section of the page

The link to the help pages is not visible

In figure 18 the most important links of the entry page are shown. The comment rectangle had to be added to all pages of this Swiki to permit a short feed back to all users. We added the comment rectangle for a didactical purpose: we wanted to sensitise students about the suitability of the structure of every page they created.

2. Start and moderation of the first lessons

We introduced the class to the subject the same way we did with the other class working without the Swiki. Instead of the distribution of papers we showed the tasks with the beamer then a short introduction to the available literature was given: we tried to point out which book could be interesting for which specific subject.

We did not force any specific group composition; they just got the advice to work in pairs.

It was important for our goal to have a certain amount of input after the first lesson to allow comments by the other members of the community. We advised them to start editing immediately and then correct or complete the texts in the following lessons. We tried to interfere as little as possible to permit a free choice of the subject and to avoid manipulation of the texts they chose to work on. In some cases questions rose about the pre test. We tried to point out where they could find the answers and in few cases during the discussion we gave hints about the solution. Such questions were asked especially at the beginning, after two lessons no one asked anymore.

3. Following phases of scripting /evaluation

After the first impact we gave the specific homework to comment on all entries in the Swiki and sign the comments through editing in the comment-box. This task was difficult to enforce. After the first week just a few students wrote something or just made a comment like: ‘oh, great page’, without any justification. So we interfered and discussed all such comments asking what was great in the summary or why they found it great. After the second week the comments remained rare but the quality increased. We noticed that some summaries changed through comments written by the other members of the community. But these highlights remained rare (more about this in the chapter conclusions).

A big task for the teacher was to read all summaries after each lesson and comment them. There we tried to correct just the most evident mistakes and to ask for explanations when foreign words were found.

4 Results and specific conclusions

4.1 Introduction

According to the principal questions (chapter 3.2, page: 41) the structure of the results will be segmented in the following way:

First, we compare the three learning units and try to describe some impressions about scripting as well as how the tool has been perceived by the students. This section is called subjective analysis.

A results section will be dedicated to the comparison of two classes who undertook the human embryology scenario. Here, the results of the two different tests can be shown.

Finally, we will compare the output of the different classes for the human embryology unit.

After each of these results sections we introduce a conclusion chapter to give an interpretation of the results.

4.2 Comparison of the scripting strategies

We lead scenarios concerning three different subjects, and in one of these three scenarios we compared two classes with different settings. In fact, the scenarios about evolution and anatomy also had the purpose of testing out some strategies to improve scripting for the embryology unit, where a ‘real’ comparison took place and tests had to be accomplished. In this section, we want to describe our experiences and the way we changed scripting for the different units and within the different units. The first unit was about evolution, the second about human anatomy, and the third about embryology. The three units did not all have the same pedagogical goal, but some scripting elements could be ‘reused’, and scripting formulas are especially valuable for different types of units.

An overview of the different pedagogical goals of the three units is given in figure 18. The left column depicts what the inputs through scripting elements should lead to.: For example, in the evolution unit we wanted to have many different pages (definitions of concepts) in a short amount of time to permit students to link concepts afterwards. We wanted to let the hypertext ‘grow’ quickly and be quite complex.

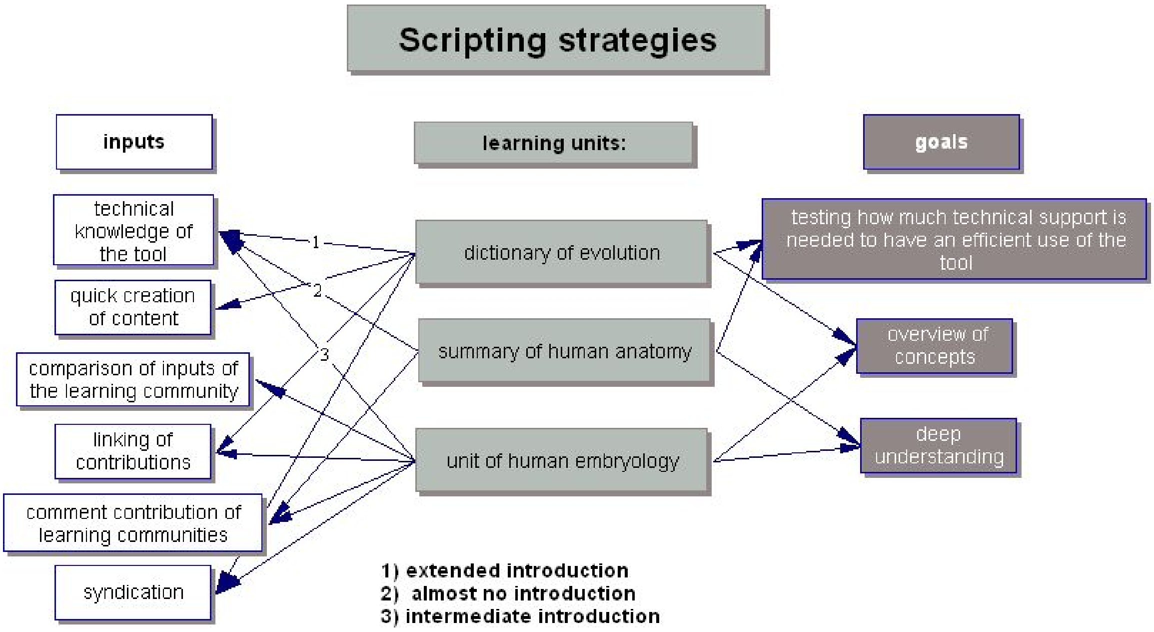


figure 18: Comparison of scripting strategies in the three learning units

For the dictionary of evolution we dedicated the most time and greatest number of different elements to introduce the tool. We first presented an example of an existing Swiki to the whole class, and then introduced the different editing possibilities. After that, input students had the opportunity to play in a sandbox for about twenty minutes. Finally the prepared Swiki was introduced.

The Anatomy Swiki was introduced by simply pointing out the possibilities of the tool through a page with many editing examples included in the Swiki (amount of time: 10 Minutes). The time spent for an introduction in the embryology unit was something in between the two other sets. We made an evaluation of another learning unit of about 30 minutes, where students immediately edited pages in the Swiki. The greatest number of problems emerged when students wanted to edit the same page simultaneously. This problem did not happen for the anatomy class because the whole class did not do their homework at the same time. Some other minor problems arose when they wanted to insert some formatting elements like tables or internal links. Some students had problems with the size of pictures they wanted to insert, and some students changed the title of their page while others made links to this site. This happened at the same time and caused a problem. **We had to intervene for technical problems about three to six times in two lessons.**

The assistance given during work was similar for the evolution and the embryology units. Students worked with the tool in the lessons and sometimes had technical questions which had to be answered. For the anatomy unit the work took place at home, and therefore no technical support by the teacher was possible.

Students were encouraged to produce a certain amount of input as quickly as possible to permit the comparison and linking of different inputs. This scripting element was particularly pushed during the evolution Swiki. We did not force it in the two other units and we can say that it was a mistake. We saw a quicker evolution of the hypertext and a quicker involvement of students in different concepts in the evolution unit. We thought that for the other units with the pedagogical goal of achieving a deep understanding of the concepts, it would have been a bad idea to force a quick input. In hindsight we can say **that it is much more important to initiate and sustain the feedback culture than to wait for perfect inputs to comment.** The habit of commenting and comparing the inputs of the learning community must be sustained.

For the embryology unit, the comparison of the inputs of the community was an important goal while the unit was in process, and for the anatomy unit after the work was finished. It must be remembered here that for the anatomy Swiki the work was done at home, and most of the students saw all results just two weeks later when they had to prepare the class test. For the evolution Swiki we did not force this goal as we just wanted to have as many concepts linked as possible.

The goal of the comparison of the inputs was both to improve the quality of the personal input and to reach a deep understanding of the unit. Post hoc we assigned a big importance to this scripting phase. The way we put this scripting phase into practice was to strongly encourage the students to comment, correct and ask questions to the other inputs of the community. However, we did not have a tremendous amount of success with our strategy (see also chapter 4.2.1). We still think that encouraging comments from the students is a valuable method for the comparison, but the way we communicated to them was not effective enough to increase the amount of comments.

For a further discussion of this important scripting element please see the chapter 'final conclusions'.

We tried to open the units to friends and parents through creating guest books and giving the homework to 'tell a friend' about the site, and to gain valuable feedback from an external expert (embryology Swiki). The syndication was quite successful, however post hoc we feel that we **should have introduced it from the beginning and not at the end of the unit. This would have permitted** an external feedback during the work process, rather than just for the result.

In summary, we felt that the main pedagogical goals were reached for all units. Students got a good overview of the concepts of evolution and reached a deep understanding in human anatomy and embryology.

4.2.1 Factors increasing impacts

Here we tested out which factors could be important for increasing the degree of discussions and impacts within members of the learning community.

One input of the teacher was to comment on all entries of the students as soon as possible. He or she would then ask the students to do the same. Reading and commenting upon inputs during and between the lessons proved to be the major role of the teacher. We tried not to correct the students' mistakes immediately, but instead we asked them to make some points more precise.

As well, we forced the students to comment themselves on the inputs of the other group members by repeating this task frequently, about three or four times in each learning unit. We had to do so because students did not seem to react very well to this task**. It was quite difficult to create a comment and feedback culture within the classes and we think that for these three units we did not have a great amount of success.** The input and comment rate did not augment during the courses.

We tried to make categories for the feedback of the students.
We found an evolution of the type of feedback occurred during the work process. The first comments were quite clumsy, such as ‘oh, great page’ or ‘you are the greatest’ and were related to the authors and not to the input. It appeared that the students thought they had been asked to comment on the persons and not on the input. Then the teacher gave some examples of possible categories like:

- Semantic question (I do not understand this word, sentence..)
- Pragmatic question (why did you choose this sub-subject? It is not related to the main theme)
- Personal opinion (I do not like the way you explain this for the following reason, or your page is very interesting; I did not know that…)
- Advice (have a look to the following page, article…)

After the phases of clumsy comments had passed, an extended questioning phase happened. Most of the questions were semantic ones, and just few were pragmatic. At the end of the unit the personal opinion and ‘clumsy- type’ notes gained importance.

4.2.2 Guided learning versus independent learning

The results of the three units concerning the dilemma of constructivist work cannot be formulated directly. We tried to establish whether or not the teacher intervened too many times during the embryology unit. These results can be seen in table 17. For the conventional set-up, the teacher should have intervened more than during the Swiki set up**. For the conventional set up of the embryology unit, interventions by the teacher were requested more often than during the Swiki-supported unit. This could be because the scripting connected with the tool permits a more autonomous realisation of the tasks**. Such self-guided learning is fruitful for metacognitive skills.
From these results, we conclude that **interventions should be prepared about twice or three times a lesson in each working group**. Of course, it is also important that the lessons be customized to fit the needs of the individual students within a group. Normally a teacher knows which students need or want a higher degree of guidance.
In general, our impression was that the students were motivated to work by themselves. In contrast to a conventional lesson, they did not require frequent guidance. Our concept of preparing guiding elements in advance (see chapter 2.1.3.1; p. 28) worked well.
One of these guiding inputs was to push students to comment on inputs of the other members as a means of leading the class to a high degree of self-regulation and self-evaluation. However, this input had to be repeated frequently. We asked the students if they felt embarrassed to comment on other inputs, but they responded that this was not the case.

4.2.3 Amount of work produced by the teacher

The amount of work for the teacher is comparable for the different scripts. However, the division and the type of work changes slightly. For the embryology unit, the comparison between the Swiki class and the conventional class shows the following:

For the preparation phases, a comparable amount of time was spent in both classes. One big difference was the implementation of the tool and the way we structured the embryology Swiki. We spent about three hours creating the primary structure, finding and scanning some images, and uploading text information, although a teacher who practices such a unit for the first time should calculate much more time for the set up of the Swiki. The time spent to prepare such a collaborative unit is much greater than the time needed to produce a teacher-centred unit. However, when the unit is running the preparation time of a collaborative, student-centred unit decreases, while for a teacher-centred unit the time demands remain equal.

During the month that the unit was running, the preparation time necessary for the Swiki class was much higher than that of the conventional embryology class. Also, the time required increased throughout the unit, as the more text that was produced in the Swiki the more time it took to read it. Fortunately, in the Swiki it is possible to compare different versions of a page, and this feature has often been used to read and comment on just the added text. The preparation time of the Swiki class is comparable to the preparation of a teacher-centred lesson.

For the conventional embryology class almost no time was spent on preparation for the unit. However at the end of the course, the teacher had to spend a lot of time to read and comment on all the summaries of the class. For the Swiki class this took much less time because the work could be done while the unit was running.

In summary, we conclude that for a teacher with good technical knowledge, a computer-supported collaborative unit demands at least the same amount of time as a conventional teacher-centred unit. However, the time repartition differs for the two scenarios: while for a conventional set up each lesson takes about the same amount of time to prepare and evaluate, for a computer-supported collaborative unit time repartition is not equal for each lesson. The starting period of the unit is more time-consuming than the following lesson.

4.3 Subjective perception of the scenarios

Using a questionnaire, we asked the same questions to all participants in the three units. The following chapter compares their answers:

4.3.1 Students' satisfaction

4.3.1.1 Satisfaction derived from working with the computer

We asked students in the three scenarios whether they liked working with the computer (see table 8). The phase of computer euphoria is over in our schools. All students have their own mail and internet account at school. For most of our students, computers have become a communication and work tool like cellular phones or books. However, the use of a computer within regular lessons is not very common, except in specific lessons of informatics, where students deepen their capacity to handle both the machine and the software. In their biology curriculum they used computers two or three times for research on the Web, for text processing, and for working with a learning software. There were no statistically significant differences between the three scenarios. An interesting result occurred for the unstructured scenario of anatomy, where students worked without any assistance or much introduction to the tool. Here, a polarization occurred between students who liked it totally (55.5%) and students who did not like at all (22.6%); no students said they enjoyed it only partially. Although the work seemed to divide the class in two parts, this result was not statistically significant due to the small amount of participants (n = 9). For the two other scenarios, a highly significant difference could be found between ‘working with the computer was fun’ and ‘working with the computer was partially fun’ against the other possibilities (Fisher; p< 0.006; n = 22 for structured evolution and Fisher; p<0.009; n = 17 for structured embryology). These differences indicate that students liked working with the computer in a structured environment.

<table>
<tr><th></th><th>Do not know</th><th>Agree Totally</th><th>Agree Partially</th><th>Do not Agree</th><th>N</th></tr>
<tr><td>Structured evolution</td><td>0 (0%)</td><td>11(50%)</td><td>8(36.4%)</td><td>3(13.6%)</td><td>22(100%)</td></tr>
<tr><td></td><td></td><td colspan="2">Fisher (p=0.0058)</td><td></td><td></td></tr>
<tr><td>Structured embryology</td><td>0(0%)</td><td>9(52.9%)</td><td>5(29.4%)</td><td>3(17.7%)</td><td>17(100%)</td></tr>
<tr><td></td><td></td><td colspan="2">Fisher; (p=0.009)</td><td></td><td></td></tr>
<tr><td>Unstructured anatomy</td><td>2(22.2%)</td><td>5(55.5%)</td><td>0(0%)</td><td>2(22.2%)</td><td>9(100%)</td></tr>
</table>

table 8: comparison of three scenarios : ‘It was fun to work with the computer’ (Bold italic values have been regrouped and denote significance against other values (also regrouped); see Fisher test) -> related to figure 21

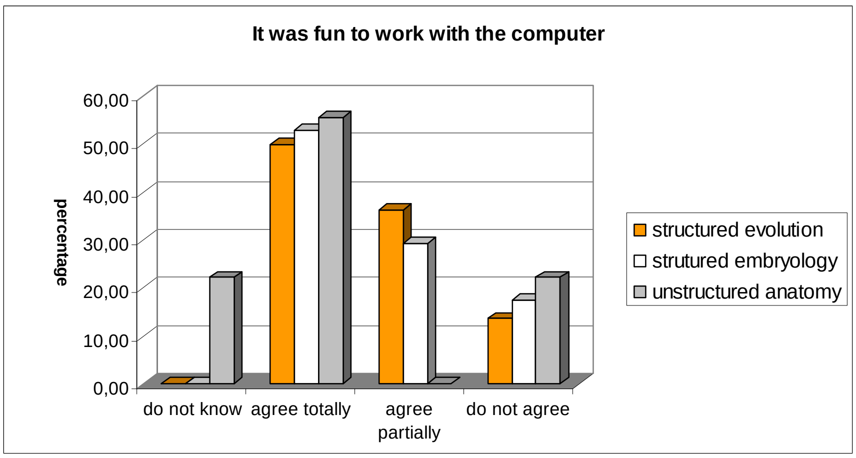


figure 21: comparison of three scenarios: satisfaction to work with computer

4.3.1.2 Level of comfort with the tool

We also wanted to know whether students felt comfortable working with the Swiki. The amount of students who felt comfortable was higher in the two structured Swikis than in the unstructured Swiki. For the evolution Swiki we found a very significant difference between 'agree' totally and all other possibilities (Fisher; p=0.0012; n = 23). For the other scenarios no statistical significance could be shown. Table 9 shows that a higher percentage of students did not feel comfortable with the tool in the unstructured anatomy Swiki than in the other scenarios (no statistical significance).

	Do not know	Agree Totally	Agree Partially	Do not Agree	N
Structured evolution	0 (0%)	***17(73.9%)*** Fisher (p=0.0012)	5(21.2%)	1(4.4%)	23(100%)
Structured embryology	0(0%)	***9(52.9%)*** Fisher; (p=0.026)	***5(29.4%)***	3(17.7%)	17(100%)
Unstructured anatomy	0(0%)	3(33.3%)	4(44.4%)	2(22.2%)	9(100%)

table 9: comparison of three scenarios: 'comfort while working with the Swiki'

4.3.1.2.1 Difficulties with creating new pages in the Swiki

One of the tasks that students had to do frequently was the creation of new pages to enter information. We also wondered whether students had difficulties with that (see figure 23). Almost all of the students in the three set-ups found it easy to create new pages in the Swiki (evolution Swiki: significant difference: 'do not agree' against others: Fisher, p <0.5; n = 23; evolution Swiki: highly significant 'do not agree' and partially agree' against others: Fisher, p = 0.002; embryology Swiki: highly significant: 'do not agree' and partially agree' against others: Fisher, p<0.001, n = 17; no statistical significance for the anatomy Swiki was found (n= 9)). Again because of the few participants for the anatomy Swiki no significant difference could be shown between any of the answers. Also, t the ratio of answers within the anatomy Swiki does not differ much from the other two set-ups.

	Do not know	Agree Totally	Agree Partially	Do not Agree	N
Structured evolution	0 (0%)	2(9.1%)	***9(40.9%)*** Fisher (p=0.0023)	***11(50%)***	22(100%)
Structured embryology	0(0%)	0(0%)	***8(35.3%)*** Fisher; (p<0.001)	***9(58.82%)***	17(100%)
Unstructured anatomy	0(0%)	1(11.1%)	3(33.3%)	5(55.5%)	9(100%)

table 10: comparison of three scenarios: difficulties with creating new pages

To examine whether or not there were significant differences in difficulties with creating new pages between the three scenarios, we regrouped these three questions (1. It was fun to work with the computer, 2. I felt comfortable while working with the Swiki and 3, I had difficulties with creating new pages) for the statistical analysis. We assigned the following values to the different answers: Agree totally = 3, agree partially = 2, and do not agree = 1. We then had a numerical sum for each answer, and these sums could be compared against each other (all analyse of differences between units in the following result chapter has been done the same way). A Mann-Withney test showed a significant difference between medians of evolution against anatomy Swiki (U = 1027.5; p=0.03) but no differences between embryology and anatomy (U = 574; p = 0.13) or embryology and evolution (U = 1559; p= 0.41). Therefore, **the students had significantly fewer difficulties using the computer and the tool in the two structured Swikis than the unstructured unit.**

4.3.1.2.2 Work obstruction caused by the tool

What exactly did the students have to accomplish with the tool? They had to edit pages, create new pages, and link pages together. We wanted to know whether they had difficulties editing, since this is the main function of the Swiki, and if they had the sensation that editing obstructed or slowed down their tasks (see figure 19). For the two structured Swikis, students thought that editing was easy or partially easy (evolution: extremely significant: ‘do not agree’ against others: Fisher: p<0.001; n = 23; embryology: significant: ‘agree partially’ and agree totally’ against others: Fisher: p=0.017; n = 17). In the unstructured Swiki, students had more difficulties editing, and they agreed that the tool obstructed their ability to accomplish the task. The task of the anatomy Swiki was the same as that of the embryology Swiki, to formulate summaries about a subject.

	Do not know	Agree Totally	Agree Partially	Do not Agree	N
Structured evolution	0 (0%)	1(4.4%)	3(13.0%)	***19(82.6%)*** Fisher (p=0.0002)	23(100%)
Structured embryology	0(0%)	1(5.9%)	***6(35.3%)*** Fisher; (p=0.017)	***10(58.82%)***	17(100%)
Unstructured anatomy	0(0%)	2(22.2%)	5(55.5%)	2(22.2%)	9(100%)

table 11: comparison of three scenarios: difficulties to edit input with the Swiki -> figure 19

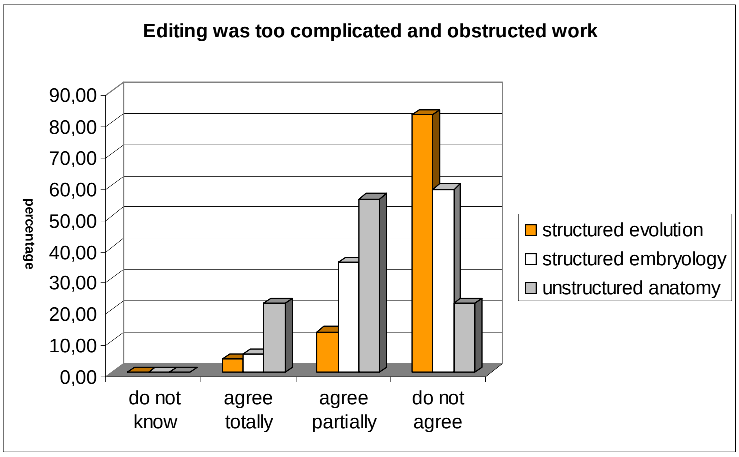


figure 19: comparison of three scenarios: difficulties to edit input with the Swiki

The comparison of the three set-ups concerning this question showed a statistical difference between anatomy and evolution (U = 40; p = 0.0065) but no difference between the other settings (anatomy <-> embryology: U = 45; p = 0.09; and evolution <-> embryology: U = 393; p = 0.2).

4.3.2 Working together, efficiency, and danger of getting lost within the created hypertext

The following questions are more directed toward the accomplished work (see table 12). We wanted to know whether or not the students discussed amongst themselves while they were working. Students worked in pairs, and we tried to encourage discussions about the various subjects. However, we were surprised by the results of the questionnaire. Even though we found a statistically significant difference between ‘agree partially’ and all others in the evolution setting (Fisher, p=0.006, n = 23), we expected a larger number of votes in the category ‘agree totally’. However, very few students agreed totally with the statement, and this result was similar for all three units. Therefore, not too many discussions about the subjects happened during the work. Instead, it seemed that students preferred to share their tasks; after a decision making phase, one student worked on one subject and the other on another. This observation was also made during the lessons. At the beginning of the learning units most pairs were sitting together and discussing, but by the end of the unit there were fewer groups together. It was more frequent that one person wrote in the Swiki while the other searched for content to add. However, the questionnaire was completed at the end of the unit. If the same question was asked toward the beginning of the work, it may have given a different result.

<table>
<tr><th></th><th>Do not know</th><th>Agree Totally</th><th>Agree Partially</th><th>Do not Agree</th><th>N</th></tr>
<tr><td>Structured evolution</td><td>1 (4.4%)</td><td>3(13%)</td><td>15(65.2%)
Fisher
(p=0.0067)</td><td>4(17.4%)</td><td>23(100%)</td></tr>
<tr><td rowspan="2">Structured embryology</td><td rowspan="2">0(0%)</td><td>6(35.3%)</td><td>9(52.9%)</td><td rowspan="2">2(11.8%)</td><td rowspan="2">17(100%)</td></tr>
<tr><td colspan="2">Fisher (p=0.026)</td></tr>
<tr><td>Unstructured anatomy</td><td>0(0%)</td><td>1(11.1%)</td><td>3(33.3%)</td><td>5(55.5%)</td><td>9(100%)</td></tr>
</table>

table 12: comparison of three scenarios: many discussions while working

The comparison of the three scenarios with respect to discussions indicated a significant difference between anatomy and embryology (U = 39; p = 0.03), but no statistical differences between the two other set ups (Anatomy<->evolution: U = 65; p = 0.14; evolution <->embryology: U = 143; p = 0.21).

We also wanted to know whether or not groups thought they worked efficiently (see table 13). We did not ask them what they thought 'efficient' means. In all three units, only a few students thought they were not efficient. The majority thought themselves to be partially or very efficient. For the anatomy Swiki no one was 'not efficient'. We will discuss in the conclusions chapter what students may have thought the term 'efficient' meant. For the evolution Swiki, a significant difference exists between 'agree partially' and all others (Fisher: p=0.001; n = 23), and a significant difference exists between 'agree totally' and 'agree partially' against all others (Fisher, p<0.05, n = 23). The number of students who considered themselves to be 'very efficient' was greatest in the unstructured anatomy unit, however there were no significant differences between the answers within this unit. The comparison of the three scenarios with respect to efficiency showed a difference between anatomy and evolution (U = 47; p = 0.031) but no difference between the others (anatomy <-> embryology: U = 53; p = 0.28; and embryology <-> evolution; U = 130; p = 0.23).

<table>
<tr><th></th><th>Do not know</th><th>Agree Totally</th><th>Agree Partially</th><th>Do not Agree</th><th>N</th></tr>
<tr><td>Structured evolution</td><td>0 (0%)</td><td>2(9.1%)</td><td>17(77.3%)
Fisher
(p<0.001)</td><td>2(9.1%)</td><td>21(100%)</td></tr>
<tr><td rowspan="2">Structured embryology</td><td rowspan="2">1(5.9%)</td><td>5(29.4%)</td><td>10(58.8%)</td><td rowspan="2">1(5.9%)</td><td rowspan="2">17(100%)</td></tr>
<tr><td colspan="2">Fisher (p=0.026)</td></tr>
<tr><td>Unstructured anatomy</td><td>0(0%)</td><td>5(55.5%)</td><td>4(44.4%)</td><td>0(0%)</td><td>9(100%)</td></tr>
</table>

table 13: comparison of three scenarios: efficiency of working

An interesting result is shown in table 14: in the two structured Swikis, over 55 % of all students just partially agreed with the opinion of their working companion. The amount of agreeing in the unstructured Swiki is higher. We found a statistically significant difference within a Swiki when we compared 'agree partially' and 'agree totally' against others (Fisher: p= 0.03 (evolution) and Fisher: p = 0.035 (embryology); n = 17)

	Do not know	Agree Totally	Agree Partially	Do not Agree	N
Structured evolution	0 (0%)	***6(27.7%)*** Fisher (p=0.03)	***13(59.1%)***	4(18.2%)	23(100%)
Structured embryology	0(0%)	***3(17.7%)*** Fisher (p=0.035)	***11(64.7%)***	3(17.7%)	17(100%)
Unstructured anatomy	0(0%)	6(66.6%)	3(33.3%)	0(0%)	9(100%)

table 14: comparison of three scenarios: agreeing with the tasks to accomplish -> figure 20

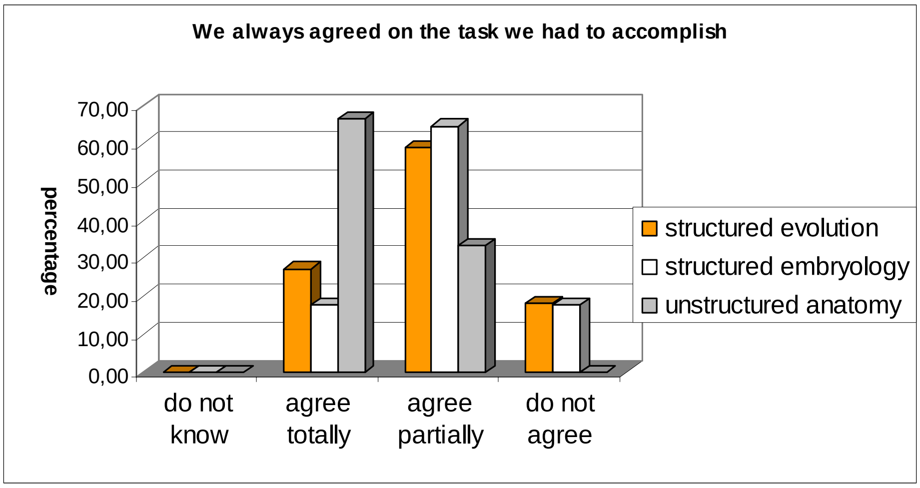


figure 20: comparison of three scenarios: agreeing on the tasks to accomplish

For the question of agreement between the students, we also tested the differences between the three units:

A significant difference could be shown between both structured units and the unstructured one: Anatomy <-> evolution: U = 55; p = 0.04 and anatomy <-> embryology: U = 34; p = 0.02) while no significance could be shown between both structured Swikis (embryology <-> evolution: U = 181; p = 0.7). **Students in the unstructured setting agreed more often about which tasks to accomplish than students in the structured units.**

The last evaluated question centred on the created hypertext. We wanted to know whether students got lost easily in the text. We found a significant difference between the unstructured Swiki (anatomy) and the other two Swikis. Students had a greater impression of getting lost within the hypertext of the anatomy Swiki than in the other Swikis. We counted the number of pages and links of the three units and found the amount of links and pages in the anatomy Swiki is no greater than in the two other Swikis. Table 15 shows the impression of getting lost within the hypertext.

	Do not know	Agree Totally	Agree Partially	Do not Agree	N
Structured evolution	0 (0%)	1(4.4%)	5(21.7%)	***17(73.9%)*** Fisher (p=0.0009)	23(100%)
Structured embryology	0(0%)	1(5.9%)	3(17.7%)	***13(76.5%)*** Fisher (p=0.035)	17(100%)
Unstructured anatomy	0(0%)	4(44.4%)	5(55.5%)	0(0%)	9(100%)

table 15: comparison of three scenarios: It is easy to get lost within a text with many links'-> figure 21

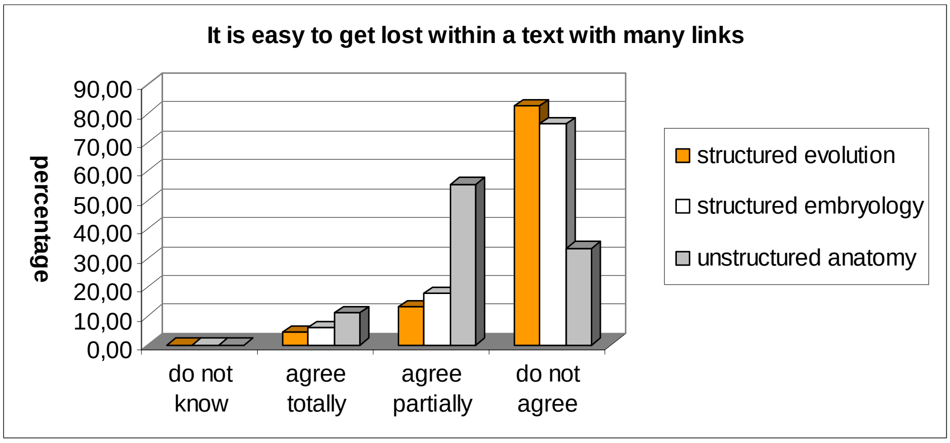


figure 21: comparison of three scenarios: It is easy to get lost within a text with many links'

For this question, the comparisons of the three units leads to a significant difference (A Mann - Withney test showed: anatomy <-> evolution: U = 60; p = 0.09; anatomy embryology: U = 46; p = 0.07 and evolution <->embryology: U = 189; p = 0.81). **The difference between the two structured Swikis and the unstructured Swiki is almost significant, while no difference could be seen between both structured Swikis.**

4.3.3 Perception of the teacher during the embryology course

The following section emerges from several questions we asked only in the embryology section. The questions are related to the students' perception of the teacher during the courses, and how members of the learning community had an impact of the quality of the final result.
A first question we asked was whether students had the sensation of learning more from the teacher than from their peers (see table 16). In the Swiki class, 2 students learned more from their peers than from the teacher, whereas in the conventional class 5 students learned more from their peers than from the teacher (no statistical difference between these values); This result is the opposite of what we expected, and will be addressed further in the conclusions.

	Do not know	Agree Totally	Agree Partially	Do not Agree	N
Class working with a Swiki	2(11.8%)	2(11.8%)	10(58.8%)	3(17.7%)	17(100%)
Class working conventionally	0(0%)	5(29.4%)	8(47.0%)	4(23.5%)	17(100%)

table 16: subjective perception of the following question: 'I learned more from the peers than from the teacher'

We found no statistical difference between the two classes for this question (Swiki <->conventional: U = 115; p = 0.64)
We also wanted to know whether the teacher intervened too many times during the courses, asking too many questions or giving unnecessary advice. Our scripting strategy was not to intervene while work was ongoing, and we wanted to see if the students had this perception. In the Swiki class, students seemed to be more disturbed by the interventions than in the conventional class (see table 17). 47% of the students working in the Swiki set up agreed partially with the question asked, while just 11% of the conventional class agreed.

	Do not know	Agree Totally	Agree Partially	Do not Agree	N
Class working with a Swiki	1(5.9%)	1(5.9%)	8(47.1%)	7(41.2%)	17(100%)
Class working conventionally	0(0%)	0(0%)	2(11.8%)	***15(88.2%)*** Fisher (p=0.0004)	17(100%)

table 17: subjective perception of quantity of teachers intervention during work process; Statement: 'The teacher intervened too many times while we were working'.

Here the comparisons of the two classes lead to significant difference (U = 74.5; p = 0.02). Students of the conventional class were less ‘disturbed’ by teacher interventions than the Swiki class.

4.3.4 Impact of the input of all members of the learning community on the quality of the work of each group

It was important for us to know whether the input of the learning community had an influence on the quality of the final product. In the conventional class, the learning community did not have many opportunities to intervene while the work was ongoing, except in discussions during the lessons. In contrast, the students in the Swiki class had the chance to comment on the work of the other students, and could write comments and questions about the work of other participants.
In the Swiki class, 11 students responded with ‘agree partially’ to the statement “The interventions of members of the learning community improved the quality of the written summaries.” In the conventional class, 9 Students answered that they did not agree with this statement (see table 18).

	Do not know	Agree Totally	Agree Partially	Do not Agree	N
Class working with a Swiki	0(0%)	3(17.7%)	***11(64.7%)*** Fisher (p=0.03)	3(17.7%)	17(100%)
Class working conventionally	2(11.8%)	1(5.9%)	5(29.4%)	9(52.9%)	17(100%)

table 18: Students’ perception of the improvement in the quality of work through intervention by other members of the learning community. Question: ‘The interventions of members of the learning community improved the quality of the written summaries.’

For this question we also found a statistical difference between the two classes (U = 71.5; p = 0.03). In contrast to **students in the conventional class, Students in the Swiki class had a greater impression that contributions from other members of the learning community lead to an improvement of their work.**

4.4 Conclusions about usability of the tool and satisfaction of students

The conclusion section has been split in two to permit a discussion about the different results for each unit. The chapter entitled ‘final conclusions’ will incorporate the discussions of all the results sections.
Here we will offer some conclusions about the way students perceived their work and how they thought the tool to be useful for their tasks. A general remark concerning the students’ responses is

that their opinions tended to vary a lot depending on such factors like how they happened to be feeling that day, and this seemed to have a big influence on their opinions. In particular, students between the ages of 16 and 19 seem to be rather susceptible to such fluctuations. All further conclusions should take this into consideration. We also had just 9 students in each unit we compared, as the other students were ill when they had to answer the questionnaire. Such a low number of participants made a statistical comparison difficult.

Many students seemed to genuinely enjoy working with the computer (-> table 8). This fact was not assumed a priori to be true, since students at this high school have many opportunities to work with computers, and the novelty of computer use in the classroom has worn off. In other units where the teacher gave students the choice of working with the computer or with books, more than half of the students chose to work with books. We think that students liked working with the computer because they enjoyed the specific work with the tool (-> table 9). We also saw a difference between students working in a set-up with a structured scripting and students working with an unstructured scripting. All groups enjoyed working with the computer, but not all groups liked the tool to the same degree. The group without introduction and without scripting input throughout (=anatomy Swiki) liked the tool less than the other groups. Furthermore, the unstructured anatomy group thought that the tool obstructed their work much more than the other two groups (->table 11). **We conclude that structuring the work has a positive influence on the sense of satisfaction that the students gained from the tool and the work in general.**
The creation of new pages and the editing of input was more difficult for the group without structuring than for the other groups (table 10). The same group also had a greater impression of getting lost within the created hypertext of the class (table 15). In fact, the hypertext created in the unstructured anatomy unit had far fewer links than in the two other Swikis. However, **students still thought they were getting lost often within the few links, while the students that were guided had a different sensation**. We believe that the students in the unstructured unit were not able to create a clear mental model of the hypertext created by the learning community. They were more fixed on accomplishing their goal, without being aware of other possibilities like commenting or completing the work of others. Assisting the students through comments and comparisons of other works of the community seemed to allow them to get a better idea of the structure of the hypertext. This fact may lead to a more precise mental model of the product, and the danger of getting lost decreases. However, the students working in the unstructured unit seemed to learn much by reading the inputs of other members of the community (table 15). Although this meant that these students read the whole hypertext and learned more from the inputs of other members, they still had difficulties navigating through the text.
When students were asked whether they discussed their work a lot with their partners, the students of the structured units responded that they discussed more than students in the unstructured unit (table 12). **Discussion is an important element of building a concept and learning in a constructivist way especially when different opinions merge and have to be compared.** We asked whether peers agreed on which tasks to accomplish (table 14). Students in the unstructured

unit agreed more often than the other students. This could be a result of peers having no choice but to discuss when they do not agree on something. Such discussions of contrasting opinions are fruitful for learning, and we believe this leads to a better quality of learning in set-ups with structured script.

Students in the unit with the unstructured script appeared to be more efficient than students in the other set-ups (table 13). However, the results from this question are difficult to interpret. What is efficiency for a student: is it to accomplish the tasks easily and quickly, or is it to learn as much as possible? Without structured script, the students could just work on their tasks and did not 'lose' any time comparing and commenting on other inputs. When students had to answer to questions asked by the other members of the community, like they had to in the evolution and embryology Swiki, they thought to lose time.

In retrospect, we should have put the general question of whether or not they felt they had learned a lot, and then tested for a difference in the increase in knowledge between the two groups.

In conclusion, we believe that Swiki is perceived as an appropriate tool to accomplish difficult collaborative tasks for high school students without prior knowledge of collaborative editing. Our first general hypothesis is supported by our results. Furthermore, we can say that a **structured script used in combination with a Swiki facilitates interactions within the learning community, and creates a better mental model of the work produced by the learning community.**

4.4.1 Students' perception of the impact of the teacher and the importance of the inputs of the learning community on the work of each group

This section is related to a comparison between the two classes working on the same embryology unit but with different scripts.

Although we had hoped to show that students learned less from their teacher than from their peers, it was not possible to make this conclusion. (see table 16). This may be due to the fact that students hesitated to say that they learned more from their peers than from a teacher, or that they were simply not aware of learning accomplished by themselves.

During the embryology unit, the teacher did not intervene very often while the work was going on. In our scripting strategies for both classes it was important for us to try to sustain the self-regulation of the learning process by intervening as little as possible. Students of the conventional set-up indicated that they would have liked more assistance, while students working with Swiki were rather content with fewer interventions. Here it is possible that students were again unwilling to express their real opinion. Another possibility is that students working with Swiki had enough interventions through comments of other members of the community, while the other students would have liked more interactions with the teacher (or others) (see table 17).

An interesting fact supporting the hypothesis that students in the conventional setting would have liked more interaction is that they thought that the work of the other members of the learning community had no influence on the quality of their own work. This is in contrast with the Swiki group, where more students thought that there was a positive influence of the members of the class on the personal work. **We conclude that the Swiki students had a larger amount of interaction with the other members of the community, and this led to an improvement of their personal work.**

4.5 Comparison of pre test, post test, and final test for the embryology unit

4.5.1 Increase of factual knowledge

We will call the class working with a Swiki the 'Swiki class' and the other class the 'conventional class'. We noticed that the Swiki class had a slightly worse knowledge in the pre test, but showed a small improvement for the post test (as shown in table 19 and 25). We concluded that the Swiki class had a greater increase in knowledge, since the Swiki class (vocational high school) normally shows inferior pedagogical performances compared to the conventional class (normal high school). However, the differences in the increase of knowledge between the conventional class and the Swiki class are not statistical significant (see table 19).

		Pre test	Post test	Final test
	Amount of questions	Number of correct answers: average(standard deviation)	Number of correct answers: average(standard deviation)	Number of correct answers: average(standard deviation)
Conventional Class	19	5.9 (2.1)	9.7 (2.6)	10.4 (2.8)
Swiki Class	19	5.4 (2.5)	9.8 (2.9)	10.8 (2.1)

table 19: Increase of factual knowledge between pre- post- and final test.

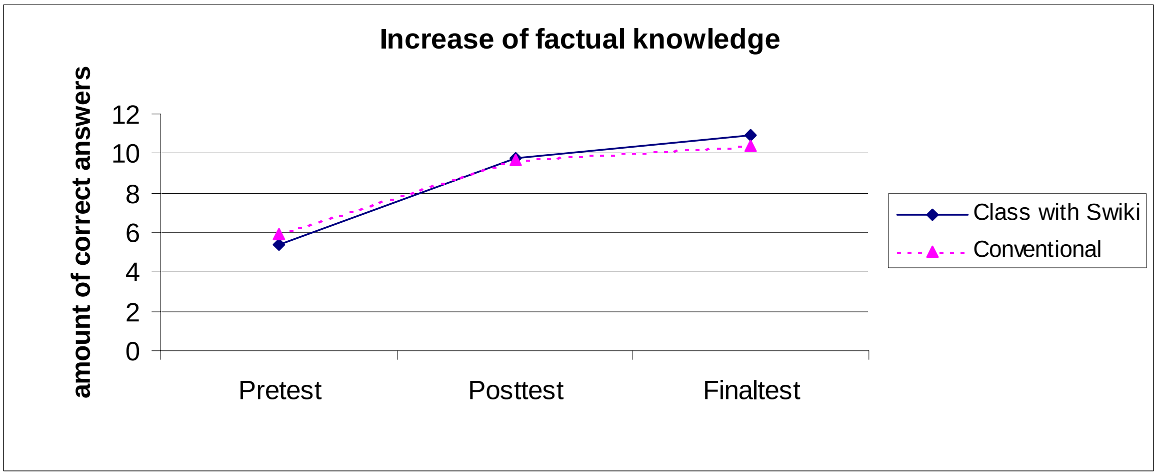


figure 22: Increase of factual knowledge between pre-, post- and final test; average of the class.

The comparison between pre- and post-test was made with an ANOVA, and showed a statistically significant increase of factual knowledge between the two tests. No significant difference in factual knowledge between the two classes could be found for either the pre or post test (see table 20).

One-way Analysis of Variance (ANOVA) $F(5, 101) = 14.841$	
Pre test conventional <-> pre test Swiki	No significance
Post test conventional <->post test Swiki	No significance
Pre test conventional <->post test conventional	$p < 0.001$
Pre test Swiki <-> post test Swiki	$p < 0.001$
Final test Swiki <-> final test conventional	No significance

table 20: Increase in factual knowledge between pre- post- and final test: Analysis of variance

4.5.2 Students' confidence in their answers

We asked all students to state how sure they were about their answers. We found an increase in self-assurance between pre and post test for both classes. The students of the Swiki class were a little bit less certain about their answers in pre and post test compared to the students of the conventional class. The increase of self-assurance within pre and post test was almost parallel for the two classes (see figure 23, the effective values are shown in table 21). We measured students' confidence in the following fashion: If a student was very sure of his or her answer we gave 3 points, quite sure: 2 points, and not sure at all: 1 point. Then we multiplied each correct answer by the confidence factor, and calculated the average for all 19 questions. We did this for each student, and then calculated the average over all students in a class.

		Pre test	Post test	Final test
	Amount of questions	Confidence in correct answers: average(standard deviation)	Confidence in correct answers average(standard deviation)	Confidence in correct answers average(standard deviation)
Conventional Class	19	11.4 (4.6)	21.4 (8.3)	21.3 (7.9)
Swiki Class	19	9.2 (5.03)	18.2 (7.8)	20.4 (4.7)

table 21: Increase of confidence in correct answers between pre- post- and final test.

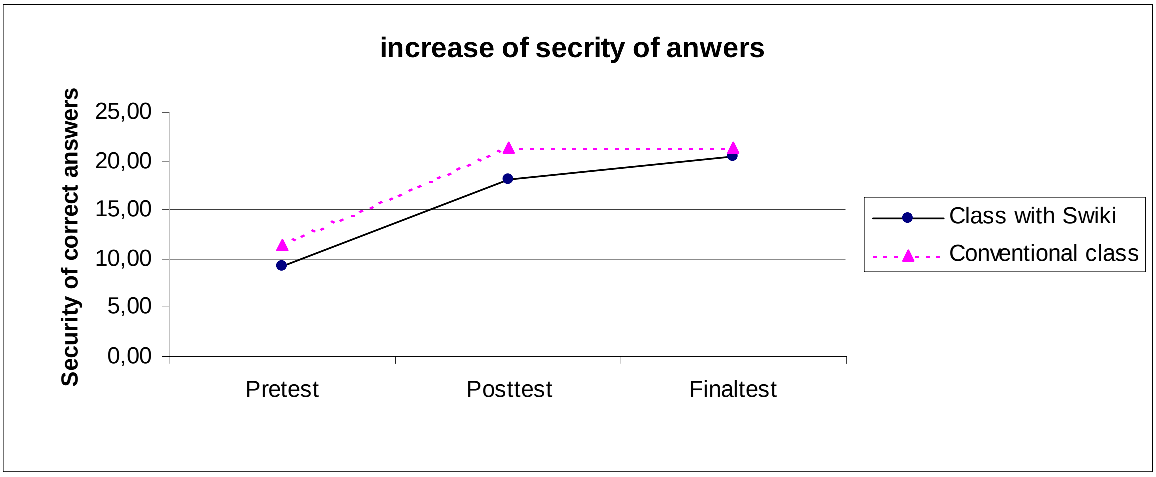


figure 23: Average of increase of security of correct answers between pre- post- and final test.

We also made a statistical comparison of the students' confidence in their answers between the two classes with an ANOVA test (see table 22).

Both classes showed a significant increase self-assurance between the pre and post test, although no significant difference could be found pre, post or final test of the two classes.

One-way Analysis of Variance (ANOVA) F(5, 101) = 11.05	
Pre test conventional <-> pre test Swiki	No significance
Post test conventional <->post test Swiki	No significance
Final test conventional <-> final test Swiki	No significance
Pre test conventional <->post test conventional	p< 0.001
Pre test Swiki <-> post test Swiki	P< 0.01

table 22: Increase in confidence in correct answers between pre, post and final test: Analysis of variance

We also wanted to find out whether students had a high degree of confidence in their answers that turned out to be incorrect. This is also important to show if students are aware of the mistakes they make, or at least get 'a feeling' about what could be wrong. For this purpose we multiplied the security factor (3 = totally sure; 2: partially sure; 1: not sure at all) with each wrong answer, and calculated the sum for each student. We found a decrease (not significant) in the confidence in the wrong answers between pre- and post test. Again, no statistical differences between the classes could be found (see table 23, figure 24 and table 24).

		Pre test	Post test	Final test
	Amount of questions	Confidence in wrong answers: average(standard deviation)	Confidence in wrong answers: average(standard deviation)	Confidence in wrong answers: average(standard deviation)
Conventional Class	19	18.24 (4.6)	15.41 (3.8)	13.9 (3.6)
Swiki Class	19	16.6 (5.6)	13.5 (5.1)	12.18 (4.9)

table 23: Average of confidence in incorrect answers between pre-, post- and final test.

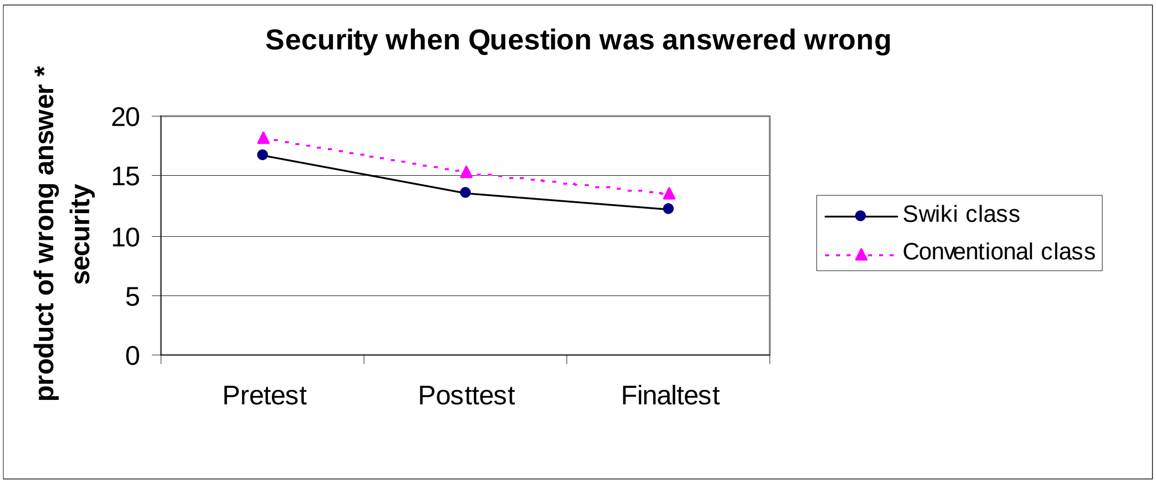


figure 24: Average of confidence in incorrect answers between pre post and final test.

One-way Analysis of Variance (ANOVA) F(5, 101) = 4.016	
Pre test conventional <-> pre test Swiki	No significance
Post test conventional <->post test Swiki	No significance
Pre test conventional <->post test conventional	No significance
Pre test Swiki <-> post test Swiki	No significance

table 24: Increase in confidence in incorrect answers between pre and post test: Analysis of variance

4.5.3 Development of unknown answers

Students also had the possibility of responding that they did not know the answer to the question. We wanted to know whether the average number of unknown answers decreased between pre and post test. Our results indicate a decrease in unknown answers between pre and post test (no significance). The number of answers in the pre test for the Swiki class was higher than in the pre-test for the conventional class, although this was not statistically significant. The number of unknown answers in the post-test is similar between the two classes (see table 25 and figure 25). There is also a decrease between pre test and post test for both classes (no significance). An increase in the quantity of unknown answers can be seen between the post test and final test of the Swiki class, while in the conventional class a small decrease can be seen.

		Pre test	Post test	Final test
	Amount of questions	Number of unknown answers: average(standard deviation)	Number of unknown answers: average(standard deviation)	Number of unknown answers: average(standard deviation)
Conventional Class	19	1.7 (1.6)	0.6 (0.6)	0.5 (0.5)
Swiki Class	19	2.5 (2.0)	0.8 (0.8)	0.9 (0.8)

table 25: Average number of unknown answers in pre- and post test.

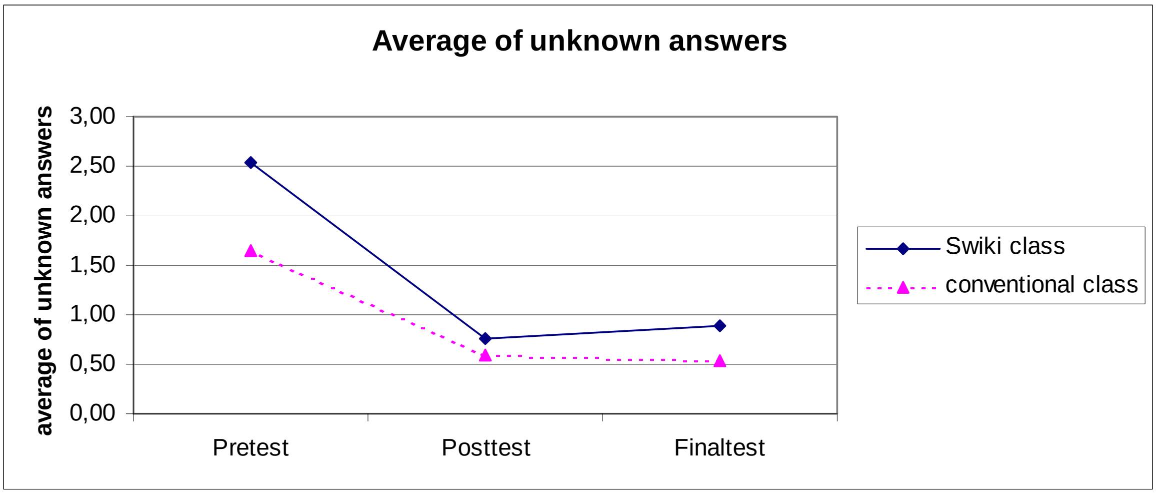


figure 25: Average number of unknown answers in pre-, post- and final test.

One-way Analysis of Variance (ANOVA) $F(5, 101) = 6.213$	
Pre test conventional <-> pre test Swiki	No significance
Post test conventional <->post test Swiki	No significance
Pre test conventional <->post test conventional	No significance
Pre test Swiki <-> post test Swiki	$p< 0.01$

table 26: Average of unknown answers in pre- and post test: Analysis of variance

4.6 General conclusions about the different tests

For both the Swiki and the conventional classes, the increase in knowledge was comparable, an astonishing result considering the difference in academic capabilities between the two classes. We did not expect a similar increase in knowledge from the vocational high school class, as we assumed that they would need more time to achieve the same level of knowledge.
The performances of the two classes can be compared not only concerning the factual knowledge. The questions about security of answers showed similar independent results (amount of correct answers is independent from the security of correct, the security of wrong answers and the number of answers they answered as ‘not know’). **All these results point out that the two classes showed the same performances in the different tests. The metacognitive performance of the Swiki class seems to be slightly better** (see 4.6.2).

4.6.1 Factual knowledge

Our experience in teaching students of vocational high school show a deeper performance compared with normal high school. The performance of the high school class with the conventional script is also good and comparable with performances of other classes in preceding years. The measured performance of the vocational class working with the structuring script and the Swiki can be compared with the performance of a normal high school class in a conventional unit. **We conclude that students of the vocational class were deeply involved in the subject and felt at ease with the set up. Based on their capacities they showed a better performance than the students of the normal high school. The better performance in factual knowledge is caused by the set-up we used. Comparing and commenting the work of the learning community seems to be an important factor and has a positive influence on the increase of factual knowledge.**
The increase of factual knowledge may not be the central evaluation point for such constructivist curricula but this parameter permits an easy comparison. To compare other capacities we wanted to find out weather students were aware of what they knew and whether they were sure about their answers.

4.6.2 Awareness of personal knowledge

Student’s confidence in correct and wrong answers was similar in both classes. We can see a slightly better performance for the Swiki class concerning the confidence in wrong answers. For the confidence in correct answers the conventional class showed a slightly better performance. We would say that students of the Swiki class had either a better confidence in what is correct or they did not risk as much as the other students or may be they answered the questionnaire more accurately.

The number of questions students of the Swiki set up did not know decreased between pre and post test. **We conclude that they became surer about the subject** or may be they learned to take more risks when they answered the questionnaire. The risk hypothesis is not according to the results of the confidence in correct and wrong answers.

Over all questions the Swiki class showed a better confidence in their personal knowledge. We tend to say that scripting permits and forces students of the Swiki class to think more about what they know and what they do not know. Thinking about what is known and what should be known are metacognitive skills. **We conclude that structured script and collaborative tool lead to better metacognitive performances.**

4.6.3 Final test

The performances shown in the final test were astonishing. We were not supposed to have an increase of knowledge and security. In other publications after this amount of time normally the knowledge level decreases because students forget some facts.

We searched possible reasons for it. The first explanation may be that students could see the answers of the questionnaire after the post test. They were displayed on the evaluation site so that students could see which mistakes they made. After the test the file was removed from the server.. We did not tell students that there would be another test with the same questions after the holidays. We also asked the students whether they had the answers for the final test but they denied having them.

Another possibility is that students could remember more details once they had seen the answers because they could make associations to what they knew. We presume that they must have learned many things related to the questions and so they could just associate the correct details for the answers (we remember that the questions were quite difficult). We conclude that for both set-ups they had a good learning performance. **The two compared set-ups correspond with constructive learning environments. Following the theory such an environment should enforce the long term learning effect. The final test confirms this theory. We could not statistically prove a better performance for the Swiki scripting, but a tendency for better performance can be seen** (table 19).

4.7 Comparison of the summaries produced in the two embryology classes: Results

As mentioned in chapter 3.7.3.3. and 3.7.3.4., students of both classes had to write summaries of different subjects related to the learning unit. The goal of these summaries was to permit all members of the learning community to see and understand the work of any particular group, and to enlarge their knowledge about the treated subject matter. We compared the texts produced by the members of each class in the following manner:

- Length of the summaries
- Number of topics treated
- Quality of the content of the summaries (judged by the teacher)

4.7.1 Length of the summaries

The length of the summaries was decidedly different between the two classes. To measure this we printed out all summaries with the same character size and took the pictures off. For the Swiki class we had **36 pages** (without all comments) of output while for the conventional class we had **10 pages**. Even if we consider that more students worked in the Swiki class (not all of these students wrote pre- and post tests), the difference in the amount of output is considerable.

4.7.2 Number of topics treated

Here we found a considerable difference between the two classes. While the conventional class published summaries of **9 different topics,** the Swiki class completed summaries on **14 different subjects**. Some summary subjects were proposed by the teacher. The conventional class chose the proposed titles, while the Swiki class changed the titles and added new ones.

4.7.3 Quality of the summaries

It is difficult to find objective criteria for assessing the quality of a descriptive text. When two texts concerning the same subject are being compared, the assessment is a little bit easier. For our research we did not specify the title and or the subject for the summary that the students had to produce. They were simply instructed to write about an important aspect of the unit. Within the area of embryology, there is a myriad of possibilities of different subjects to write about, and it was important for us to let the students chose what they wanted to discuss. In Between the two classes we found some summaries about the same subject, which was to be expected since we proposed some topics to give a starting idea to the students.
Another difficulty with judging the quality of the summaries was the fact that for the Swiki class we found many ‘patchwork’ summaries. The ‘patchwork’ summaries occurred when different groups added paragraphs or subunits to a summary. This was not possible in the conventional class.

Unlike the conventional summaries, the ''patchwork' summaries could not be attributed to only one or two authors. Finally, the structures of the summaries also differed, in part due to the possibilities of the Swiki. In the Swiki group, we found an interwoven hypertext, compared to the conventional class, which tended to produce more linear texts with some pictures included.

However, despite the discrepancies between the two summaries of the two classes, we still attempted to compare the 'quality' of the produced texts.

We found four summaries with the same titles but not same the focus. The summaries were all written accurately, however one big contextual mistake was found in the conventional class. In general, though, we judged the quality of the summaries between the two classes as about comparable: **two summaries were written better by the Swiki class, and two were written better by the conventional class**.

Considering all aspects of the summaries, if the teacher had graded each class' summaries, the Swiki class would have earned a better mark, due to the larger variety of treated subjects and the longer texts of comparable quality to the texts of the conventional class.

4.7.4 Structure of the Hypertext created with the Swiki

We wished to analyse the structure of the pages produced by the students in the Swiki class. They were instructed to add a quick editing section at the bottom of each of their created sites (see figure 13), where we expected other students to write their comments. We found 93 comments in the Swiki at the end of the learning unit, in addition to some comments and questions which had been created while the work was going on, but had been erased by the authors of the summary. There were several different types of comments:

- Semantic questions (I do not understand this word, sentence..)
- pragmatic questions (why did you choose this sub-subject? It is not related to the main theme
- Personal opinions (I do not like the way you explain this for the following reason, or your page is very interesting; I did not know that…)
- Advice (have a look to the following page, article…)

We also counted the number of links in the Swiki and found **20 external and 41 internal links.** An internal link is considered a pointer, created by a student within a single page or from one page to another in the Swiki, and there were just 5 pointers pointing to the same page. The Links to the start page with the index were not included in this sum.

4.8 Conclusion about the summaries of the embryology units

The longer and more diverse summaries of the Swiki class are an important point to consider when judging the students' performance. Both classes had the opportunity to search information in the web and introduce it into their summary, and both classes had similar levels of internet competence. The Swiki class found a greater number of interesting subjects, and were better able to relate them to their task. They were more aware of the work of the other members of the class, and effectively judged their inputs through their comments and questions. **They developed metacognitive skills through association and linkage of different concepts.**

We conclude that the quality of the summaries of the class working with an additional tool is better than for the class working in a conventional way.

5 Final conclusions

This chapter summarises the previous conclusion chapters and terminates this dissertation. We will try to create an overview of our experiences during this process of teaching and research, and give some perspectives for the future.

Three different learning units embedded in a normal biology curriculum of high school students were set up. The first unit was about the creation of a collaborative dictionary, the second concerned the publication of different summaries about human anatomy, and the third unit treated human embryology. The first two units described the handling of the collaboration tool and there the results focussed on the ‘usability’ of the software. The third and main unit compared two classes: one using a computer supported collaboration tool (a Swiki) and the other having a classical set up. There we compared in different tests (pre, post and final test) the increase of factual knowledge and the confidence in the answers of the students.

Our main goal was to apply theoretical settings of constructivist, action based learning in real learning environments and check out student’s reactions, their productions and their learning efficiency.

- **Active:** the students’ mindful processing of information and responsability toward their specific product, but also toward the product of the whole learning community. They actively manipulate objects and reflect upon what they have accomplished. Concretely they compose hypertexts, compare them with the ones of other members of their class, judge and comment the other texts and link the different concepts.
- **Complex:** students manage to deal with complex concepts without the didactical transposition of the treated subjects. We set up concrete problems without creating special simplifications within concepts or facts; e.g. for the unit about embryology we started by the question why abortion in Switzerland can take place within the firs 12 weeks of pregnancy? The concrete question used in the text of law has been used for introduction. The answer of this question implies a complex approach.
- **Collaborative:** students modelled and observed the contributions of all other members of the learning community. To answer such complex questions different points of view need to be kept in mind and discussed. Students elaborated the different concepts and exchanged their experiences.
- **Constructive:** the students’ construction of a sense of meaning for different phenomena, and the defense of their own opinion through publication of results and comments on other inputs.
- **Conversational:** the social, dialogical process takes place not only within the community, but is also extended to include parents and friends, and even a midwife (in the evolutionary Swiki).

We called our set-ups: Action based, hypertext - constructive, computer supported, collaborative learning units (ABAHCOCOSUCOL).

We reinforced students' metacognitive capacities by permitting a high degree of self regulation, self –observation, self-judgement, and self-reaction (Davidson, 1995, Schönfeld 1987). We implemented feedback mechanisms to enhance comparison and commenting on the work of all members of the community, in order to also encourage the process of self-observation by the students of their own work and processes..

We set up a computer-mediated group activity where the Swiki takes the role of an individual and a group artefact, relating to the activity theory approach of computer as 'extention tools' (see p. 23 and Nardi 1996). We also chose to use the term 'action' to describe an operational work unit of a student or a group of students. This choice is connected to the goal- related notion of the term 'action'. Other researchers choose the term 'activity', however we believe that 'action' fits better to what students do (produce, think, and manage) while learning. We built our conclusions on action which (following activity theory) is always situated to a context and it is impossible to understand without it. Our scenarios were embedded in a normal curriculum and took place in normal classrooms. t This learning situation is perfectly comparable to usual lessons.

We **emphasized** two factors within our learning units: 'scripting' and the 'supporting tool'. These factors were difficult to separate for the analysis because of their degree of overlap. The importance of scripting has to be pointed out because in a hierarchical model the script would be placed in a higher position than the supporting tool (to prepare a unit a teacher should first decide what he or she wants to do, and then decide which methods and tools he or she will use).

All our set-ups were efficient. Students were at ease and showed good performances compared to similar courses lead in the past. The adopted scripting strategies fulfilled our goals, and the tool turned out to have a good degree of usability. We stressed the usefulness of the Swiki under different environments and found **a better performance of the tool in combination with a structured scripting environment.** As well, we directly compared two classes, with one class working with the Swiki and the other without, and concluded that **the work with the Swiki lead to a better learning performance when all factors were considered** (see chapter 5.2). Here again we point out the cross-linking of tool and scripting: the Swiki permitted a scripting strategy that reinforced exchange, comment and comparison. We attribute the superior performance of the Swiki class to these three factors, which were induced by the script and reinforced through the tool.

Summarising the results, three suggestions can be formulated for further analyses and for teachers who would like to set up a similar scenario: These suggestions concern performance, scripting strategies, and the tool used.

5.1 Learning performance in action based, hypertext – constructive, computer supported, collaborative learning units (ABAHCOCOSUCOL)

A student's performance is an integral element in evaluating any teaching method. Depending on the specific goal of the unit, a good performance may mean such different things as:

- **Good factual knowledge**.
  Comparison of two units where one (vocational high school with presumed lower pedagogical performances) class worked in an ABAHCOCOSUCOL and the other normal

high school class in a conventional set up showed a comparable increase of factual knowledge.

- **Long-term knowledge retention**.
  A final test six weeks after the end of the unit delivered the slightly better performances than a test performed just after the unit finished.
- **Mastering a certain problem-solving strategy.**
  To construct the hypertext, link concepts and distil relevant information to regroup concepts is a sustained skill during the work with the hypertext.
- **High quality of produced work.**
  The produced inputs were longer and the choice of themes in the hypertext were waster in an ABAHCOCOSUCOL compared to a conventional learning environment.
- **Have a good use of some specific handling.**
  Students got a good introduction in web publishing and managing of hypertexts
- **Increased metacognitive skills.**
  Students had to comment all other inputs of the members of the class. Arguing about the quality of the work of the community forces the awareness of the personal thoughts and produced work.

For an ABAHCOCOSUCOL we point out the high quality of the product, the good long-term learning effect, and the definite increase of factual knowledge. To reach an optimal performance it is crucial to create and support an active and intense exchange between members of the community. We compared scenarios were the exchange between students differed and found a better performance and satisfaction of students learning in units were the exchange had been sustained and reinforced.

5.2 Scripting strategies

Scripting for ABAHCOCOSUCOL can be cut in four phases:

- Initiation
- Comparison
- Re-grouping
- Discussion

An initiation phase leads students into the problem and gives them an indication for an appropriate first action. For this phase, there is no big difference between an ABAHCOCOSUCOL and conventional teaching. The comparison phase is very important and should start immediately after the unit is up and running. Here a difference from conventional constructive learning can be seen, where a comparison between the work of all members of the learning community is difficult to set-up, and such an environment of commenting and comparing cannot be easily created. The comparison phase then leads into the re-grouping of the produced work, which aids in the construction of mental models of the different concepts and is fruitful for learning. This sets the stage for the discussion phase, and the feedback and comment culture described above leads to a re-grouping of the content.

These phases can be repeated more than once. At the end of the learning unit a discussion should give students the opportunity to formulate and discuss different opinions or concepts.
The positive feedback cycle of production, comparison, and re-grouping can also be formulated in the following way (see figure 26):

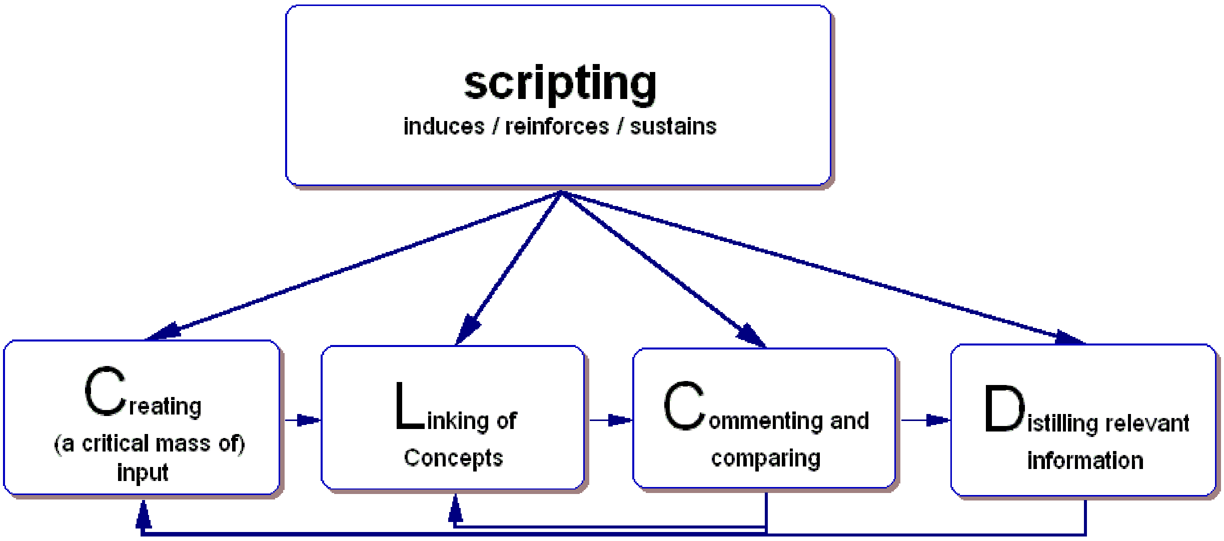


figure 26: Scripting for action based, hypertext –constructive, computer supported, collaborative learning units (ABAHCOCOSUCOL).

The scripting input leading to the creation of input is important at the beginning of the unit. Here we call it 'creation of a critical mass of input'. Students should immediately compare and comment the works of the other to augment the interactions between the learning community. Scripting should induce students to publish what they have produced as soon as possible and it should be mentioned that there will be an 'evolution' of the text during the unit due to the comments and questions of the other members of the community. The 'critical mass' of input at the beginning is important for the start of interactions and creation of the communication culture. Of course other 'creating inputs' can be made during the learning unit for instants when new questions rise.
The linking of concepts is important for the awareness of the common goal and the cross-linkage of the treated concepts of the unit. The learning community creates one collaboratively elaborated hypertext where the different pages are interwoven and linked together. Creating links sustains the awareness of the community and gives a basis for the comments and comparisons produced as a further action of the students. Finally the distillation and re-grouping of relevant information leads to an self evaluation of the product of the learning community.

5.3 Swiki is an appropriate tool for ABAHCOCOSUCOL

The unstructured collaboration tool was well-adapted to our needs. It turned out to be easy enough to use after a 20 minute introduction, it was stable enough to permit the focalisation of content production, and it was open enough to adapt its structure and strategies while the units were running. Furthermore, it permitted a good level of collaboration without other communication tools such as forums or chat groups, and it could be adapted to different subjects, and to fit the needs of the different classes. Students liked to publish articles but they did not like so much to comment the work of other members. The creation and support of a feedback culture turned out to be important for learning success. Scripting should intervene here and support the communication culture. Swiki turned to be an optimal tool for small and medium projects. We did not test any bigger learning projects with long inputs about different subjects. We can imagine that such project need different conception and a more structure within the produced document. We tried to sustain input quality and quantity without regarding structure.

5.4 Tip's for the teacher who wants to set up a ABAHCOCOSUCOL

The following guidelines should be considered by teachers who are setting up a Swiki for ABAHCOCOSUCOL:

- Watch the structure of the entry page
- Be aware of editing conflicts
- Give a short introduction to the tool
- Be careful of signatures and references, and mention it whenever it is possible
- Prepare the main inputs and the guiding scripts
- Build a hypothetical framework of core mechanism(s) to foster the pedagogical goal and the actions of the students for every sub unit of you course
- Create a feed-back culture from the beginning on. Induce students to interfere and intervene in a constructive way in the actions of other members of the class

The size of the Project has a big impact on the structure of the constructed hypertext. While for smaller projects (one or two classes working for five to eight lessons) no specific structuring is necessary for larger projects it is important to steer the development of the hypertext in order to build up indicators for main concepts and additional information.

5.5 Perspectives

Our set-up describes learning units bound to biology lessons in high school. **The principal settings of our** ABAHCOCOSUCOL **can be used for a large range of educational purposes. They are not bound to a specific school subject or to a learning environment where students and teacher see each other regularly.** The major advantages of our concept are:

- the wiki (=quick) set-up
- the considerable adaptability[26]
- the good usability of the tool
- the easy communication possibility
- the scalability of the system

[26] ABAHCOCOSUCOLS has also been adopted in a blended distance education cours about media-didactics with adults. The scripting strategies were the same; the performance of the participants was good as well as their satisfaction about the tool.
See: http://idefix.gymliestal.ch:8888/Mediendidaktik

Action-centred constructivist learning may include many elements other than the hypertext production that we focused on in our work. Research into the impact of such elements in 'real' learning situations has really just started. We hope that the experiences we gathered and the syndication of the methods and techniques will lead to a proliferation of these ideas to the many teachers and instructors in the educational community.

However, several long-term goals remain as-of-yet unrealised. It may be a long time before:

- Communication, Collaboration and Content management systems (C3MS) permitting ABAHCOCOSUCOL or similar learning units are so popular and easy to manage and set-up that they can be used by the average teacher.
- Teachers realise that the effort to set up an action-based unit is outweighed by the advantages of such a system, and the learning performance is good.
- Students will realise that the internet is a not just a platform for consumption, but permits an active participation and the construction of a new (better?) web.
- Teachers realise that constructive learning models as adopted frequently in 'normal classroom education' can easily be improved by additional computer tools.
- Teachers realise that they will not be replaced by a computer. They have to accept that for certain goals, a computer can be an efficient means of assistance for students. However, for certain other tasks such as action-centred settings, the teacher in the role of facilitator will always be necessary.
- Educational software developers realise that not every pedagogical goal can be realised by a system of one-way information transmission and subsequent examination.

What do we need to achieve these goals?

- We need a deeper knowledge of the impact of action-based scripting and how it can be improved in relation to the teacher, the students and the tools. The further development of software should be based on that research and not vice versa.
- We also need further long-term research to examine how this sort of learning environment influences students' behavior.
- Furthermore, we need facilitating tools adapted to the capacities of normal teachers, which means that they must be easy to manage, robust, and without too many options and gadgets.
- We need syndication for the quality and possibilities of such learning.
- Finally, we need the courage to argue against the prevailing tendency of many educational software producers to develop instruction-based, low-interaction forms of educational software.

Our work is a contribution to the second-generation Web[27], where the importance of the collaborative potential of the Web is pointed out, the two-way writing possibility is important and decentralisation of control of production is postulated.

[27] http://istpub.berkeley.edu:4201/bcc/Fall2001/feat.2ndgenweb.html

We have shown how it is possible to set up efficient constructive learning units with low technical knowledge and comparable time expense for the teacher. We analysed and described concepts and recipes for next-generation teaching and learning.

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7 Appendix

Nachtest Embryologie Klasse 2Db

Bitte füllen Sie das nachfolgende Formular wahrheitsgetreu aus. Die Resultate werden in meiner Abschlussarbeit publiziert werden.

Name: ☐

Vorname: ☐

Klasse: ☐

email: ☐

Fachbezogene Fragen:

Bitte beantworten Sie sowohl die eigentliche Frage (links) wie auch die Frage zur Sicherheit über ihre Antwort.
Falls Sie die Frage links mit 'Ich weiss es nicht' beantworten, dann kreuzen Sie rechts: 'gar nicht sicher an'!

3. Frage:
Was ist ein Embryo?

<table>
<tr><td>Ein ungeborenes Kind kurz vor der Geburt</td><td>☐</td><td rowspan="5">Bin mir meiner Antwort:
ganz sicher: ☐
ziemlich sicher: ☐
gar nicht sicher: ☐</td></tr>
<tr><td>Eine noch nicht befruchtete Eizelle</td><td>☐</td></tr>
<tr><td>Ein ungeborenens Kind vor der Fötalphase</td><td>☐</td></tr>
<tr><td>Ein ungeborenes Kind nach der Fötalphase</td><td>☐</td></tr>
<tr><td>Ein ungeborenes Kind vor der 18. Schwangerschaftswoche</td><td>☐</td></tr>
</table>

Ich weiss es nicht	☐	

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4. Frage:
Was ist ein Fötus

Ein ungeborenes Kind vor der Embryonalphase	☐	Bin mir meiner Antwort: ganz sicher: ☐ ziemlich sicher: ☐ gar nicht sicher: ☐
Eine noch nicht befruchtete Eizelle	☐	
Ein ungeborenens Kind nach der Embryonalphase	☐	
Ein ungeborenes Kind ganz am Anfang der Schwangerschaft	☐	
Ein ungeborenes Kind vor der 18. Schwangerschaftswoche	☐	
Ich weiss es nicht	☐	

---

5. Frage:
Was ist die Plazenta?

Der obere Teil der Gebärmutter, dort wo sich das Ei einnistet	☐	Bin mir meiner Antwort: ganz sicher: ☐ ziemlich sicher: ☐ gar nicht sicher: ☐
Der mütterliche Teil der Verbindung zwischen Mutter und Kind	☐	
Der kindliche Teil der Verbindung zwischen Mutter und Kind	☐	
Der Mutterkuchen	☐	
Chorion und Alantois ohne proximale Nabelschnur	☐	
Ich weiss es nicht	☐	

---

6. Frage:
Welche Substanzen passieren die Plazenta

Alle Proteine, Kohlenhydrate, Fette; keine Gase	☐	Bin mir meiner Antwort: ganz sicher: ☐
Alle Substanzen ausser Gasen	☐	
Keine Substanzen, ausser Nährstoffen	☐	

Nährstoffe, einzelne Gase, einige Medikamente und Bakterien	☐	ziemlich sicher: ☐
Nährstoffe, einzelne Gase, Alkohol und einige Viren	☐	gar nicht sicher: ☐
Ich weiss es nicht	☐	

7. Frage:
Wann ist die Bildung der Organanlagen abgeschlossen?

Nach der 24. Woche	☐	Bin mir meiner Antwort:
Nach der Fetalphase	☐	ganz sicher: ☐
Nach der Embryonalphase	☐	ziemlich sicher: ☐
Nach der 6. - 7. Woche	☐	gar nicht sicher: ☐
Nach der 11. - 12- Woche	☐	
Ich weiss es nicht	☐	

8. Frage:
Wie lange dauert eine 'normale' Schwangerschaft in Wochen?

38	☐	Bin mir meiner Antwort:
39	☐	ganz sicher: ☐
40	☐	ziemlich sicher: ☐
41	☐	gar nicht sicher: ☐
42	☐	
Ich weiss es nicht	☐	

9. Frage:
Was versteht man unter dem Begriff 'Abort'?

Das Punktieren des Fruchtwassers vor der 12 Woche	☐	

Das Verlieren des Kindes vor der 28. Woche	☐	Bin mir meiner Antwort: ganz sicher: ☐ ziemlich sicher: ☐ gar nicht sicher: ☐
Das Einsetzen von Blutungen während der Schwangerschaft	☐	
Das Einsetzen von Wehen vor dem Geburtstermin	☐	
Die Geschlechtsbestimmung des Kindes mittels Ultraschall	☐	
Ich weiss es nicht	☐	

---

10. Frage:
Wann findet die Befruchtung der Eizelle bei einer Zyklusdauer von 28 Tagen statt?

6 Tage vor dem Einsetzen der neuen Menstruation	☐	Bin mir meiner Antwort: ganz sicher: ☐ ziemlich sicher: ☐ gar nicht sicher: ☐
Unmittlebar vor dem Einsetzen der Menstruation	☐	
Bis zu 24 Stunden vor dem Eisprung	☐	
Bis zu 24 Stunden nach dem Eisprung	☐	
Mehr als ein Tag nach dem Eisprung	☐	
Ich weiss es nicht	☐	

---

11. Frage:
Wo findet die Befruchtung der Eizelle statt?

Im Eierstock	☐	Bin mir meiner Antwort: ganz sicher: ☐ ziemlich sicher: ☐ gar nicht sicher: ☐
Im Cervix	☐	
In der Gebärmutter	☐	
In der Scheide	☐	
Im Eileiter	☐	
Ich weiss es nicht	☐	

---

12. Frage:
Wie lange können Spermien im weiblichen Körper überleben?

36 Stunden	☐	Bin mir meiner Antwort: ganz sicher: ☐ ziemlich sicher: ☐ gar nicht sicher: ☐
48 Stunden	☐	
72 Stunden	☐	
96 Stunden	☐	
120 Stunden	☐	
Ich weiss es nicht	☐	

13. Frage:
Von welchem Zeitpunkt an ist eine Frühgeburt ohne apparative Unterstützung überlebensfähig?

Ende 19. Woche	☐	Bin mir meiner Antwort: ganz sicher: ☐ ziemlich sicher: ☐ gar nicht sicher: ☐
Ende 28. Woche	☐	
Ende 33. Woche	☐	
Ende 36. Woche	☐	
Ende 38. Woche	☐	
Ich weiss es nicht	☐	

14. Frage:
Zu welchem Zeitpunkt der Schwangerschaft sind Missbildungen des Kindes besonders folgeträchtig?

Gegen Schluss der Schwangerschaft, da das Kind schon fast fertig ist und der Körper sich nur noch wenig regenerieren kann	☐	Bin mir meiner Antwort: ganz sicher: ☐ ziemlich sicher: ☐ gar nicht sicher: ☐
Gegen Schluss der Schwangerschaft, da sich das Gehirn zu diesem Zeitpunkt besonders stark entwickelt	☐	
Am Anfang der Schwangerschaft, weil die betroffenen Zellen sich stark teilen und somit der Schaden gross ist	☐	
Am Anfang der Schwangerschaft, weil sich die missbildeten Zellen noch stark teilen und zu diesem Zeitpunkt noch einen starken Einfluss auf die anderen Zellen ausüben	☐	
Ist in jedem Stadium der Schwangerschaft gleichermassen folgeträchtig	☐	
Ich weiss es nicht	☐	

15. Frage:
Ist die Abtreibung in der Schweiz erlaubt?

Nein	☐	Bin mir meiner Antwort: ganz sicher: ☐ ziemlich sicher: ☐ gar nicht sicher: ☐
Ja, während der gesammten Schwangerschaft falls die Frau vergewaltigt wurde	☐	
Ja, vor der 12. Woche wenn für die Mutter oder das Kind durch die Schwangerschaft ein Schaden oder eine seelische Notalge entstehn kann	☐	
Ja, während der gesamten Schwangerschaft wenn das Kind körperliche oder geistige Anomalien aufweist	☐	
Ja, vor der 12. Schwangerschaftswoche	☐	
Ich weiss es nicht	☐	

16. Frage:
Welche Folgen für das Kind kann übermässiger Alkoholkonsum der Mutter während der Schwangerschaft haben?

Die Folgen werden meist erst nach den ersten Lebensjahren sichtbar: eher tiefer Intelligenzquozient wird oft nachgewiesen	☐	Bin mir meiner Antwort: ganz sicher: ☐ ziemlich sicher: ☐ gar nicht sicher: ☐
Das Kind ist bei Geburt kleiner und leichter	☐	
Das Kind ist retardiert (= Entwicklungsrückstand gegeüber anderen Kindern)	☐	
Bis heute konnten wissenschaftlich keine Folgen nachgewiesen werden	☐	
Das Kind ist in seiner motorischen Entwicklung gehemmt	☐	
Ich weiss es nicht	☐	

17. Frage:
Wie lange ist eine Eizelle befruchtungsfähig?

12 Stunden	☐	Bin mir meiner Antwort: ganz sicher: ☐
24 Stunden	☐	
36 Stunden	☐	
48 Stunden	☐	

72 Stunden	☐	ziemlich sicher: ☐
Ich weiss es nicht	☐	gar nicht sicher: ☐

18. Frage:
Was bedeutet der Begriff 'Chorion'?

Mütterliches Gewebe der Plazenta	☐	Bin mir meiner Antwort:
Kindliches Gewebe der Plazenta	☐	ganz sicher: ☐
Kindliches Gewebe der Nabelschnur	☐	ziemlich sicher: ☐
Gewebe, das sich im Fruchtwasser befindet	☐	gar nicht sicher: ☐
Gewebe der Gebärmutter	☐	
Ich weiss es nicht	☐	

19. Frage:
Was ist eine Eileiterschwangerschaft?

Wenn das Ei im Eileiter befruchtet wird	☐	Bin mir meiner Antwort:
Wenn ein Ei zu spät in die Gebärmutter hinunterwandert	☐	ganz sicher: ☐
Wenn die Eileiter stark vergrössert sind und und sich das Ei dort einnistet	☐	ziemlich sicher: ☐
Wenn sich das Ei im Eileiter einnistet	☐	gar nicht sicher: ☐
Wenn sich die Eileiter während der Schwangerschaft krankhaft verändern	☐	
Ich weiss es nicht	☐	

20. Frage:
Zu welchem Zeitpunkt der Schwangerschaft findet die Einnistung des befruchteten Eis statt?

Ein Tag vor der Befruchtung der Eizelle	☐	Bin mir meiner
Unmittelbar vor der Befruchtung der Eizelle	☐	ganz sicher: ☐
Ein Tag nach der Befruchtung der Eizelle	☐	

Einige Tage nach der Befruchtung der Eizelle	◻	ganz sicher: ◻ ziemlich sicher: ◻ gar nicht sicher: ◻
Eine Woche nach der Befruchtung der Eizelle	◻	
Ich weiss es nicht	◻	

21. Frage:
Welche Aufgabe hat das Fruchtwasser?

Miternährung des Kindes	◻	Bin mir meiner Antwort: ganz sicher: ◻ ziemlich sicher: ◻ gar nicht sicher: ◻
Schutz des Kindes vor Druckeinwirkungen von aussen und vor Austrocknung	◻	
Schutz vor grossen Temperaturschwankungen (Kälte und Wärmeschutz)	◻	
Schutz vor lauten Geräuschen (Schallschutz)	◻	
Schutz vor Krankheiten (Immunschutz)	◻	
Ich weiss es nicht	◻	

22. Frage:
Für den Mann: Ihre Freundin ist ungewollt schwanger; für die Frau: Sie sind ungewollt schwanger geworden.
Wie gehen Sie mit dieser Tatsache um? Formulieren Sie sachlich, welche Schritte Sie in den nächsten sechs Wochen zu unternehmen gedenken, falls Sie abtreiben möchten.

Name dieses Feldes :proabort.

23. Frage:
Sie sind seit einem Jahr in einer festen Beziehung und Ihre Ausbildung dauert mindestens noch ein Jahr. Sie (bzw. Ihre Partnerin) werden schwanger. Welche

Gründe sprechen gegen bzw. welche für eine Abtreibung? Beantworten Sie diese Frage in zwei bis drei Sätzen.

Name dieses Feldes :contraabort.

Allgemeine Fragen:

25. Frage:

Nennen Sie 5 verschiedenen Arten der Schwangerschaftsverhütung.

1. ; 2. ; 3,

4. ; 5.

Persönliche Fragen zum Swiki und die Gruppenarbeit:

Frage 1:
Sie haben sich wohl gefühlt bei der Arbeit mit dem System (Webseite).

Ich weiss nicht	trifft zu	trifft teilweise zu	trifft nicht zu

---

2. Frage:
Sie hatten Schwierigkeiten mit der Formulierung der Texte und dem Editieren von neuen Seiten.

Ich weiss nicht	trifft zu	trifft teilweise zu	trifft nicht zu

---

3. Frage:
Das Editieren ist zu kompliziert. Es behindert die Arbeit.

Ich weiss nicht ◉ trifft zu ○ trifft teilweise zu ○ trifft nicht zu ○

4. Frage:
Die Arbeit mit dem Computer hat Ihnen Spass gemacht.

Ich weiss nicht ◉ trifft zu ○ trifft teilweise zu ○ trifft nicht zu ○

5. Frage:
Ihr Partner und Sie haben während der Arbeit oft über das betreffende Thema diskutiert.

Ich weiss nicht ◉ trifft zu ○ trifft teilweise zu ○ trifft nicht zu ○

6. Frage:
In der Gruppe waren Sie immer der gleichen Meinung bezüglich den besprochenen Themen.

Ich weiss nicht ◉ trifft zu ○ trifft teilweise zu ○ trifft nicht zu ○

7. Frage:
Sie waren effizient.

Ich weiss nicht ◉ trifft zu ○ trifft teilweise zu ○ trifft nicht zu ○

8. Frage:
Beim Lesen und editieren der Seiten Ihrer Klassenkameraden haben Sie neue, wichtige Erkenntnisse gewonnen.

Ich weiss nicht ◉ trifft zu ○ trifft teilweise zu ○ trifft nicht zu ○

9. Frage:
Wie lange brauchten Sie, um zu lernen, im Swiki eine Seite zu lesen?

konnte ich sofort	3 - 5 Minuten	eine Stunde	Einen Tag

10. Frage:
Wie lange brauchten Sie, um zu lernen, im Swiki eine neue Seite zu erstellen?

konnte ich sofort	3 - 5 Minuten	eine Stunde	Einen Tag

11 . Frage:
Wie lange brauchten Sie, um zu lernen, im Swikiin einer neuen Seite einen Text zu editieren?

konnte ich sofort	3 - 5 Minuten	eine Stunde	Einen Tag

12. Frage:
Sie lernten in dieser Unterrichtseinheit mehr von meinen Klassenkameraden als vom Lehrer.

Ich weiss nicht	trifft zu	trifft teilweise zu	trifft nicht zu

13. Frage:
Die Arbeit mit dem Swiki empfand Sie als frustrierend

Ich weiss nicht	trifft zu	trifft teilweise zu	trifft nicht zu

14. Frage:
Es störte Sie, dass Jedermann im Swiki meine Seiten editeren kann..

Ich weiss nicht	trifft zu	trifft teilweise zu	trifft nicht zu

15. Frage:
Sie könnten sich vorstellen, in weiteren Unterrichtseinheiten mit einem Swiki zu arbeiten

Ich weiss nicht	trifft zu	trifft teilweise zu	trifft nicht zu

16. Frage:
Das Kommentieren der Seiten von anderen Gruppen war Ihenen peinlich, Sie wollten den anderen nicht zu nahe treten.

Ich weiss nicht	trifft zu	trifft teilweise zu	trifft nicht zu

17. Frage:
Das Thema hat Sie interessiert:.

Ich weiss nicht	trifft zu	trifft teilweise zu	trifft nicht zu

18. Frage:
Es war mühsam, die bereits erstellten Seiten wegen den Kommentaren der anderen Klassenmitglieder wieder zu ändern:.

Ich weiss nicht	trifft zu	trifft teilweise zu	trifft nicht zu

19. Frage:
Wie empfanden Sie die Rolle des Lehrers während der Erstellung der Zusammenfassungen?

Der Lehrer sass uns zu stark auf der Pelle:

Ich weiss nicht	trifft zu	trifft teilweise zu	trifft nicht zu

20. Frage:
Wie empfanden Sie die Rolle des Lehrers während der Erstellung der Zusammenfassungen?

Der Lehrer hat während der Arbeit zu stark interveniert mit (sicher gut gemeinten) Vorschlägen:

Ich weiss nicht	trifft zu	trifft teilweise zu	trifft nicht zu

21. Frage:
Wie empfanden Sie die Rolle des Lehrers während der Erstellung der Zusammenfassungen?

Durch die Vorschläge des Lehrers während der Arbeit hat sich die Qualität der Zusammenfassung verbessert:

Ich weiss nicht	trifft zu	trifft teilweise zu	trifft nicht zu

22. Frage:
Durch die Vorschläge und Kommentare der anderen Schülerinnen und Schüler (nicht Gruppenmitglieder) während der Arbeit hat sich die Qualität der Zusammenfassungen verbessert:

Ich weiss nicht	trifft zu	trifft teilweise zu	trifft nicht zu

Schlussbemerkungen:

Bitte auf den 'Eingabe' Knopf klicken nur wenn Sie alle Fragen beantwortet haben.

Eingabe

Anzeige löschen

DANKE FUER DIE BEANTWORTUNG DER FRAGEN