Together – different experiments with interdisciplinary courses in informatics in higher education

Dipl.-Inform. Ingrid Rügge*, Center for Computing Technologies (TZI),
Dipl.-Psych. Esther Bernds, Forschungszentrum Arbeit - Umwelt - Technik,
University of Bremen, P.O.Box 33 04 40, D-28334 Bremen, Germany
*phone: +49 421 218 7829, fax: +49 421 218 7820, email: ruegge@tzi.org, http://www.tzi.org/~ruegge

Abstract: In this contribution we introduce three examples of interdisciplinary and application-oriented courses in informatics in higher education. We think that our didactic concepts seemed suitable to increase the participation of women in studies of computer sciences and will present our intentions and curricula. We will report about our experiences with the execution of the developed courses and discuss the results of our evaluation.

Motivation

Feminist research in computer science has determined that women in informatics prefer a holistic education including the characteristics *application-oriented* and *interdisciplinary* (compare Schade 1998). In order to increase the participation of women in a discipline like informatics it is important to take these facts into account when developing curricula for women in higher education. In addition, it is necessary to develop and test concrete courses, which meet these requirements. The summer courses of the project "*Informatica Feminale* – summer university for women in informatics" (see e.g. Oechtering, Rügge, Vosseberg 1998 or Oechtering, Vosseberg 1998) offer an ideal framework for this task, since the project has been explicitly designed as an experimental space for teaching and studying. We have taken this opportunity to develop and test in practice innovative didactic conceptions for higher education in informatics in which we have developed different courses, which are application-oriented and interdisciplinary in their contents as well as in their execution. We will introduce these three strategies and report on our experiences testing the same. However, we would like to point out here that even if we describe form and contents separately, we are nevertheless convinced that form and contents are interdependent and cannot be separated.

First example: Seminar "From 'Virtual Reality' to 'Graspable User Interface': new Interfaces"

There has been a variety of approaches in the field of human-computer interaction on new interfaces and interaction metaphors within the last years (about the discourse within the German-speaking countries see e.g. Rügge et al. 1998). Two common features of these have been mentioned frequently: the focus on special, restricted applications and the goal to design the interface between human and computer in a more natural and intuitive way. The chosen applications are not located in office environments (that is the right application area of the famous desktop metaphor). You rather find them in production, in maintenance, or in architecture. New in/output media came to use (e.g. wearable computers, data gloves, head mounted displays etc.), new interaction metaphors, and new user interfaces (like virtual or augmented reality, ubiquitous computing etc.). Furthermore, it is typical for this research that in most cases the involved working groups are put together interdisciplinary, since in this manner innovative synergy effects are to be expected. The topics of computer sciences in this field contain a wide range of thrilling challenges: Real time processing, various pattern recognition problems, and complex ergonomic questions – not to forget the ethical and social implications, which a responsible computer scientist should always take into consideration. Prerequisite for a successful interdisciplinary cooperation is a common understanding of the problem definition and a common language – a demand which sounds trivial, but which causes considerable problems in its realization.

With this characterization – application-oriented and interdisciplinary – the described field of research is particularly suitable as curriculum contents of an interdisciplinary course during the summer courses for women in informatics (for documentation of this course see Rügge 2000). We still strengthen this holistic approach by giving the lectures with two equal persons: a computer scientist and a person

from the field of therapeutic educational science. We chose a seminar as our teaching form (28 classes). Before the summer courses every participant had to prepare a paper, present her paper during the seminar, and lead the discussion during her presentation slot. Our "lived" interdisciplinarity took into account the limitations of the discipline computer sciences (compare Falck 1995). We included broader aspects like the concept of studying playfully (Vester 1978: 174ff) and the basic thesis on an existing connection between grasping (greifen) and understanding (begreifen) that can be used to make the transition between reality and virtuality much easier (for details compare Robben/Rügge 1998).

Our two disciplines and the contents of the session were evenly distributed. Our two very different points of view referred to one object and entered into interaction with each other. Our common object was the human perception which is modeled and simulated in computer science and which is employed in therapeutic pedagogy for the diagnosis and treatment of disturbances for examining and stimulating. Feeling it is one way to figure out the differences between real and virtual worlds. To reach this aim, we have combined scientific lectures on new user interfaces (like Virtual and Augmented Reality, Force and Touch Feedback, Ubiquitous and Wearable Computing, Construction Kits, Physical Manipulation Interfaces, Tangible Bits, Graspable User Interfaces, Real Reality and their technological bases Head Mounted Displays, Shutter glasses, the Phantom®, Tracking systems, data gloves etc.) with exercises to become aware of our own perception (e.g. with touch-, smell-, or hear-memory games; tactile stimulation by touching various filled bags; optical illusions; moving in the room; turning off single sensory perceptions etc.).

It is easy to remind oneself and others of the human perception abilities, since the human body is always present in the real world (see Kükelhaus, zur Lippe 1982 for a detailed program on an integral "experience field"). We carried out the perception exercises without any theoretical explanations. On the one hand there was not enough time to do so. On the other hand we did it consciously without rational explanations, since the usual explanation models of perception research, medicine, and psychology are normally computer metaphors. We wanted to avoid analyzing perception phenomena with concepts, which sound like computer language, but mean something completely different. Doing something and gaining experience at the same time were the relevant aspects of the introduction into this topic complex. We have promoted this, nothing else. Our assumption was, that the obvious theoretical gap, and the questions that remained unanswered arouse the participants' curiosity. This could motivate them to do own research in this direction.

The perception exercises made the integration of seemingly playful elements into the seminar possible. This had two simultaneous effects: On the one hand, the participants get an easy approach to a new field of research – human-computer interaction and its various applications. On the other hand, the playful environment relieves the educational environment. We would have enjoyed making a wider scope of experience accessible: the new input/output devices of HCI. Unfortunately, this was not possible because the appropriate technical equipment was not available.

The cooperation between Martina Janßen, working in the field of therapeutic educational science, and me, a computer scientist, was carried out after a long discourse about points of contact between computer science and psychology, physiology, medicine. We have been friends for many years. In this time, we frequently discussed the contents, limits and aspects that our professions hold in common. Thus, we developed a mutual understanding and a common language. In our opinion these years of preparatory work were the prerequisite for our excellent and innovative cooperation.

The special feature of the teaching form "seminar" is its orientation towards communication (i.e. talking with each other, listening, giving feedback, negotiating etc.). Therefore, we introduced detailed feedback as integral part of every presentation. Feedback should only refer to the way of the lecture, the used material and the style of presentation; informatics' topics were excluded explicitly in this phase. For grading (and also without) I offered the participants the possibility to write a paper on the lecture. When writing this paper the students had to take into account the remarks and results of the discussion. I further offered to comment the paper in detail and to return it to the author – if desired. "Desire" is another keyword of our seminar strategy, which I would like to emphasize particularly: We

have tried to give as few instructions as possible before, during and after the seminar. In the first place we only made offers and let the participants choose. We also have tried to put the participants into the position to take a choice. Before the summer studies the following materials were sent to them:

- A list of all possible topics,
- An abstract of the expected contents of the presentation,
- A detailed list of references on any topic, and
- A catalogue with principal questions.

An example of the distributed information on one topic:

> *Subject:* Multi-Modal, Multi-Sensory Interfaces
>
> *Abstract:* The knowledge that humans not only gain cognition by the sense of sight has already influenced the interface research. Attempts to integrate various human perception faculties and different abilities to express oneself in *one* interface represent the first step in this direction. At this point spoken language plays an essential role as input possibility.
>
> *References:*
> Chu, C-C.P.; Dani, T.H.; Gadh, R. (1997): Multi-sensory user interface for a virtual-reality-based computer-aided design system. In: Computer-Aided Design Vol. 29, No. 10, 709-725
>
> Cohen, P.R.; et al (1997): QuickSet: Multimodal Interaction for Distributed Applications. In: Proc. of the Fifth Annual International Multimodal Conference. New York: ACM Press,
>
> Oviatt, Sharon; DeAngeli, Antonella, Kuhn, Karen (1997): Integration and Synchro-nization of Input Modes during Multimodal Human-Computer Interaction. In: CHI'97, ACM (http://www.acm.org/sigchi/chi97/proceedings/paper/ slo.htm)
>
> Rügge, Ingrid (1999): Wenn ich das nur (be)greifen könnte! In: Dokumentation des 24. Kongreß von Frauen in Naturwissenschaft und Technik, 21.-24. Mai 1998, FiT-Verlag, Darmstadt, 1999, S. 322-328

After the first uneasiness concerning the perception exercises was overcome, a relaxed and trustful atmosphere developed. Thus allowing the execution of very sensitive perception exercises already on the second day. The participants treated each other with great consideration in the phases of feedback and voiced criticism only very hesitantly. It was obvious that they did not have any experience with this method yet. In their home universities they seemed to have learned even to be afraid of public feedback. They accepted constructive criticism gratefully. This reservation vanished completely (only or already?) on the last day. At that time, the participants obviously felt self-assured and an intensive and productive phase of evaluating our seminar curriculum evolved.

The participants made new, positive experiences concerning the form, the atmosphere and the support in a teaching event in informatics. They got new and interesting information about possible computer science applications and made new experiences with their own perception. They could talk about their study situation with other women from other universities, and they got curious about testing the described human-computer interfaces. They were grateful for the feedback and the explicit recognition. They had fun and went home very much satisfied. In any case, they were able to see beyond the end of their noses in informatics, with a critical view. In particular, the "real interdisciplinarity" – with its inconsistencies and contradictions – fulfilled them with enthusiasm.

Second example: Workshop "Computer, Internet, and Communication – It's the mixture that counts!"

A challenge for every computer scientist is the connection of knowledge about software, hardware, bits, and bytes with a natural presentation of her own knowledge. This knowledge and abilities were to be acquired in an interdisciplinary workshop. The course was organized in small groups, so that principles of informatics and communication technique could form an overall picture in the course of the workshop.

In this course Anne Pfoh, an engineer for system analysis, and I, a psychologist, formed the teaching team. The teaching event consisted of 28 classes. Appropriate professional journals and books served as an introduction, in addition to internet-sites and lectures to teach the basic knowledge. The aim of the course was primarily to demystify computer jargon, but also to acquire knowledge independently, to apply the acquired abilities, and to present the work results. The participants could choose one theme from the suggested topics of our two disciplines. They could work on this theme in small groups. At the end of the workshop, every group presented their results. Thus, the speakers got feedback about their presentations. In addition, the members of the other groups got an introduction in topics they had not worked on yet. Already the phase of finding a theme showed that the participants were interested in general communication topics. The introduction about communication contained already an interactive process and was accompanied by practical exercises, discussions, and collecting of examples.

Topic: Computer and Internet	*Topic: Communication*
UNIX	Structuring and planning
Internet services	Writing papers
Hardware	Designing web pages
Programming of HTML	Training and moderation

At the beginning of the workshop we introduced feedback for every day in the morning, i.e. every participant put her feelings into short words: whether she brought in something new for the current day or whether she still wanted to say something about the previous one. It was not only to discuss contents, but also to talk about personal experiences and feelings. Each day closed with feedback about the lessons of the current day and the impressions gained during the day. This procedure presupposed that all participants left their PC and got together. In these phases it was obvious that the personal condition of individual participants often depends on the sticking together and the productivity of her project team. Discontent arose e.g. if the group process stagnated, since decisions lined up and weren't taken, or if the group had the feeling of not having progressed sufficiently. Satisfaction got recognizable, if a group conflict dissolved, work steps were formulated clearly and considerably, and if the atmosphere in the group was regarded as positive.

Since the possibility to work on the contents also depends on the communicative competence of the group, every group could receive support on demand for their individual problems and questions. They got instructions, hints and guidelines for the further procedure. For example: In one group the process to find a topic and to set the work steps for the week stagnated. The participants did not know how to improve the climate of their group. Their description of the problem showed that they had not regulated the management of the discussion, that they had avoided limiting long talks, and that they had not visualized their work results clearly. Discussing these problems with the psychologist induced the participants to proceed in a structured manner. So they could continue working on the contents.

The main part of the workshop consisted of project work in small groups. The participants had to work on their topics without any help. In addition, the lecturers gave them possibilities to ask questions during arranged periods. The participants unanimously judged this open form as being very positive.

The two lecturers profited from their miscellaneous competencies already during the preparation of the workshop. The informatics' engineer implemented the web pages with information about the workshop. The psychologist supported her with information on the design and the clarity of web pages. However, the two lecturers worked separately to prepare their contents of the course. The participants noticed this missing coordination already at the start of the course, because they did not understand the connection of the two disciplines. In the workshop's classes the coherence between

topics of informatics and communication techniques improved considerably. Therefore we recommend early communication about interdisciplinarity and the possible benefit from the connection between two disciplines.

During the course the thematic focus changed: In the beginning, questions of communication were in the foreground. In the project phase the participants first worked on the computer science bases of their topic. Approx. 1½ days passed till the first questions about communication-oriented arrangement of technical contents, group dynamics and moderation arose. On the last day, the presentation of the topics and the feedback of the participants brought the technical contents and the communicative competence together . The evaluation showed that everybody had profited from the lived and learned interdisciplinarity. Furthermore, it proved the existence of a great need for educational events that combine technical know-how with know-how on communication and presentation.

Third example: 3D-Modeling Workshop

This third project also extended over 28 classes. It differed from the previous ones in describing interdisciplinary event strategies with respect to one special topic: The interdisciplinarity was integrated in an indirect way. There was only one lecturer, a computer scientist. I was the "frame" of the whole project and brought the different parts together. Interdisciplinary aspects were integrated by visiting companies, institutes, and other departments as well as by lectures from invited external experts.

The aim of the workshop was to understand the modeling process of the geometry of three-dimensional objects by studying some aspects of the procedure with self -experience and observation. Three different modeling procedures were employed in this course (see below). The research question was: How intuitive are the different procedures and the handling of the tools? First and foremost the perspective change was important, and sharpening the look for the contexts of using digital geometric modeling tools and CAD-systems (Computer Aided Design), too. The participants had to investigate the pre-knowledge to which these tools refer. They had to answer questions about the abilities the tools require and about their limitations. With these questions in mind, the participants could develop an idea of how to design an intuitive modeling or designing tool.

The procedure in this course followed the principles of action-oriented didactics, i.e. the participants got tools, material and instructions for the handling and had to collect experiences of their own by exploration. They had to observe themselves and their fellow students in accordance to some principal questions and they had to write down their observations. In this way, recurrent perspective changes were guaranteed during studying. Beyond this, modeling with the different methods was partially recorded on video. At the end of the project, the participants had to compare the tested methods by the following principal questions:

- How do I handle the method? How does my fellow student handle the tool?
- How understandable/intuitive is this manner of 3D-modeling?
- To which prior knowledge/experience does the method refer?
- Which senses are mentioned? How?
- Which knowledge is required for the procedure? Which abilities are necessary for the handling?

The three used 3D-modeling methods are

- Building a spatial construct from 12 (easily distorted) dodecahedra of cardboard with scissors and scotch tape as tools. It had to be produced with help of a pattern and written instructions,
- Modeling with clay in the ceramic laboratory of the department of educational science of the University of Bremen. An experienced student of this department taught this method,
- Using of a semi-professional software tool for 3D-modeling. The participants got used to the software by using the online help system, the multi-media tutorial, and an extensive printed quick-introduction. The teacher was available for questions during the entire course.

The explorative procedure was completed by competent offers from the outside. Experts of other disciplines or branches and other professionals gave suggestions, instructions or examples. This is another manner to integrate interdisciplinary aspects into education curricula. You better call it "a multidisciplinary course with intradisciplinary parts". The course leader plays the central role in this didactic conception, since she has to point out the connections between the different disciplines and she has to bridge the gap between them. This is no easy task and requires intensive preparation.

During this course I realized four events with persons of other disciplines: The student who taught the modeling in the ceramic laboratory has already been mentioned. In addition, there was a "potential customer" who visited the project to be advised about the possible use of computer technology for her task. A psychologist introduced her research question to the participants: A study of the ideas of fairness and justice in distribution-conflicts in public spaces. She also presented her investigation method: The use of a concrete material model of a complete street scene (with scaled down wooden house fronts and the corresponding playmobil® figures, with wooden cars, with sidewalks, frontyards, road signs etc.). The participants of her research workshops had to describe the conflicts that appear in their streets. To do so, they used the concrete material model of the street. They built scenes with the things available and communicated with each other at and with the model about the situations. The psychologist described the advantages and the limits of this investigation method. The participants of the project were invited to discuss whether the boundaries of the physical model could be overcome by linking the real model with a suitable three-dimensional virtual one.

Furthermore the students had the opportunity to visit an institute, where virtual 3D-models are transformed (back) into physical ones. The keyword is *rapid prototyping of geometric models*. The person who demonstrated this production procedure was a computer scientist specialized in production and automation. Finally, the students could visit a company, which builds 3D-animations professionally. The owner was a physicist. On the spot, the participants could inform themselves about the possibilities and difficulties of this job as well as about the required abilities and skills.

Some participants of this course were little confused by the procedure of the project. Their prior knowledge and the range of their expectations had been so wide that not all needs could be fulfilled. Those who wanted to study handwork in the workshop were disappointed. Only those who actually got involved in the experiment and who wanted to change their perspective were satisfied. Fortunately, this was the majority.

Conclusion

The positive response to the introduced concepts in the context of the summer studies of the project *Informatica Feminale* does not allow the simple conclusion that they are suitable for everyday studies or that they are particularly attractive for women. This hypothesis requires further research. However, the evaluation of the courses gives some (not new but nevertheless interesting) hints to deficits in the conventional study culture we want to point out: Besides the frequently missed teaching of links to applications, besides the not existing integration of the subject into the context, and besides the missing teaching alternative viewpoints, we have to mention the study atmosphere. Indifference, reservation, and „feign“ pervade the study culture of many computer science departments of German universities. Didactically doubtful lectures and seminars in which the students uncritically copy this style do not produce an educationally beneficial communication and cooperation culture. They do not

let any productive "quarrel culture" arise. In particular, they seem to be repulsive to women (compare Schinzel et al. 1999). One more reason to use and to improve opportunities like the summer courses of the project "*Informatica Feminale* – summer university for women in the informatics" is to test alternatives in a dialogical discourse between students and lecturers. In addition, our experiences and results are further reasons to establish similar facilities.

Acknowledgements

We thank our cooperation partners Martina Janßen and Anne Pfoh for the wonderful interdisciplinary teamwork. We thank the participants of the three educational events for their openness and readiness for our experiments. We further thank Jens Bendig, Uwe Haupt, Susanne Hofmann, Marcus Joppe, Doris Köhler, and Prof. Dr. Oberliesen for their active support at the preparation and execution of our lessons. We thank Renate Post-Gonzales for her preseverance during proofreading and
Sabine Melchert for giving the finishing touch.

References

Bach, M.J. (1991): UNIX – Wie funktioniert das Betriebssystem. München, Wien: Carl Hanser. London: Prentice Hall International Inc..

Falck, Margrit (1995): UnDISZIPLINierte Softwaerentwicklerinnen und ihre methodischen Ansätze. In: Pilz, Peter; Oedekoven, Cornelia; Zinssmeister, Gaby (eds.): Forschende Frauen. Frauen verändern die Naturwissenschaften. Mössingen-Thalheim: Thalheimer: 119-133.

Foley, J.D.; van Dam, A.; Feiner, S.K.; Hughes, J.F.; Phillips, R.L. (1990): Computer Graphics: Principles and Practice. Menlo Park: Addison Wesley

Kirckhoff, M. (1993): Mind Mapping, 8. Aufl., Bremen.

Kükelhaus, Hugo; zur Lippe, Rudolf (1982): Entfaltung der Sinne. Ein "Erfahrungsfeld" zur Bewegung und Besinnung. Frankfurt a. M.: Fischer Taschenbuch.

Münz, S.; Nefzger, W. (1999): HTML 4.0 Handbuch. Professional Series. Franzis.

Oechtering, Veronika; Rügge, Ingrid; Vosseberg, Karin (1998): Informatica Feminale – Sommeruniversität für Frauen in der Informatik. In: Winker, Gabriele; Oechtering, Veronika (eds.): Computernetze – Frauenplätze. Frauen in der Informationsgesellschaft. Opladen: Leske+Budrich, 167-173.

Oechtering, Veronika; Vosseberg, Karin (1998): Informatica Feminale – A Place for Educational Experiences. In: Proceedings of the 5th IFIP TC9 World Conference on Human Choice and Computers, Genf, August 1998, 253-264.

Pöppe, Christoph: Fast platonische Körper oder Das wohltemperierte Dodekaeder. Spektrum der Wissenschaft, Papiermechanik 3

Robben, Bernd; Rügge, Ingrid (1998): Mit den Händen beGreifen: Real Reality. In: Rügge et al. (1998), 133-146.

Rügge, Ingrid; Robben, Bernd; Hornecker, Eva; Bruns, F. Wilhelm (eds.) (1998): Arbeiten und begreifen: Neue Mensch-Maschine-Schnittstellen. Münster: LIT.

Rügge, Ingrid (2000): Von 'Virtual Reality' bis 'Graspable User Interfaces': neue Schnittstellen – ein interdisziplinäres Seminar. In: Oechtering, Veronika, Vosseberg, Karin (eds.): Informatica Feminale – Sommeruniversität für Frauen in der Informatik. Sichten von Informatikerinnen auf ihr Fachgebiet. Leske+Budrich: Opladen, 2000. To appear.

Schade, Gabriele (1998): Geschlechtsspezifische Medienkompetenz. Ein Erfahrungsbericht der TU Ilmenau. In: Winker, Gabriele; Oechtering, Veronika (eds.): Computernetze – Frauenplätze. Frauen in der Informationsgesellschaft. Opladen: Leske+Budrich: 157-166.

Schinzel, Britta; Kleinn, Karin; Wegerle, Andrea; Zimmer, Christine (1999): Das Studium der Informatik: Studiensituation von Studentinnen und Studenten. In: Informatik Spektrum 22/1, 13-23.

Schulz von Thun, F. (1981): Miteinander reden: Störungen und Klärungen – Psychologie der zwischenmenschlichen Kommunikation. Reinbek.

Schwerpunktthema "Virtualität", Rundbrief der Fachgruppe "Frauenarbeit und Informatik", 19/1999.

Seifert,; J.W. (1995): Visualisieren –Präsentieren – Moderieren. Offenbach: Gabal.

Vester, Frederic (1978): Denken, Lernen, Vergessen. München: dtv.

Watzlawik, P.; Beavin, J.H.; Jackson, D.D. (1982): Menschliche Kommunikation: Formen, Störungen, Paradoxien. Bern, Stuttgart, Wien: Huber.