BREAKING WITH TRADITIONAL MULTIMEDIA COURSE DESIGN – SOME GUIDELINES OF THE SIMBA NETWORK

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Introduction

Easy to use, flexible learning components that support the learner in acquiring key concepts of informatics and follow up to date developments in didactics and technique are the dream of every course designer, lecturer and learner. In this paper we will present our approach to the development of e-learning materials that tries to overcome some drawbacks of a traditional fixed course design strictly oriented towards a curriculum in the hope to get closer to the above mentioned ideal.

The first part will explore the guidelines that led the design of our learning modules. We will explain why we think the approach to be flexible, sustainable and in particular suitable to support female learners. In our opinion setting up e-learning modules goes beyond simple webhosting of traditional materials. We propose an integrated approach where content selection and presentation naturally fit together. The second part of the paper draws a line between the theoretical foundations and the currently developed learning materials.

Project guidelines

We tried to design study materials that are helpful not only for students enrolled in computer science, but for the more and more common students majoring in another field and also qualifying in informatics. Another objective was: the units should be designed in such a way as to support and motivate the still underrepresented female students of computer science.

Which path we followed in designing learning components becomes visible if one carefully inspects the project title. USI standing for „Artificial languages as a universal approach to key concepts of informatics“ is one of seven projects at five universities to form the SIMBA network which stands for „Key concepts of informatics in distributed multi-media components under special consideration of the learning interests of women“. The projects are supported by the German Federal Ministry of Education and Research (BMBF), started in July 2001 and run until December 2003.

Taking the keywords as well as a further objective not yet mentioned, it sums up to the following:

- key concepts of informatics
- distributed multi-media components
- consideration of learning interests of women
- artificial languages
- sustainable integration into education.

These five issues will guide us through the first part of this paper.

Didactics along key concepts of informatics

In focusing on key concepts we cover most parts of informatics curricula, but not necessarily oriented towards specific university courses or lectures. The choice of concepts follows the criteria for *fundamental ideas* of informatics as defined in Schwill (1993). A fundamental idea meets the *horizontal criterion*, which means it can be observed manifold in various situations while at the same time putting on some systematics. A second criterion is the *criterion of sense* meaning that the idea is firmly established in everyday life and understood by common sense. The *vertical criterion* ensures that the fundamental idea can be made explicit and found in phenomena at different cognitive levels.

And finally the *time criterion* demands that an idea has a certain history in informatics and is of relevance for a longer period of time.

By applying these criteria to select key concepts one can be sure to cover vast areas of informatics knowledge touching a variety of topics on all cognitive levels. The different projects of SIMBA develop materials on areas like computer graphics or algorithms. The Potsdam USI project (www.informatikdidaktik.de/Forschung/SIMBA) covers the key concepts connected to languages. An overview is given in Table 1.

Table 1 Overview of projects within the SIMBA network

project partners	**subprojects** (Note that acronyms relate to German project titles)
Prof. Dr. Volker Claus University of Stuttgart	PAL: Profound algorithms
Prof. Dr. Gitta Domik University of Paderborn	CB: Computer generated pictures
Prof. Dr. Reinhard Keil-Slawik University of Paderborn	KE: Communication ergonomics
Prof. Dr. Johannes Magenheim University of Paderborn	DDI: Didactics of informatics
Prof. Dr. Peter Marwedel University of Dortmund	RaVi: Visualization of Computer Architecture
Prof. Dr. Sigrid Schubert University of Siegen	RvS: Computer networks and distributed systems
Prof. Dr. Andreas Schwill University of Potsdam	USI: Artificial languages as a universal approach to the key concepts of informatics

Another advantage of the orientation on key concepts becomes clear, when looking at our learning components from the user's point of view. Small fine-grained components that cover vast areas of informatics on different cognitive levels will be interesting for students with different needs and backgrounds. They can function as a complementary offer to full time university students in vocational training settings, or form a flexible alternative for part-time in-service training.

Sustainability

The development of electronic learning material is time-consuming and very expensive. So many projects try to develop entire self-contained multimedia courses and export them to as many as possible different educational institutions and settings (*horizontal sustainability*). The attempts are not very successful so far, since materials with a stringent lecture orientation and a fixed script often make it difficult if not impossible to be used by other lecturers. This is not only due to the closed content section but also to the fact that such material comes along with a fixed didactics and methodical approach. Teachers adopting such a complete course have to give up what makes them teachers – their personal and unique didactical and methodical approach to teach a certain subject. With our small units we hope to overcome this dilemma. Their size, wide-spread content and flexible didactic approaches make them easy to adapt and integrate them into courses and on different cognitive levels not only specific for informatics but also usable in other sciences. In the terminology of the project this is called *vertical sustainability*, a notion due to SIMBA partner Keil-Slawik.

What makes an approach to informatics via languages so special and universal?

The approach is universal, because languages can be found in various domains of informatics – starting with the omnipresent programming languages, via specification and command languages to query languages used in data bases. Moreover, there is a general tendency to state informatics problems through language even if there does not seem to be an obvious connection as in picture processing. The approach is simple, because when stating a problem using a language one can fall back on the well studied functionalities of languages – classification, manipulation and transformation. Every problem is reduced to a problem on words. When starting from the everyday concept of language and its use there is a smooth transfer to formal artificial languages, thus proving the criterion of sense.
These remarks already indicate that there must lay some fundamental ideas of informatics in the concept of language.

Multimedia technique and design

The area is widely discussed and various publications can be found, among them Holzinger (2001), Issing/Klimsa (2002), Vester (1998). At this point it will suffice to give a small overview and indicate some design choices specific to our project SIMBA.

Findings in learning theory and about online learning methods suggest that learning be more effective if it involves different senses, a variety of learning methods, changes in the information system. Supportive is also an adaptable learning time and grouping the knowledge pieces in practicable units. Learning with modern multi-media technique is often associated with an explorative style following the constructionist learning theory.
As for the technical part there are established standards for the design of online learning material. Every system should offer easy navigation and a consistent layout. A page should not be overloaded, make sparse use of colours, use a clear letter type.

A hemisphere adapted presentation of information guided our page design. The left hemisphere usually processes sequences in a logical-analytical style, whereas the right one works on information in a parallel holistic fashion. Therefore on a standard page we present pictures and small examples on a strip on the left hand side and text will fill the right hand part of the page.

Gender mainstreaming in a technical subject

What differences are there between female style and male style learning and how can we be supportive?

In Germany female students are underrepresented in informatics. The reasons for this are not quite clear, but probably a rather anxious attitude is already formed during schooling and within the family. Often noted are the following reasons (Metz-Göckel et al., 2002; Leufen 1994, Schubert/Schwill 2003):
Girls seem to underestimate their knowledge in technical subjects and their ability to acquire informatics knowledge. But not only self-conception of girls and young women differs from their actual abilities, also the role the gender takes in science teaching books is misleading. While boys are often shown actively experimenting and problem solving, girls mostly stay decoratively in the background.
Concerning natural sciences and technical subjects women often show to have a broad interest on interdisciplinary projects, a demand which is often not met in traditional style lessons. So the pure technical knowledge alone will not be as motivating as showing its relation to other study fields and its relevance for the society. This is also visible in the choice for enrolling in a university program. While there are 10% female students in *pure* informatics at the University of Potsdam, their proportion in interdisciplinary university programs is much higher – over 40% of the Magister program students where informatics is combined with one or two other subjects are female (numbers as of winter term 2002/2003).
Differences can also be observed in the use of computers and networks. While interactive components are appreciated by both – male and female students, young men widely use computers for playing games, whereas young women estimate the computer rather as a tool and for research purposes. For boys the computer often seems to be a device they want to master and fully understand. Women on the other hand rather want to know what it can be useful for, how does it fit in career plans, and what are its social effects.
Interesting is also what Röttger (1994) concludes from her analysis of studies on the use of (classical) media among the youth. Observable is a tendency that boys prefer visual media while girls more extensively use linguistical/auditive materials.

These findings suggest that it will be advantageous to offer a wide range of learning strategies and present informatics knowledge profoundly embedded into its usage and its social as well as cultural consequences. Our evaluation efforts have to be sensitive about differences of male and female style learning.

Details about USI

In the second part of the paper details of the implementation of the USI project are given along with their foundation in our guidelines.

Overall architecture and technical choices

At the bottom our architecture consists of *units*. Each unit covers one small topic and can be assigned to one of three cognitive levels, which are introductory, intensive and demanding. Picking out the concept of automata as language recognisers, such units on the different levels would be: 'Components and functionality of every-day automata, like ATMs', 'Components and capacity of finite automata (FA)', and 'Minimizing FA'. A unit is small enough to be worked through at once – taking from ten minutes up to an hour, if one follows all the examples and small tasks. Its content is divided on up to ten pages, but the average lays at around five. Naturally, there are more units on the intensive and the demanding level than on the introductory. Units on different cognitive levels that present knowledge instances covering the same topics are grouped together and called *theme* in our terminology. Themes are for instance 'Automata', 'Grammars' or 'Basics of recognition'. On the top level of our system's architecture there are *modules*. These can be more or less extensive, the core module covering four themes with over thirty units. This organisation is very helpful to the learner, since navigation displays exactly a unit's place within a module.

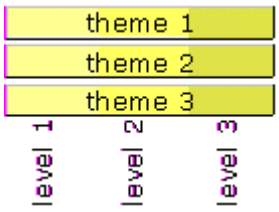

Figure 1: Module architecture

As noted before our page design is hemisphere adapted with graphical elements on the left hand side and text block taking up the right hand part. A page is integrated into a frameset that permanently displays the in-module navigation possibilities and some standard links as *home*, *content* and *contact*. At the bottom of each page one can find the unit-internal navigation that allows easy access to every page of the unit.

There is some minor drawback between our nice arranged page design (including navigation) and screen size. Though a survey among our students showed that there is still a small minority working with a resolution of 800 x 600 the modules are best viewed on 1024 x 768.

Our units are realised in static html. The technical choices were always based on the concern that the modules be easily accessed and used online and offline and as much as possible independent of technological developments and proprietary software products. Therefore, interactive page components rely on JavaScript. Graphics are saved in standard formats. Java is used for applications in order to ensure a usage on all platforms. This is done to support learners with restricted possibilities to access the internet and moderate computer systems. (For a large part female learners.)

This architecture conveys already how we met some of our guidelines. Though the overall architecture looks like a complete course on some concept, its flexibility is shown on the units level. On the one hand they are the right chunks for a learning session – in being complete and not taking too much time. On the other hand these small components are easily transferable to other learning contexts whether inside or outside informatics. To simplify the transfer an export interface is implemented. To find the appropriate learning component some information on content, size and technical requirements are given. Units, themes or special components below unit level (e.g. an interactive Java application or a gif-picture) can be downloaded. Since this is a standard feature of all projects in the SIMBA network, a course designer can select exactly those parts that enrich his or her lecture (vertical sustainability). Furthermore this architecture is reflecting the vertical criterion and the horizontal criterion for choosing key concepts. This knowledge organisation is also flexible enough to integrate new units. Their place is easily found by choosing the suitable theme at the proper cognitive level.

Different ways into learning

Following the findings that there are differences in acquiring informatics knowledge we offer different strategies for accessing our system:

- Scenario based
- Problem based
- Content based

In a scenario approach a learner goes quite passively through a sequence of scenes that present unusual aspects of everyday life situations. By this the learner could develop a certain awareness up to what point his or her acquired abilities will lead. It also exemplifies the embedding of informatics knowledge in other sciences or everyday life. A scenario shows the close connection of a key concept to notions of everyday life thus fulfilling the criterion of sense.
In the problem based approach a concrete (small) problem and everything the user will need to solve it is given. While solving the task the learner is faced with exactly the same difficulties that come along when handling artificial languages on computers. When working through the actual module that covers the topic of the problem the learner has already some basic competences and ideas.
Of course our system offers the possibility to start from some kind of a table of contents. But again, this is organised as a pyramid, so the learner can easily see which module forms the basis of another. This kind of representation conveys information not only on a textual level but also in a graphical dimension.

This method is bi-directional – a learner can be forwarded to some specific knowledge unit of the content area and vice versa, a unit can point to a scenario to make the relation to everyday life or other sciences clear.

Architecture of a typical unit

The in-module design varies, since we hope to find out through feedback and surveys, what advantages and disadvantages the actual users of our modules see.

In our module on recognising languages the first page of a unit gives an overview of the content in order to direct the learner to the important knowledge parts. This is done by simple text or an item list or questions, that can be answered after working through the unit. The first page also informs about prerequisites, the learner should already know to fully understand the current unit.
The actual content pages use differently structured text, pictures, animations and small interactive components to present the topic. Interactions reach from controls for animations to small quizzes. The latter are used in two situations, they make an unusual introduction to some topic or give a feedback on the learners knowledge. These content pages try to combine various methods and different information channels. We have to admit though that acoustic information is not used.
The last page consists of a link list. These project internal links would usually offer deeper information, present another aspect of the topic, confront the learner with some connected problem or point to some related topic. The learner can either follow a proposed link or get back to the main navigation page. In either case a student can conceive the network into which the just traversed unit fits in.

Some results

Some USI materials were actively used in a lecture context. There is a version online, which will be updated continuously. There were some rough evaluations in connection with its use in lectures of theoretical computer science, an obligatory lecture for almost all informatics students at Potsdam university. The online version will be extended with a feedback section soon.

Our evaluation conveyed only small differences between the male and the female students. On top of that the female group was very small with only 13 women. We found out, that the materials were used mostly for rehearsal. Male students used the modules more often for preparation than the female ones. A majority of female students gave good and very good marks for conciseness while the male ones are only satisfied with it. Especially graphic elements and pictures seem to be highly supportive and both groups asked for more. Female students could do with a little more text, while most of the male students are satisfied with the amount. More examples (e.g. for a grammar transformation) were

demanded by both groups. These findings are giving just tendencies however, since the test group was small and most students did not spent more than four hours on the modules.

Conclusions

With artificial languages we chose a simplifying and universal approach to teach *key concepts* of informatics that is not strictly oriented towards a standard informatics curriculum, but still puts on some systematics. In allowing *multiple approaches* and embedding the knowledge into its social context, we try in particular to *support female learners*. This is underpinned by our notion of key concepts that fulfil the criteria for fundamental ideas and as such offer presentations in various fields and on various cognitive levels. In the development of learning materials we apply an *integrated* approach combining matters of content and design. Structuring the material into small and flexible units enables teachers to integrate them into their own lectures without having to give up too much of their didactic concept and methodical approach thus guaranteeing a certain sustainability of the modules.

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