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ISG Research Group
Continued Multi-disciplinary Project-based Learning (CM-PBL) 2002-2007
Project Report

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ISG Research Group
http://www.med-informatik.ukaachen.de/

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1 Introduction

A Teacher is a Facilitator, Mentor, Guide.

The ISG Research Group is one of three research groups at the Department of Medical Informatics at RWTH Aachen University. From April 15, 2002 until April 14, 2007 the author will have been the head of the ISG Research Group. The group consists of the head, who is a senior scientist with a PhD in Medicine, one up to three student assistants (over the years: 15 hours per week), about fourteen active students, graduates and post-graduates, working on a student's research project, a diploma or a doctoral thesis, and two trainees (Mathematisch Technische Assistenten).

This project report describes how the ISG Research Group performed its research and training of the students, graduates and post-graduates (short: students) as scientists by means of Continued Multi-Disciplinary Project-Based Learning (CM-PBL).

The task of the head of the research group is to guide and to support the students during their work on their thesis. Thus she is called teacher in this report. As the teaching and the research takes place in medical informatics, a senior scientist with a PhD in computer science with a research group on his own works as a consultant and co-teacher of the students in the work on their theses in medical informatics.

The ISG Research Group focuses its work on web-based information systems in health care. Furthermore it investigates mobile devices for patients, medical professionals and researchers. The approach is multi-disciplinary. The disciplines are computer science, medicine, economics and sociology.

Beside the guidance and support of the students in the work on their theses, the teaching tasks of the head include also lectures, seminars, practical courses and workshops for students of computer science and medicine. Areas are for example hospital information systems, evidence based medicine, health economics, quality management in health care, knowledge management, didactics and communication and qualitative research methods.

The author developed CM-PBL based upon own experiences with and training in project work in an international consulting company, literature work, training-courses in Problem-Based Learning at Maastricht University (NL) and last not least the continued cooperation, support and feedback of the students and the co-teacher Dr. Cord Spreckelsen.

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2 Course of the Report

As project work is one of the core tools used in CM-PBL this report starts with the description of the "Project Logistics" (3), continues with the "Scientific Work and Training" (4), gives an "Example on the Coaching of the Students" (5), shows an "Explorative Evaluation of the Students' Satisfaction" (6), and closes with a "Conclusion and Outlook" (7). The Appendix starts with "Appendix 1: Theses" (8.1). The developed tools and modules and their related publications are named in Appendix 2 (8.2). Appendix 3 (8.3) lists the project reports. The publications of the ISG Research Group are listed in Appendix 4 (8.4).

To ease the reading the male personal pronoun is used for the students, graduates and post-graduates and may be regarded as gender-neutral. Furthermore often students, graduates and post-graduates are shortly named students. The teacher is a woman and thus the female personal pronoun is used. The co-teacher is a man. Overall eleven women and twenty-two men were team members during the period April 2002 – April 2007.

The author of this project report will have been the head of the ISG Research Group from April 2002 until April 2007. She is the teacher of the students. Furthermore she is the project manager of the two core projects and of several sub-projects performed in the ISG Research Group, which were used for CM-PBL. The two core projects are CERES and UMData (see Appendix 2 (8.2) and Appendix 3 (8.3)).

3 Project Logistics

3.1 Policy

A central task of the university lecturers and scientists at our university is the training of the students as scientists: to guide them and to support them. It is a contract to fulfil by both parties: the teacher trains the student and the student works on his or her research project and thesis professionally (in time, reliable etc.). The results of the thesis can (but they do not have to) be of use for further research and teaching projects. Thus teachers and students work together respectfully, equally and in partnership.

In the ISG Research Group with its CM-PBL approach the students benefit from the principles

- dual controlled guidance and support by two senior scientists: a teacher and a co-teacher,
- peer group discussion with other students and experts from the own and other areas,
- training in presentation techniques (hearings),
- training in project work,
- training in multi-disciplinary work: to learn to understand and to talk to experts from other disciplines.

The approach is to train the students and postgraduates as scientists on realistic scenarios in a broader context. This was mostly the development of an application embedded in a research project. The main project was over the years "CERES: A Web-based Information System on Hospital Data" [WWS06a], [WS06]. Appendix 2 (8.2 lists the larger research projects of the ISG Research Group and the developed applications and tools.

The students, postgraduates and trainees are educated in project work and project management. They are full members of the project team ISG Research Group. The senior scientist is the teacher and the project manager. The co-teacher, having a research group on his own, is consultant of the ISG Research Group and is asked for expertise on particular questions. The role of the co-teacher was shaped during the years. In the beginning he attended weekly the meetings. After two years he took part on invitation. For more details see "Teaching and Feedback" (4.3) in "Scientific Work and Training" (4).

3.2 Roles and Tasks of the Members

From April 15, 2002 until April 14, 2007 the author will have been the head of the ISG Research Group, the project manager and the teacher of the trainees, students and post-graduates on their student's research projects, diploma thesis and PhD theses. A second senior scientist at the institute cooperates as co-teacher on the thesis in computer science, resp. medical informatics. The ISG Research Group consists of one senior scientist (the author), two trainees (Mathematisch Technische Assistenten), one up to three student assistants (over the years: 15 hours per week) and about fourteen active students, working on a student's research project, a diploma or a doctoral thesis.

Tasks of the project manager: She has to communicate the project to the chair, to external persons or institutions. She is the central contact person and teacher of the project team members. She is in charge of the success of the project ([NB96], p 119). The style of project management depends on the personality and the professional skills of the project manager. Good communication and respect to the knowledge and skills of the project members, who are experts and professionals in their area, and a consensus aimed decision process support the project manager and the team to run a creative and successful project. The continuous of the project manager tasks are:

- Coordination of the goals and the requirements with the chair.
- Design of the project organization, structure and schedule.
- Recruiting and introduction of new project members.
- Controlling: finances, human and technical resources, schedules, tasks.
- Quality management and quality assurance.
- Decision and guidance.
- Internal and external communication.
- Internal and external negotiations.
- Internal and external reports (e.g. to the chair) and publications.

Tasks of the student assistants: Setup and maintenance of the research servers ceres.imib.rwth-aachen.de and scout.imib.rwth-aachen.de. Introduction of new team members on the research server. Access of new team members to the research server (user name and password). Project related IT-support for the team members. Implementation or re-engineering of particular modules or applications of the research projects. Assistance of the deploying of new applications on the research servers. Development and maintenance of the "CERES Software Development Guidelines" [IBSW07], [ISW07].

Tasks of the trainees: Implementation or re-engineering of particular modules or applications of the research projects. Data entry and maintenance. Support of the project manager in preparing meetings and conferences and other external communications.

Tasks of the students, graduates and postgraduates: Willingness to work in the CM-PBL context on his or her thesis. Willingness to become acquainted with new research areas. Professionally work on his or her research project and thesis: in time, reliable etc.

Tasks of all team members: Work in the CM-PBL context: participation in the weekly meetings, communication via email and the research server, consideration of the data security policy (see 3.6), in time cooperation on the documentation, support of the other team members in their research projects by giving feedback (see 4.3.2, 4.6), preparation of the meetings, of conferences and projects concerning the whole research group (e.g. the Klinik-Scout and its sub-projects in 2006 [WWS06a], [WS06], [WB07], [WC07], [Weß07f], [Weß07g], [Weß07e], and others [BW07], [IBSW07], [ISW07]).

3.3 Communication

Weekly team meetings lasting two hours: The team meets in the library of the institute to discuss the stage of affairs and to perform the hearings. The project manager documents the results of the meeting in the project documentation [Weß07a]. Every team member reads the documentation as preparation for the following meeting and gives instantly feedback if the documentation shows an error or misses something. The team meetings are used for:

- Discussion of the progress of the single theses during hearings (see 4.6).
- Discussion of and decision on the progress and the tasks of the larger projects.
- Training of the students on particular scientific methods, e.g. the literature work [Weß05b] and the use of qualitative research methods in medical informatics [Weß06b], [WWS06b].

Annual Balance and Outlook In December 2005 and 2006, on the last meeting of the year, the project manager presented an annual balance on the current year and an outlook on the following year, and discussed it with the team [Weß05a], [Weß06a]. The team reflected the year passed and decided on the strategies and tactics of the year to follow. In 2005 they performed an explicit evaluation on the success and the problems of CM-PBL in the ISG Research Group (see section 6).

Meetings of the teacher or the co-teacher or both with a student at the institute to discuss the stage of his thesis (student's research project, diploma and doctoral thesis) and to decide about the further steps.

Meetings of several project members on particular questions at the institute to use the available resources, though mostly the students work at home, using IT instruments, such as the research server and the Internet for the development and the communication.

Emails The mailing list isg@mi.rwth-aachen.de contains every active team member. To avoid misunderstandings and gaps every team member sends emails to this account. They are requested to describe the topic in the concern line. If just two team members discuss a special problem, they do it two-sided.

3.4 Documentation

Documentation is both a project management tool and an important part of research and development. The ISG Research Group performs it as continued project documentation (e.g. [Weß07a], [Weß07d]), on internal project webpages (e.g. [ISG07b]), in the source codes, and in the theses and additional files (e.g. a specification).

The continued project documentation is written by several authors. The responsible developers document the developing process and the technical information of their tools and modules. They announce new added texts in e-mails. The project members are obliged to read the project documentation and give feedback to the authors.

The decision to use TeX [SKPH98] for project documentations like [Weß07a] was encouraged by the following reasons:

- The stability of a document with several files is very high.
- The different combination of files for several purposes is easy to perform.
- A singular bibliography and a singular glossary exist for the whole project as a bib-file.
- Figures can be used in several files.
- Mathematical formulae are easy to write.
- The layout of the compiled document is agreeable.
- Compiled to a PDF it can be read by anyone who got the freeware 'Acrobat Reader', `http://www.acrobat.com/`.

To be able to work on the project documentation in TeX with several authors in a sophisticated style, the team uses CVS (Concurrent Versions System, see for example `http://www.tortoisecvs.org/`). The team members are asked to consider as authors the following hints:

- Write in a plain style.

- To identify yourself as author, start the section with your initials and the date (yymmdd) in squared brackets, e.g. [CW 030729]
- Update the bibliography regularly.
- Structure: use 'chapter', 'section' and 'subsection'. A more detailed differentiation is pretty confusing in a large document.
- Use labels for 'chapter', 'section', figures and tables.
- Start the labels with 'cha', 'sec', 'fig', 'tab' and go on with Java identifier like labels: words beginning with capitals, but without spaces between words, e.g. 'secProjLogDataSecurity'.
- Tags are needed for chapter, section, subsection, reference (ref), citation (cite), url, figure (fig) and labels.
- Enumeration and itemization are useful to structure text.
- File-names: use clear names. Example for [Weß07a]: start with 'c', go on with an abbreviation of the according chapter, close with a short title of the section, the file is about, e.g. 'c-proj-log-data-security' for 'CERES Data Security Concept' in the chapter project logistics.
- Compile TeX to PDF and erase errors, before you commit your update of the documentation via CVS.

The internal project webpages were implemented to be used as

- Project management tools: a list of links [ISG07c], the member list [ISG07d], the documentation of milestones [ISG07e], the installation steps for new members [ISG07a] and "Scientific Work", theses in progress and finished theses, [ISG07f]. A task list was used from 2002–2004 and skipped due to its inefficiency [ISG04].
- Documentation platform: [ISG07b].
- Access to web-based applications developed during the projects [Chr04b], [ISG06], [WB06], [Iß02], [BBB07], [Kar05b], [Sun05b], [Sun05c], [ISG07g], [PB06].

The team member gets access via the Internet with a user name and a password.

The source code of developed applications and modules is stored on the research server via CVS.

The theses and related files such as the specification and the hearing presentations are stored by the student in his home directory on the research server. The theses are published on the public website of the research group (currently `http://isg-med.de/publications/`).

3.5 Research Server

The ISG Research Group uses a server as internal research server (ceres.imib.rwth-aachen.de nickname ALF). It contains the work on the different research projects (the largest is the CERES Project), the development platforms, the applications, the documentations, the internal project webpages, the public website of the ISG Research Group (currently http://isg-med.de/) and the work of the team members (../home/ "name of the team member"/).

A second server (scout.imib.rwth-aachen.de nickname PAULA) was set up in 2006 to host the Klinik-Scout for the web-based evaluation (see [WWS06a], [WS06], [WC07], [Weß07g], [Weß07f]).

3.6 Security Concept

Every project member is committed to the data security concept of the ISG Research Group.

The used protocols and tools for the work on and with the research server are SSH (Secure Shell), SSL (Secure Sockets Layer) and HTTP(S) (Hypertext Transport Protocol). FTP (File Transfer Protocol) and CVS (Concurrent Versions System) are to use with a username and a password delivered to the team member by the ISG student assistant.

PGP (pretty good privacy) is used for e-mails with secret information, e.g. the announcement of new passwords. The project members are obliged to store their public key in their folder on the research server. Usually the project members just mention in their e-mails what they stored on the research server.

A new project member gets an introducing e-mail including his or her passwords for the access to the research server from the responsible student assistant. The used data security tools and necessary steps are listed in "Installation steps for new members" [ISG07a]. The project members get support from the student assistant in charge and the project manager.

3.7 The Public Website

The author implemented the ISG website (currently `http://www.isg-med.de/`) in 2004 [Weß07c]. She is the author and is supported technically by a student assistant.

The website presents the work of the ISG Research Group to the public and it is used as project controlling tool: the list of publications, projects and teaching tasks, open topics and theses in progress plus the member list, including the alumnis are kept up-to-date:

About us: `http://isg-med.de/home/`

Team: http://isg-med.de/team/

Research Projects: http://isg-med.de/projects/

SW Guidelines: http://isg-med.de/guidelines/

Teaching: http://isg-med.de/teaching/ with Teaching Materials

Theses in Progress: http://isg-med.de/theses/

Open Topics: http://isg-med.de/open-topics/

Publications: http://isg-med.de/publications/

Contact: http://isg-med.de/contact/

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4 Scientific Work and Training

4.1 Approach

CM-PBL is based upon tools and techniques known from project management [NB96], [Sch04], and upon the methods of problem based learning [Sch83], [Sla96], [VdVDdG+04]. It aims to train the students, graduates and post-graduates not only as scientists but also in project work, collaborative work, multi-disciplinary work, presentation and documentation techniques – short in professional and social skills to be of use in their future professional career.

From 2002 until April 2007 the ISG Research Group hosted student's research projects in medical informatics, diploma theses in computer science and doctoral theses in medicine (see section 4.2).

Two senior scientists, this is a teacher and a co-teacher, guide and support the students to facilitate a high quality of the research and training process and of the results: the applications and the theses.

The teacher and the students build the research group and identify themselves as team. The training is based upon realistic scenarios, e.g. the development of an application, in a broader context, a research project (see "Appendix 2: Developments (Prototypes)", 8.2) or the evaluation of a sub-project (e.g. [Ram07]) . The main project of the ISG Research Group was over the years "CERES: A Web-based Information System on Hospital Data" [WWS06a], [WS06], [Weß07a].

From 2002 until April 14, 2007 a co-teacher is mandatory in the ISG Research Group, because during this period the head of the group will have been a physician and social scientist. This means: the theses in computer science need a second expertise and teaching.

Thus a second senior scientist, who is a physicist, PhD in computer science, works as consultant for the research group on particular questions and as co-teacher for the students, who work on a student's research project in medical informatics or a diploma thesis in computer science.

Additionally the team members train themselves: the team is a peer group, which gives explicit feedback on the work of each team member. The feedback is given during the weekly team meetings, which are moderated by the teacher. At least one team member presents his work and gets immediate feedback in a hearing (see 4.6).

4.2 The Theses in the ISG Research Group

4.2.1 Statistics

From April 2002 until April 2007 the ISG Research Group hosted overall 32 thesis projects and 4 trainee's projects. 6 of the theses were abandoned. All theses were performed as a research project, mostly embedded in a larger project, e.g. the CERES Project (see "Appendix 1: Theses", 8.1,).

The successfully finished or nearly finished theses are:

16 student's research projects in medical informatics, students of computer science with the specialty medicine: [Ißl07], [Pal02], [Kar02], [Wey02], [Brü03], [Cho03], [Chr04a], [Sun05a], [Sch06], [Sob06], [Pel06], [Hur07]), [Ted07], [Gei07], [Bec07], [Raf07].

4 diploma theses in computer science: ([Kar05a], [Ißl05b], [Pal05], [Wey06].

6 doctoral theses in medicine. These include Dr. med.: the candidate studies medicine or is a physician; Dr. med. dent.: the candidate studies dentistry or is a dentist; Dr. rer. medic: the candidate comes from another discipline and chose a medical topic. He has to fulfil some other requirements, e.g. a course in medical terminology (see [Aac02], [Aac05]). Status March 2007: 1 completed [vDP04], 2 finished, promotion procedure open ([Web07], [Möl07]), 2 nearly finished ([Cri07], [Ram07]), 1 still in progress.

4 trainee's projects The trainees as "Mathematisch Technische Assistenten" worked on own trainee's projects, all embedded in a larger project.

Six students stopped their work on a thesis. Three candidates cancelled a PhD thesis in medicine, one after three months, and two after six months. All of them rationalized it with time management problems. One cancelled a PhD thesis in computer science after a year and rationalized it with the change of her career plans: she had realized during the work on the thesis that she did not want to become a scientist and instead wanted to work practically. One student cancelled after five months the work on a master thesis in biomedical engineering and rationalized it with time management problems. One student had preliminary to stop the work on a diploma thesis in computer science after three months due to an illness. The re-start is unclear.

4.2.2 Student's Research Project in Medical Informatics

The student's research project is a small thesis in the specialty medical informatics during the studies of computer science (diploma). There exists an tacit agreement at the faculty of computer science at RWTH Aachen University, that it should last three

months full time, this means about 400 hours work on the thesis, given 1600 hours for one year of a full time job in Germany. [WLSS04] gives some insight on the organizational characteristics of the specialty "medical informatics" at RWTH Aachen University.

The student's research project is mostly the first thesis a student of computer science performs at RWTH Aachen University. So this is intended as a training in scientific work and can serve as preparation of the diploma thesis, concerning both the scientific skills of the student and the topic or field, he works on.

4.2.3 Diploma Thesis in Computer Science

A diploma thesis requires some additional organizational points – and so will the bachelor and master theses. See also "The Surveyors" (4.3.3) and the up-to-date guidelines to study computer science at RWTH Aachen University, to download on the university's website (`http://rwth-aachen.de/`).

The four theses between April 2002 and April 2007 lasted about nine months each. This is about 1000 up to 1200 hours given given 1600 hours for one year of a full time job in Germany. The preparation lasted about three months: identification of the topic, literature work and proposal. The thesis itself is allowed to last six months from the announcement on: requirements analysis, design and implementation, further literature work, writing of the report, preparation of the final lecture for the second surveyor.

4.2.4 Doctoral Thesis in Medicine

A doctoral thesis is the independent project of a scientist (PhD student). Thus the contact to the ISG Research Group may be not so close as during a student's research project or a diploma thesis. For instance a candidate, who is working in a company, is not able to join the weekly team meetings. Nevertheless he is integrated in the team by following the early milestones, e.g. "Joining the team" and the regularly emails via the mailing list of the team (isg@mi.rwth-aachen.de).

From April 2002 until April 2007 the author guided and supported six candidates on their work on a doctoral thesis in medicine (see section 4.2.1). In addition to the milestones, described in section 4.5, the teacher and the student meet regularly about every six weeks. Several days beforehand the student sends the latest version of his thesis in progress ("Scientific work is writing.") to the teacher. The teacher gives the student the feedback on their meeting and they discuss the progress, open questions and problems and the tasks up to the next meeting.

The candidates work several years on their theses, caused by the fact that they did it in addition to their jobs or studies. A doctoral thesis in medicine in the ISG Research Group required about one year fulltime (1400 up to 1600 hours).

4.3 Teaching and Feedback

4.3.1 Teacher and Co-teacher

A Teacher is a Facilitator, Mentor, Guide. A student needs a teacher during his work on a thesis.

The teacher has to be a scientist, who is acquainted with the scientific area of the student's thesis. The teacher's work includes the identification and shaping of the thesis' topic and the design of the project plan (schedule) together with the student. Furthermore the teacher supports the literature retrieval and gives regularly feedback to the research and development work in progress and to the work on the thesis report. To achieve a high quality both a teacher and a co-teacher should guide and support the student in his work on the thesis (dual-control – "vier-Augen-Prinzip").

The head of the ISG Research Group is the teacher of the student. A second senior scientist, who is a physicist, PhD in computer science, is co-teacher of the students, who work on a student's research project in medical informatics or a diploma thesis in computer science.

4.3.2 The Team as Peer-Group

The students get feedback from their teachers during special meetings and by email. They get feedback from the team when they present their work and on short discussions in the meetings (see Hearings, 4.6).

The students use also the opportunity for intermediate feedback by the team. The colleagues in the team are professionals, who work on the project and are acquainted with the problems, if not in detail so at least in a common sense.

If a student identifies a problem in the analysis, the design or the implementation of his tool, or if he does not understand an existing tool or its documentation, he is recommended not to hesitate to ask the team via email (isg@mi.rwth-aachen.de). By this he can be sure that he did not forget an expert. Furthermore he can reach alumnis (former team members) who can offer some help. A convenient period to muse about "How can I understand or solve this problem alone?" should be not longer than two hours.

4.3.3 The Surveyors

In computer science at RWTH Aachen University a student needs for his diploma or doctoral thesis two surveyors ("Gutachter"). At the Department of Medical Informatics the first is the chair of the institute. The second is mostly a professor of computer science at RWTH Aachen University.

In preparation of his thesis the student writes a proposal, which outlines the problem,

the idea and the planned approach together with a project plan and so far retrieved literature. This literature shall offer an overview on the stage of science and development on the area of the thesis (see section 4.4).

The student asks one of the professors, whether he would commit himself to function as second surveyor. Some professors agree just after a short talk with the student on the topic of the thesis, resp. its proposal. Some ask for a discussion with the student plus his teacher(s). Some ask for a lecture on the proposal.

In general after the submission of the finished thesis a second lecture takes place: the student presents his thesis in short (about twenty minutes) and afterwards the student and the teachers and the first and the second surveyor discuss the thesis. The surveyors consider the results of this discussion in their report on the thesis ("Gutachten").

The second surveyor is not a third teacher, but he often can make relevant suggestions for the thesis (eg. additional references or modifications of the approach).

4.3.4 Going Outside: Publications

The students, esp. those who work on their diploma or their doctoral thesis ar asked to publish one or two papers on their work. The submission to a conference or workshop is welcome as well. The students should focus on distinguished journals, conferences and workshops.

Student's research project: Publication is a CAN. The teacher asks the student after the ending, whether he wants to publish. If a student does not want to publish as first author, the teacher or the co-teacher can do this.

Diploma thesis in computer science: Publication is a SHOULD. The student is asked to announce, whether he wants to publish a paper four months after the start of the diploma thesis (two months before the deadline for the thesis). The teacher and the co-teacher support the student. Examples are [IKWS05] and [WWS06c]. If a student does not want to publish as first author, the teacher or the co-teacher can do this (e.g. [WISK05]).

Doctoral thesis in computer science: Publication is a MUST. The student who works on such a thesis wants to become a scientist. Thus it is a normal part of his work to publish. The student must submit a paper to a distinguished journal, conference or workshop at half time of his work (i.e. after identification, draft, literature review and first successes in analysis and design and implementation) and at the end of the thesis. Of course the student is free to publish intermediately.

Doctoral thesis in medicine: (Dr. med. / Dr. rer. medic. / Dr. med. dent.) Publication is a SHOULD, if the student does not want to become a scientist. The student is asked to submit a paper to a distinguished journal, conference or workshop at

half time of his work (i.e. after identification, draft, literature review and first successes of the study) and at the end of the thesis. Of course the student is free to publish intermediately. If a student does not want to publish as first author, the teacher or the co-teacher can do this.

Doctoral thesis in medicine: (Dr. med. / Dr. rer.medic. / Dr. med. dent.) Publication is a MUST, if the student wants to become a scientist. For the procedure see "Doctoral thesis in computer science".

Another platform to get feedback from scientists is the colloquium at the Department of Medical Informatics at RWTH Aachen University. The ISG Research Group used this platform several times: [WKW+03], [WKI+03], [Ißl05a].

4.4 Characteristics of Scientific Work

The theses are done both in computer sciences and in medicine. The term thesis means in this context: student's research project in medical informatics, diploma thesis in computer science, doctoral thesis in medicine or computer science and publications, e.g. in journals or on conferences.

Medical informatics is a supporting science for the health care area [Hem98]. It puts instruments and tools at the disposal of the health care professionals and scientists to facilitate health care, management, epidemiologic research, to name only a few, and last not least the communication. The development of concepts, programs and applications are important results of computer sciences research for the area of medical informatics [LzB02]. Certain steps are needed to fulfil the criteria of scientific work (see [Eco05], [DLLS02]):

- Identification of a problem.
- Formulation of an idea for a solution.
- Orientating literature research.
- Formulation of a research and development hypothesis.
- Definition of the goals including the requirements analysis on the application.
- Literature research and work.
- Design and description of the method.
- Development of the application, including the documentation.
- Testing, resp. evaluation of the application.

- Discussion of the results referring to the initial identified goals and requirements and to the stage of science.
- Identification of not reached goals and requirements and the explanation of this failure or the reasons for dropping the goals, resp. the requirements.
- Prospect for the solution of still open or new identified research and development ideas and needs.

These steps offer an idea on the content of a thesis. The following points are recommended to be considered during the work on a thesis.

Examples for the sections: Problem, idea, state of science, approach, in computer science: analysis and design, result (in computer science: implementation), evaluation, discussion and conclusion, outlook.

Literature work: It must show the stage of science and developments related to the topic. The research includes both scientific results and commercial or non-profit developments. Resources are libraries, the Internet and discussions with colleagues in the project team and with extern colleagues. Literature work must be repeated regularly: it is a continuous part of scientific work. The steps are "ask", "acquire", "appraise". The student should ask plain questions, for example "what do I want to do?", "who works already on this topic?", "what is their approach, their method, their failures, their successes, their results?", "did anyone already solve my problem?", "is it of sense to work on this problem?", "is my idea something special or just 'old wine in new bottles'?". The student must perform a systematical literature retrieval. Google is not enough. Relevant libraries like pubmed (`http://www.ncbi.nlm.nih.gov/PubMed/`), ScienceDirect (`http://www.sciencedirect.com/`) and the DLBP of the Trier University (`http://www.informatik.uni-trier.de/~ley/db/`) are just three examples for a sufficient research source. Students doing a diploma or a doctoral thesis must perform at least one hearing on the results of their literature work. The other students can perform this hearing if they wish. The teacher trains the students regularly on literature work, either in personal meetings or in a lecture to the team [Weß05b] and recommends to take part in a course on literature work at the library of RWTH Aachen University.

Proposal: In preparation of his thesis the student writes a proposal. It outlines the problem, the idea and the planned approach together with a project plan and so far retrieved literature. This literature shall offer an overview on the stage of science and development on the area of the thesis.

Reflection: During the thesis project the student should always ask himself: "Do I have a good feeling – on the topic, on my work?" Especially at the milestones "Topic and schedule", "Proposal" and "Requirements analysis" it is possible to adapt the

topic, the goal and the idea for the approach in cooperation with the teacher, the co-teacher and supported by the team.

4.5 Milestones in a Thesis

To ease the reading "student" means from now on all persons working on a thesis: student's research project, diploma thesis and doctoral thesis. The guidance and support of all thesis types follows a template.

It starts with one or several discussions of the student with the teacher to identify and shape the topic and to design the project plan for the work on the thesis (literature work, proposal, presentations to the team, development, writing). For students of computer science the co-teacher must take part in at least one of the early meetings.

The goal is, to afford a high quality of dual-controlled guidance and support and to avoid unnecessary waste of time by implementing too many meetings. In addition the student presents the work on his thesis regularly in a hearing (see 4.6) during the weekly team meetings to get feedback from both, his teachers and the colleagues in the team.

The procedure in the ISG Research Group contains the following milestones:

First contact A student contacts the teacher or the co-teacher with the request for or an idea on a topic of an thesis or with an idea on his own.

First meeting student and teacher The teacher (plus the co-teacher) and the student delineate the topic and sketch a first project plan. Furthermore the teacher gives a first overview on CM-PBL in the ISG Research Group.

Decision to join the team The student writes an email to the teacher and cc to the co-teacher announcing that he wants to join the team and to work on the sketched topic.

Design of the research approach and the project plan In a personal meeting the teacher (plus the co-teacher) and the student design the research approach and the project plan. The teacher introduces the student to the ISG logistics. The project plan considers the obligations of the student (studies, jobs, private plans). The project plan includes appointments for the hearings.

Joining the team The student takes part for the first time in a team meeting. Once and a while, a student, e.g. an external doctoral candidate, joins the team via email and meets the colleagues later on.

Access to the research server An ISG student assistant introduces the student to the ISG research server (see section 3.2: Tasks of the student assistants).

Proposal The student sends the proposal, including a project plan (schedule) on his thesis to the teacher and the co-teacher via email, and gets direct feedback (three to five working days).

Start-Hearing The student performs his first hearing in a team meeting. He presents topic, project plan, approach, open questions and discusses this with the team and the teacher (plus the co-teacher, if he is present). Students working on a diploma thesis use one of the early hearings as a training for their lecture to the second surveyor (see section 4.3.3). The hearing should take place in the third, fourth or fifth week after joining the team.

Hearing on the requirements analysis Often this step represents – together with the design – the most important part of a thesis in computer science. The requirements analysis and the design go not only for developments in computer science, but as well for example for exploration or evaluation studies in computer science, medicine or social sciences. Additionally the team can play the user role and help to identify requirements. "If you fail to plan you plan to fail." Thus the student should perform a hearing on this milestone as early as possible. For example should a student in a student's research project do the first hearing about four to six weeks after starting the thesis. The experience of the hearings in the meetings of the ISG Research Group showed that the student often wanted to perform several hearings on this point.

Hearing on the design The student performs this hearing in some cases in one hearing together with the requirements analysis.

Hearing on the implementation and test results Like "requirements analysis and design" this is to see as a incremental process. The hearings can help the student to realize whether the progress of the thesis is on a good way. Some students even use these hearings for a formative evaluation of their tool. The student must perform this hearing at least once. So far some students liked to present their results after finishing a chapter of their thesis, for example during a diploma thesis.

Final Hearing The student performs a final presentation with discussion and outlook plus a short software presentation. Sometimes this hearing includes the implementation and the test results. Students working on a diploma thesis use this final hearing as a training for their lecture to the second surveyor (see section 4.3.3).

Storage of a developed application on the research server This includes the documentation. If the application is embedded in a larger project the student works with the ISG student assistant on the implementation, resp. deployment and announces the accessability via email to the team and the teachers.

Theses drafts "Research is writing". The author introduces nearly every student to the work on a thesis with this sentence. She encourages them to start writing the report as early as possible. The report grows during the research and development

progress. The students sends regularly his thesis-draft to the teacher and the co-teacher via email. They give direct feedback via email or – on special questions – in personal meetings.

Submission of the thesis report The student sends the final version to the teachers, stores it in his "home directory" on the ISG research server and informs the team via email on this. Furthermore he admits three bounded print outs at the institute: one for the university, one for the teacher, one for the co-teacher.

Closure meeting with the teacher The student and the teacher meet at the end of the thesis to reflect the quality of the process and the result of the thesis, to identify points to improve by both the student and the teacher in future work, and to discuss the publication of a paper.

Of course the topics of the hearings change, for example if the student works on an explorative study using qualitative research methods or if he works on the evaluation of a tool or an application. The student and the teacher and co-teacher are free to ask for additional hearings or personal meetings during the thesis progress.

4.6 Hearings as Feedback Tool

4.6.1 What is a Hearing

The students present regularly on milestones of their thesis the stage of their research project (see "Milestones in a Thesis", 4.5). The ISG Research Group calls it hearing.

Webster's Dictionary defines a hearing as "A listening to facts and evidence, for the sake of adjudication; a session of a court for considering proofs and determining issues. ..." (http://www.webster-dictionary.org/definition/hearing accessed on June 24, 2004).

The team uses the term hearing for the following purpose:

The student has the opportunity to present his work to colleagues in a protected area. The colleagues are experts and discuss the issue with the author in a relaxed and open minded way. Nevertheless the student has to defend his work, e.g. the identification of the problem, the approach, the selected method, the expected results. And the student has to outline the stage of sciences and developments, he found during his work on existing literature. This is a good way to improve once capacity in presenting a topic and in reflecting the stage of one's work.

The goal is to identify problems, open questions, to discuss them and to identify possible solutions, resp. approaches.

The benefits of a hearing are:

- The number of experts for the discussion increases.
- The students get experience in presenting their work to a larger audience.
- The meetings are a protected area. Thus the discussions won't be as tough as in the "real world". The first steps are easier.
- The motivation to work in a professional way increases. Professional stands for in time, clearly, admitting delays and problems, being open for help, alternatives and questions.
- The students are trained in performing a professional discussion. So far the team members discussed very professional. This stands for being respectful, open minded, being open to help, to ask and to offer alternatives.

4.6.2 How to Prepare a Hearing

The teacher and the student appoint the first hearing during a personal meeting. The following hearings are scheduled at the end of a former hearing. The lecture is planned to last about 15 minutes plus a discussion of about 15 minutes.

The student performs a hearing based upon a presentation. He stores it as powerpoint file or PDF in his "home directory" on the research server one or two working days before the hearing is scheduled. The student informs the team via email.

By this the teacher can take a look beforehand and give the student some hints how to improve the presentation.

4.6.3 How to Perform a Presentation

Mostly a lecturer uses a ppt-file, sometimes extended by little films or the presentation of an implemented tool. The sheets shall support both the lecturer and the audience to realize, where in the presentation they are. Furthermore the sheets can support the discussion after the presentation. Every lecturer should be able to present his lesson without any technical support.

The author encouraged the students to find their own style. The following points are "soft rules", which the lecturer of course can break whenever he wants.

- At first the most important point: ask yourself: who is the audience? – Prepare the lecture for it. For example: emphasize on computer science and technical details and the scientific approach for computer scientists, or focus on the user and some sociological research methods and the user evaluation for social scientists.
- Design the presentation on paper: topic, structure, schedule (this means: how many minutes for which part?).

- Use a plain and clear layout.
- Avoid dark colors as background (it is exhausting for the audience).
- Use a heading and perhaps a logo on every sheet.
- Set a footer on every sheet, including your name, the date of the presentation and a numbering, perhaps including the total number of the sheets (e.g. 1/20).
- Avoid too much text on one sheet.
- Avoid whole sentences (exceptions: citations and definitions).
- Prepare and print a handout for the audience. The listeners can follow your presentation in a comfortable way and they can take notes. This is very important for exams, e.g. for diploma or PhD presentations.
- During the presentation: never read the text of a sheet (exceptions: citations and definitions).
- Take one sheet for about 90 seconds (note: balance this with sheets with just only a little information).
- Every sheet should contain a "closed point". Thus you can leap one or several sheets and explain them in one or several sentences, if the time runs short.
- Furthermore you should design the structure of your lecture in a way, which allows to spare whole parts of your presentation.
- Start the presentation with a sheet showing the title, your name, your affiliation, the date and (perhaps) the place of the presentation (e.g. on a conference).
- Give an overview on the parts of the presentation on the second sheet.
- Close with "Thank you" or something similar and – on conferences – your corresponding address.
- Test the lecture at first alone about 48 hours beforehand and then with your peer group (research group, team, friends). The date of the latter depends on your experience. Perhaps one week, perhaps just one hour before will fit your needs.
- And last not least: "Man kann über alles reden, nur nicht über die Zeit" – keep the conditions, especially the scheduled time of your presentation. Two reasons: (1st) it is a question of politeness to your audience; (2nd) you can learn from your audience, but only if there is space for discussion.

4.7 Quality Criteria of a Thesis: Formative and Summative Assessment

The teacher and the co-teacher formalized their informal discussion on the students' progresses and problems to facilitate a high quality of both the research process and the result, the theses. From April 2005 until June 2006 they met monthly to assess the students' skills and progresses and to decide on interventions if a student seemed to need it.

The criteria they used were on one hand criteria to assess the work on a thesis in computer science (see [DLLS02], page 64):

- Knowledge and Skills (Kenntnisse und Fähigkeiten).
- Systematic and Scientific (Systematik und Wissenschaftlichkeit).
- Initiative, commitment, independency (Initiative, Einsatz, Selbständigkeit).
- Quality of the result (Ergebnisqualitaet).
- Quality of the presentation of the result (Ergebnispraesentation).

As the training and teaching took place in a team as CM-PBL they assessed also the following soft skills:

- Reliability (Zuverlässigkeit).
- Openness (Aufgeschlossenheit).
- Determination (Ziele).
- Time management (Zeitmanagement).
- Team worker (Teamfähigkeit).

Each of the scientific criteria and the soft skills had a limit. If a student hit one, the teacher and the co-teacher discussed the topics and questions the teacher had to discuss with the student soon. "Soon" means that the intervention had to take place not later than one week after the assessment.

5 Example on the Coaching of the Students

The team meets weekly in the library of the institute to discuss the stage of affairs and to perform the hearings. The project manager (this is the teacher) documents the results of the meeting in the project documentation [Weß07a]. Every team member reads the documentation as preparation for the following meeting and gives instantly feedback if the documentation shows an error or misses something.

Two meetings in February 2007 represent a concrete example, how the team worked, how it was coached by the teacher and how the feedback of the co-teacher and consultant of the ISG Research Group was considered: Meeting 20070205 and Meeting 20070212 in [Weß07a].

In the project documentation the students, the trainees, the co-teacher and the teacher are named with their initials. The documentation allows nevertheless to identify the students. To protect the privacy of the students only members of the Department of Medical Informatics are offered access to the project documentation [Weß07a].

6 Explorative Evaluation of the Students' Satisfaction

The teacher and head of the ISG Research Group asked the team members continuously for their feedback on the method (CM-PBL) and their satisfaction with the progress and result of their thesis and the larger projects of the research group. This took place once in a while either at the end of the meetings or in face to face meetings with the students. One fixed evaluation was the closure meeting of the teacher with the student (see "Milestones in a Thesis", 4.5).

In December 2005 the teacher performed an explicit evaluation with the team and the co-teacher using a qualitative research method. Qualitative research methods like semi-structured single or group interviews and discussions allow a fast and comprehensive exploration of new insights [BD03], [WWS06b]. The students and the co-teacher knew this method from a lecture [Weß06b]. Some were trained in qualitative research methods [WWS06b], and used them in their theses (e.g. [Kar05a], [Wey06], [Sob06], [Hur07], [Ram07]).

The teacher's second role in CM-PBL is to work as the project manager of the team (see section 3.2). On the occasion of preparation of the "Annual Balance 2005 and Outlook 2006" on December 20, 2005 [Weß05a] she had realized that the work of several students on their student's research project thesis did last one year and longer. To learn what the reasons might be and whether the co-teacher and the students did realize this phenomenon too, and to see whether the team could identify some approaches to solve the problem, she decided to perform a natural group discussion on the meeting of Dec 20, 2005. A natural group discussion is a group interview with an existing group, e.g. a family or a school class or members of a club [Cor95].

The interview took place in the team meeting on Dec 20, 2005 after the presentation of the "Annual Balance 2005 and Outlook 2006" by the teacher (project manager). It lasted about thirty minutes. The teacher as interviewer, the co-teacher, nine students and one trainee took part in the interview.

The teacher was the interviewer and moderator of the discussion and took the notes. She translated the comments and statements of the participants not verbatim, but analogous from German to English. In the following the teacher is named as the interviewer. The footnotes are explanations for the reader of this report added by the author.

The starting question was: "What do you guess is the reason of the mismatch of the pretty large number of students and small number of finished theses per year?"

The interviewer called the attention to the length of the theses: "The number of students in the ISG Research Group is averaged over the year about twelve to fifteen, but per year only about two to six student's research projects or diploma thesis are finished. The four doctoral thesis are still under construction. The diploma theses are to finish in a certain period (three months preparation, six months work). Hence there remains most notably one type of thesis which is responsible for the long stay of the students in

the ISG Research Group: the student's research projects."

Hence the interviewer refined the starting question to "What do you guess are the reasons for the length of the student's research projects of more than one calendar year although the intended time is three months of full time work (about 400 to 500 hours)?"

The students and the co-teacher made the following statements.

Student: "The student's research projects are not intended in the studies of computer science at RWTH Aachen University. The specialty "Medical Informatics" (Anwendungsfach Medizinische Informatik) is the only specialty which requires this. The studies of computer sciences have a pretty tough schedule, which makes it difficult to perform a student's research project in one continued period. So the student must integrate the student's research projects as a "part time job" in his studies (including exams)."

Student: "The integration in the ISG Research Group offers the student a framework, which facilitates a rather continuous work on his student's research project and the integration in his or her studies, even if the students reduces his work on the thesis for a certain period."

Co-teacher: "The meetings function as a course like a seminar. So it would be fine for the students to get not only the certificate on the student's research project but also an examinable seminar certificate on the specialty medical informatics as part of the studies of computer science (diploma) ("Seminarschein in Medizinischer Informatik (Anwendungsfach/Nebenfach) im Diplomstudiengang Informatik, für die Prüfung anrechenbar")."

The students affirmed the statement of the co-teacher.

The interviewer described the intention of a student's research project in medical informatics at RWTH: "They mean to offer a training on scientific work. Sometimes this is the first training that the student gets during his studies of computer science. The student's research project can serve as a preparation of the diploma thesis, both concerning the scientific skills of the student and the topic or field, he works on." Then she asked the participants: "What do you guess?"

The participants affirmed this description and added: (Student:) "The successful integration in our studies is crucial."

The interviewer described the time and effort, the students have to invest in the participation in the ISG Research Group and asked for the benefit: "You have to take part weekly in the meetings, to read the emails and the project documentation and to give feedback to the work of your colleagues. Is it this worth at all?"

The participants made the following statements:

Student: "It is great." (verbatim: "Ich finde es super.")

Student: "The open character of the student's research project schedule is good."

Co-teacher: "The organization and guidance by the teacher in charge, this means the interviewer, should be more formalized, for example, the design of the project plan for the student's research project (schedule), the number and contents of essential and optional hearings."

This was affirmed by the "older" students. These are students who joined the ISG Research Group before August 2005.

The interviewer changed from the role of the interviewer to the role of the teacher and gave an immediate feedback: "The university does not prescribe a scheduled period for student's research projects and doctoral thesis as it does with diploma thesis. Hence the student and I design a project plan for an student's research project, but before summer 2005 I did not perform a detailed controlling on the progress of a single student. It is and should be in his own interest to finish the thesis (student's research project or doctoral theses) in an appropriate time. But what is appropriate? During summer 2005 I realized the perdurability of the student's research projects and the doctoral theses and decided to intensify the project oriented work in these two types of theses. At present I work with five students in this intensified style."

Affirmation by the "younger students" who entered the project since August 2005 by nods and smiles.

The teacher, the co-teacher, the students and the trainee (short: the team) decided that the teacher had to document the "Procedure of the Student's Research Projects" in the continued project documentation [Weß07d][1]. Furthermore she was asked to design a certificate on the seminar "Methods of project-based multidisciplinary Research and Development in Medical Informatics, Studies of Computer Science (Diploma), Specialty Medical Informatics" for both the students of computer science and of medicine, if a medical student joins the ISG Research Group and thus attends the seminar. The co-teacher supported her on the organizational questions.

The teacher designed two seminar certificates for the team members (computer scientists and students from other areas, for instance medical students). Every team member gets such a certificate after he or she finished his thesis. The teacher and the co-teacher decided to certificate only the last term, because they saw a certificate on three, four or even five terms as not convenient.

During the first team meeting in January 2006 the students gave feedback on "Procedure of the Student's Research Projects" in [Weß07d]. They accepted the description as appropriate. They noted that "The teachers and the student must consider, that the topics of the hearings change, for example if the student works on an explorative study using qualitative research methods or works on the evaluation of a tool or application." is an important remark.

[1] In this project report it is available in section "Milestones in a Thesis", 4.5.

7 Conclusion and Outlook

Continued Multi-Disciplinary Project-Based Learning (CM-PBL) in the work of the ISG Research Group was an enhancing development process.

The ISG Research Group started as small group: the teacher and four students, one of them as student assistant. The co-teacher and the chair of the institute supported the start with great commitment. Over the years the number of the team members and the research projects grew and the way to perform CM-PBL improved.

We can not answer the question whether CM-PBL is better than other approaches to train students, graduates and post-graduates as scientists. It was the way we – as I guess – had to do it: the author is a physician and a social scientist. Thus a second teacher with knowledge on the domain computer science was mandatory to guide and support the students and graduates who worked on a thesis in medical informatics.

Of course the resources of the co-teacher were limited. Thus we had to find a way how the work could be performed continuously and in a high quality. In addition the students should get a training based on realistic scenarios. It was good fate that the work of the ISG Research Group started with the question: "Can we build a web-based information system on hospitals that gives the user an up-to-date and intuitive overview on German hospitals? Where they are. What they do. And who does it." By this we got a realistic scenario: a research project on which the students could work in several sub-projects, their theses.

From the beginning on we implemented our work using project management tools, like the weekly meetings, the documentation, the use of the research server and the agreement on the policy (see section 3). We worked continuously on the improvement of our approach.

The statistics (4.2.1) show that 6 of 32 started theses were abandoned. Four of the candidates had time management problems, one fell ill and one changed the goal of her career. In addition to the 26 successful theses there are 4 trainees who succeeded in their trainee projects.

The students were satisfied with the way to work on a thesis (see 6). They appreciated to be trained not only as scientists but also in project work, collaborative work, multi-disciplinary work, presentation and documentation techniques – short in professional and social skills to be of use in their future professional career. They learned from each other and they trained each other – and the author.

They enjoyed to work as a team and they did a good job. Their great commitment and hard work on the Klinik-Scout Project in 2006 proved this (see [WB07], [WC07], [Weß07g], [Weß07e], [Weß07f]). The chair of the institute commended the work of the ISG Research Group (see Meeting 20070212 in [Weß07a]).

The author is contented to guide and support the students based upon CM-PBL. A

scientist who thinks on doing CM-PBL may consider some points: A teacher who is similarly the project manager of CM-PBL should be aware not to include too many students at a time in a team. The author assesses as appropriate: four students working on a student's research project (or a bachelor thesis), one or two working on a diploma thesis (or a master's thesis) and one or two doctorate candidates. This allows the senior scientist to work on his or her other tasks: co-teaching of one other team; teaching seminars, lectures and practical courses and workshops; the contribution to the development of curricula in medicine and in computer sciences; administrative tasks at the department; and last not least: the research, including publications, participation in conferences, fund raising (catchword third-party funds) and the communication and cooperation with scientists at other departments and universities and to the public.

The students' cooperation and the support of the co-teacher Dr. Cord Spreckelsen facilitated to develop and to improve CM-PBL. The author developed this method based upon own experiences with and training in project work in an international consulting company, literature work, training-courses in Problem-Based Learning at Maastricht University (NL) and last not least the continued cooperation, support and feedback of the students and the co-teacher. The comparison of CM-PBL with other teaching and training methods forms a suitable next step. It has to address resources, teachers' qualifications and participants' outcome.

C Weßel – March 2007
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8 Appendix

8.1 Appendix 1: Theses

8.1.1 Student's research projects in Medical Informatics

2007

Becker N. Anfragefunktion für eine strukturelle Objektdatenbank mit Sichten. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2007. CERES Project.

Raffelsieper M. Development of a Questionnaire for Web-Based Evaluation. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2007. CERES Project.

Tedjo I. Dynamisch adaptierende Benutzerschnittstelle für eine Objektdatenbank - Eine vorbereitende Analyse zur Auswahl einer technischen Plattform. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2007. CERES Project.

Geisler S. Gewinnung krankenhausspezifischer Texte aus unstrukturierten Textdateien. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2007. CERES Project.

Hurtz S. Exploration, Analyse und Entwurf eines UML-Klassendiagramms für eine Krankenhausdatenbank. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2007. CERES Project.

2006

Peltzer S. Quality Assurance in the Modelling Tool: Ganymed. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2006. CERES Project.

Soboll M. Mobile Patientendatenkommunikation in der Nofallrettung der Stadt Aachen. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2006.

Schüler M. Multizentrische Studien mit mobiler Datenerfassung: Zusammenführung und Identifikation der Daten. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2006. UMData Project.

2005

Sunadi L. ARIADNE - Reengineering of a Data Entry Assistant. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2005. CERES Project.

2004

Christoph U. CASSANDRA - A Reference Management Tool for BibTeX. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2004.

2003

Cho SN. PERSEPHOME - Consistency Management Using OCL, Postprocessing in

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Brüffer M. ARIADNE - Entwicklung eines Werkzeuges zur Steuerung der Erfassungsschritte während der Erstellung von Krankenhausmodellen. Studienarbeit im Studiengang Informatik RWTH Aachen, 2003. CERES Project.

2002

Weymann F. CAMESE - Entwicklung eines webbasierten Front-Ends für Janus mit automatischer GUI-Generierung. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2002. CERES Project.

Karakas G. CERES - objektorientierte Analyse und Design des Akquisa Fachkonzepts. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2002. CERES Project.

Palm S. KREUSE - Werkzeug zum Import relationaler Daten in eine objektzentrierte Datenbank zur Modellierung von Krankenhäusern. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2002. CERES Project.

Ißler L. TELLUS - Entwicklung einer automatisch erzeugten, interaktiven Visualisierung von Klasseninstanzen und deren Verknüpfungen. Studienarbeit im Studiengang Informatik, RWTH Aachen, 2002. Projekt CERES.

8.1.2 Diploma Thesis in Computer Science

2006

Weymann F. Repräsentation und Abfrage von Zeit-Aspekten in einem webgestützten, objekt-orientierten Informationssystem über Krankenhäuser. Diplomarbeit im Studiengang Informatik, RWTH Aachen, 2006. CERES Project.

2005

Palm S. Datenimport und Datenmigration in Objektdatenbanken. Diplomarbeit im Studiengang Informatik, RWTH Aachen, 2005. CERES Project.

Ißler L. Implementierung und grafische Deklaration objektorientierter Sichten. Diplomarbeit im Studiengang Informatik, RWTH Aachen, 2005. CERES Project.

Karakas G. Automatisches Generieren von webbasierten und benutzungsfreundlichen Informationsseiten über Krankenhäuser aus einer objektorientierten Datenbank. Diplomarbeit im Studiengang Informatik, RWTH Aachen, 2005. CERES Project.

8.1.3 PhD Theses in Medicine

Status March 2007

2 finished, promotion procedure open:

Möller W. Abbildung krankenhausspezifischer, ökonomischer Kennzahlen in einem objektorientierten Schema. Dissertation, Medizinische Fakultät, RWTH Aachen, 2007. CERES Project: PhD Thesis in Progress.

Weber T. Erstellung eines Evaluations-Leitfadens für eine web-basierte Informationsplattform über Krankenhäuser. Dissertation, Medizinische Fakultät, RWTH Aachen, 2007. CERES Project: PhD Thesis in Progress.

2 nearly finished, promotion procedure not yet opened:

Rams J. Informationen über Krankenhaäuser im Internet - Evaluation des Web-Frontends einer Objektdatenbank. Dissertation, Medizinische Fakultät, RWTH Aachen, 2007. CERES Project: PhD Thesis in Progress.

Crisan P. Bedarfsgerechte Formulierung von Texten für ein webbasiertes Informationssystem über Krankenhäuser mit Hilfe eines integrierten Textgenerierungsprogramms - Entwicklung eines Leitfadens. Dissertation, Medizinische Fakultät, RWTH Aachen, 2007. CERES Project: PhD Thesis in Progress.

2004

von Depka Prondzinski N. Integriertes Medizin-Controlling im Optimierungsprozess der Strukturen und Abläufe im Krankenhaus. Dissertation, Medizinische Fakultät, RWTH Aachen, 2004.

8.2 Appendix 2: Developments (Prototypes)

8.2.1 Tools and Modules in the CERES Project

Name of the Projects: "CERES: A Web-based Information System on Hospital Data" and "Klinik-Scout: Web-based Multi-method Evaluation of a Web-based Information System on Hospitals".

The student is asked as developer to choose a name from the Greek or Roman mythology. It can be a god, a goddess, fairies, messenger and attendants of the gods and human beings. The name is requested to have a meaning for the thesis. This is intended to ease the communication in the team and the self-concept of the student on his thesis.

CERES Software Development Guidelines: Support of the Computer Scientists during Analysis, Design, Implementation, Tests and Evaluation. [IBSW07], [ISW07].

CERES Web Application Style Guide: Support of the computer scientist during their work on web frontends for the CERES Project. [BW07].

MINERVA 1.0: Meta-Model of "the German hospital". Formulated as UML-Classdiagram (UML: Unified Modeling Language). Concept of the database schema of the central object database (ODB). [Weß07b], [WKI+3b].

MINERVA qb: UML class diagram of German hospitals based upon the quality reports of German hospitals 2004, published 2005. Serves as schema for the ODB. [Weß07b], [WSI+04], [WWS06a], [WS06].

MINERVA 2.0: UML class diagram of German hospitals based upon a bottom-up and top-down modelling. [Hur07].

CERES Views: Implementation and graphical declaration of object-oriented views. Tool for the modelling of specific schemata derived from the basic schema. Views facilitate to adapt the structure and the extension of the presented data to the needs of different user groups. [Ißl05b], [IKWS05].

ZEUS: UML-Editor for the design of the UML-classdiagram. Generates JAVA-classes for the database schema of the ODB. [WKI+07].

GANYMED: Database related quality assurance for the hospital meta-model MINERVA implemented in the proprietary UML editor ZEUS. [Pel06].

CERES Toolkit: Database access layer between ODB and applications. Simplifies the access. Provides further capacities (e.g. Views). [ISG07b].

CHRONOS: Representation and query of time aspects in a webbased, object-oriented information system about hospitals. [Wey06], [WWS06c].

PERSEPHONE: Consistency management during the data administration (DB-Updates and manual data administration). [Cho03].

KREUSE: Data transfer from relational to object databases. [Pal02].

APOLLO: Automated data import and data migration. [Pal05].

CAMESE 1.0: Web-frontend: Automated data presentation (tables) and manual data administration. [Wey02].

CAMESE 2.0 re-enigneering: Web-frontend: web-based manual data administration for the hospital data. [WB07].

CAMESE 2.0 read-only: Web-frontend: "Table" - presentation of hospital data in the klinik-scout (new in 2006 based upon CAMESE 1.0). [WB07].

ARIADNE I + II: Web-frontend: Support of the manual data administration. [Brü03], [Sun05a].

ARIADNE definer: Application to design tours for the manual data administration using ARIADNE. [Sun05a].

TELLUS: Web-frontend: Automated graphical visualisation. [Iß07], [IWSS03].

ATLAS: Web-frontend: Map with the location of the hospitals. [BBBW07].

ATLAS re-engineering: Web-frontend: svg-based map with the location of the hospitals. [BBBW07].

FABULINUS: Web-frontend: Automated textual data presentation. [Kar05a], [IKWS05], [WISK05].

PAN: Web-frontend: "Search" - plain search application for the klinik-scout. [PW07].

Klinik-Scout: html website: information for the user on hospital data and integration of Search, Table and Map and a help function. [WC07], [WWS06a], [WS06].

PORTUNUS Questionnaire: tool for the web-based evaluation of the Klinik-Scout. [WS06], [WC07], [Raf07].

PORTUNUS Logging: tool for the web-based evaluation of the Klinik-Scout. [WC07], [Raf07].

8.2.2 Tools in the UMData Project

Name of the Projects: "Monitoring von Unfällen im Kindesalter - Handheld-Computer basierte Datenerhebung" (Monitoring of children's accidents – mobile computer based data collection) and "Monitoring von Unfällen im Kindesalter - Pflege und Export mobil erhobener Daten" (Monitoring of children's accidents – maintenance and data transfer of data collected with nobile computers).

UMData: J2Me (Java 2 Micro Edition) based application for the data collection on a Palm PDA. [WSSB02], [WSC+03a], [WSC+03b], [WSC+04].

UMData Administration: Java based application for the data administration of the transferred data on a desktop computer. The data transfer uses Java coduits. [WSC+03b], [WSC+04].

UMDataMerge: Data merging of multi-local collected data. [WSC+04], [Sch06].

8.2.3 Web-based Reference Tool CASSANDRA

Name of the project: "CASSANDRA – A Reference Management Tool for BibTeX"

The tool was requested for the collaborative literature work and writing of the team members of the ISG Research Group. [Chr04b], [Chr04a].

8.3 Appendix 3: Project Reports

The reports are stored on the research server of the ISG Research Group in ftp://ceres.imib.rwth-aachen.de/c:/home/cwessel/cw_project_reports/

Weßel C. ISG Research Group. Handover. Aachen: RWTH Aachen, Department of Medical Informatics 2007.

Weßel C. Continued Multi-disciplinary Project-Based Learning (CM-PBL). Project Report. Aachen: RWTH Aachen, Department of Medical Informatics 2007.

Weßel C. The CERES Project. Klinik-Scout goes online - January 2007. Project Report. Aachen: RWTH Aachen, Department of Medical Informatics 2007.

Weßel C. The CERES Project. Formative Internal Evaluation of the Klinik-Scout Development 2006. Project Report. Aachen: RWTH Aachen, Department of Medical Informatics 2007.

Weßel C. The CERES Project. Klinik-Scout Questionnaire Development 2006. Project Report. Aachen: RWTH Aachen, Department of Medical Informatics 2007.

Weßel C, Christoph U. The CERES Project. Scout Website Implementation 2006. Project Report. Aachen: RWTH Aachen, Department of Medical Informatics 2007.

Weßel C, Becker N. The CERES Project. CAMESE - Re-Engineering 2006. Project Report. Aachen: RWTH Aachen, Department of Medical Informatics 2007.

Weßel C, Spreckelsen C, Camen E, Link M, Spitzer K. Projekt Unfallmonitoring. UMData 1.0 und UMData 0.1. Statusbericht und Anwendungsunterlagen. Aachen; Institut für Medizinische Informatik, RWTH Aachen 2003.

Weßel C, Spreckelsen C, Camen E, Link M, Spitzer K. Projekt Unfallmonitoring UMData. Statusbericht und Anwenderschulung. Aachen; Institut für Medizinische Informatik, RWTH Aachen 2003.

Weßel C, Spreckelsen C, Spitzer K, Böhmann H. Projekt Unfallmonitoring. Vorbereitung. Aachen; Institut für Medizinische Informatik, RWTH Aachen 2002.

8.4 Appendix 4: Publications of the ISG Research Group

8.4.1 Papers in Journals

Ißler L, Spreckelsen C, Weßel C. Implementing Software Development Guidelines in a Medical Informatics Research Project. Accepted for publication in Methods of Information in Medicine 2007. CERES Project.

8.4.2 Papers and Presentations on Conferences

Spreckelsen C, Claßen-Linke I, Baumann M, Herrler A, Ohnesorge-Radtke U, Rotgans J, Spitzer K, Weßel C. Neue Medien, Kommunikation, Didaktik in der Medizin. Ein Curriculum für Studierende der Humanmedizin. Akzeptiert als Poster auf der GMA 2006 - Jahrestagung der Gesellschaft für Medizinische Ausbildung an der Medizinischen Fakultät der Universität zu Köln 10. - 12. November 2006.

Weßel C, Spreckelsen C. A Methodological and Technical Approach to Web-based Multimethod Evaluation. In: Eysenbach G.(ed.) Improving Public Health Through the Internet. Abstracts Book, 11th World Congress on Internet in Medicine, Toronto, Oct 14-19th, 2006 (pg. 121). Toronto, ON: JMIR Publications. CERES Project.

Weßel C, Weymann F, Spreckelsen C. A Framework for the Web-based Multi-method Evaluation of a Web-based Information System on Hospitals. In: Löffler M, Winter A (Hrsg.) 51. Jahrestagung der Deutschen Gesellschaft für Medizinische Informatik, Biometrie und Epidemiologie (GMDS). Klinische Forschung vernetzen. 10.-14. September 2006. Leipzig: Universität Leipzig: S. 90. CERES Project.

Weßel C, Weymann F, Spreckelsen C. Streamlining Qualitative Research Methods for Medical Informatics - A Methodological Approach. Accepted paper as poster on the XX International Congress of the European Federation for Medical Informatics (MIE 2006), August 27-30, 2006, Maastricht, The Netherlands.

Weymann F, Weßel C, Spreckelsen C. Temporal extension of an object-oriented information system about hospitals. Accepted paper as poster on the XX International Congress of the European Federation for Medical Informatics (MIE 2006), August 27-30, 2006, Maastricht, The Netherlands. CERES Project.

Spreckelsen C, Karakas G, Laue M, Brüffer M, Spitzer K, Weßel C. Explorationsphase und Anforderungsanalyse für das rechnergestützte klinische Informations- und Wissensmanagement. In: Klar R, Köpcke W, KuhnK, Lax H, Weiland S, Zaiß A (Hg.) gmds Deutsche Gesellschaft für Medizinische Informatik, Biometrie und Epidemiologie 50. Jahrestagung, 12. - 15. September 2005. gmds dae, Freiburg 2005: S. 213-215.

Weßel C, Ißler L, Spreckelsen C, Karakas G. Bürgerorientierte Präsentation von Informationen über Krankenhäuser im Internet mittels automatisierter Textgenerierung. In: Klar R, Köpcke W, KuhnK, Lax H, Weiland S, Zaiß A (Hg.) gmds Deutsche Gesellschaft

für Medizinische Informatik, Biometrie und Epidemiologie 50. Jahrestagung, 12. - 15. September 2005. gmds dae, Freiburg 2005: S. 117-119. CERES Project.

Ißler L, Karakas G, Weßel C, Spreckelsen C. Presenting information about hospitals to multiple user groups via the world wide web. In: Engelbrecht R, Geissbuhler A, Lovis C, Mihalas G(Ed.) Connecting Medical Informatics and Bio-Informatics - MIE 2005 The XIX International Congress of the European Federation for Medical Informatics. ENMI European Notes in Medical Informatics Vol I No 1, 2005 ISSN 1861-3179: p 1231-1235. CERES Project.

Ißler L. Einfache objektorientierte Sichtdeklaration mit einem domänenspezifischen Ansatz. Kollquiumsvortrag am Institut für Medizinische Informatik, RWTH Aachen, 5. April 2005. CERES Project.

Weßel C, Spreckelsen C, Ißler L, Karakas G, Möller W, Palm S, Weymann F, Spitzer K. Die Qualitätsberichte der deutschen Krankenhäuser im Internet ab 2005 - Erstellung mit Hilfe des objektorientierten Metamodells für Krankenhäuser MINERVA. In: Ammenwerth E, Gaus W, Haux R, Lovis C, Pfeiffer KP, Tilg B, Wichmann HE (Hg.) Kooperative Versorgung. Vernetzte Forschung. Ubiquitäre Information. Der Mensch im Mittelpunkt der Gesundheitssysteme des 21. Jahrhunderts. Chancen durch Medzinische Informatik, Biometrie und Epidemiologie. GMDS Innsbruck, 26.-30.September 2004. Verlag videel OHG, Niebüll; 2004: S. 144-146. CERES Project.

Weßel C, Spreckelsen C, Camen E, Link M, Böhmann H, Behr E, Spitzer K. UMData - Handheld-Computer basierte Datenerhebung für das Monitoring von Unfällen im Kindesalter, 2004. In: Kirn S, Anhalt C, Heine C (Hg). Mobiles Computing in der Medizin. Proceedings zum 4. Workshop der GMDS-Projektgruppe Mobiles Computing in der Medizin, Universität Hohenheim, Stuttgart, 19. - 20. April 2004. Shaker, Aachen; 2004: S. 69-78. UMData Projekt.

Weßel C, Karakas G, Ißler L, Palm S, Weymann F, Möller W, Brüffer M, Cho SN, Christoph U, Spitzer K, Spreckelsen C. CERES. Webbasierte Wissensdatenbank (Knowledge Repository) für Krankenhaus bezogene Daten. Kollquiumsvortrag am Institut für Medizinische Informatik, RWTH Aachen, 5. April 2003. CERES Project.

Weßel C, Karakas G, Ißler L, Palm S, Weymann F, Möller W, Brüffer M, Cho SN, Spreckelsen C, Spitzer K. CERES - a webbased knowledge repository for hospital-related data. Abstract of the Posterpresentation. In: Knocke C (Hg.). LifeTecXchange. Technologies for Life Sciences. Proceedings. Aachen, 23. September 2003. LifeTecAachen-Jülich e.V., Jülich; 2003: S. 111. CERES Project.

Weßel C, Karakas G, Ißler L, Weymann F, Palm S, Spreckelsen C, Spitzer K. Ceres - ein Instrument zur webbasierten Darstellung, Pflege und Visualisierung von Krankenhausinformationen. In Koepcke W (Hg.). Informatik, Biometrie und Epidemiologie in Medizin und Biologie. Abstracts der 48. Jahrestagung der GMDS, 14.-19. Sept. 2003. Urban und Fischer Verlag, Jena; 2003: S. 361-362. CERES Project.

Ißler L, Weßel C, Spreckelsen C, Spitzer K. Tellus - eine interaktive Visualisierung zum einfachen verstehen komplexer Objektstrukturen. In: Koepcke W (Hg.). Informatik, Biometrie und Epidemiologie in Medizin und Biologie.Abstracts der 48. Jahrestagung der GMDS, S.537-538, Jena, 14.-19. Sept. 2003: S. 537-538. Urban und Fischer Verlag. CERES Project.

Weßel C, Karakas G, Weymann F, Ißler L, Brüffer M, Palm S, Spitzer K, Spreckelsen C. Das Akquisa-Projekt. Kollquiumsvortrag am Institut für Medizinische Informatik, RWTH Aachen, 5. April 2003.

8.4.3 In Books

Weßel C, Spreckelsen C, Lehmann TM. Bildungsmöglichkeiten zum Medizinischen Informatiker. In: Lehmann TM (Hg.) Handbuch der Medizinischen Informatik. 2. Auflage. Hanser, München 2005: S. 815-826

Spreckelsen C, Weßel C, Lehmann TM. Fachgesellschaften und Fachtagungen. In: Lehmann TM (Hg.) Handbuch der Medizinischen Informatik. 2. Auflage. Hanser, München 2005: S. 827-846

Spreckelsen C, Weßel C, Lehmann TM. Bücher, Zeitschriften und Journale. In: Lehmann TM (Hg.) Handbuch der Medizinischen Informatik. 2. Auflage. Hanser, München 2005: S. 847-864

Weßel C, Spreckelsen C, Lehmann TM. Internetadressen zur Medizinischen Informatik. In: Lehmann TM (Hg.) Handbuch der Medizinischen Informatik. 2. Auflage. Hanser, München 2005: S. 865-874

8.4.4 Aachener Schriftenreihe zur Medizinischen Informatik

Ißler L, Becker N, Spreckelsen C, Weßel C. The CERES Project - CERES Software Development Guidelines Aachener Schriften zur Medizinischen Informatik 2007; 01.

Weßel C, Lehmann TM, Spreckelsen C, Spitzer K. Vorschlag zum Curriculum Anwendungsfach Medizin im Vordiplom Informatik an der RWTH Aachen Aachener Schriften zur Medizinischen Informatik 2004; 01.

8.4.5 Manuals

Brüffer M, Weßel C. The CERES Project. Ceres Web Application Style Guide. Version 1.0. In German. Aachen: RWTH Aachen, Department of Medical Informatics 2004 and 2007.

8.4.6 Seminar Papers

Peltzer S, Schüler M. Kompetenzportal und -forum zur Unterstützung des Wissensmanagement in der medizinischen Lehre und Weiterbildung. Abschlussbericht im Seminar Wissensmanagement in der Medizin für Informatiker (Anwendungsfach Medizin; Hauptstudium) im Institut für Medizinische Informatik der RWTH Aachen, 2005.

Becker N, Schwittay B, Weyand T. Wissenslandkarte für Kliniken und Klinikverbunde. Abschlussbericht im Seminar Wissensmanagement in der Medizin für Informatiker (Anwendungsfach Medizin; Hauptstudium) im Institut für Medizinische Informatik der RWTH Aachen, 2005.

8.4.7 Teaching Materials

Weßel C. Evidence Based Medicine in der klinischen Anwendung. Vorlesungsfolien. Vorlesungsreihe: Querschnittsbereich EBM - Vorlesung und Praktikum Evidenzbasierte Medizin (Modellstudiengang Medizin). Aachen: Institut für Medizinische Informatik, RWTH Aachen 2006.

Weßel C. Krankenhaus-Informationssysteme. Vorlesungsfolien. Vorlesungsreihe: Querschnittsbereich EBM - Vorlesung und Praktikum Evidenzbasierte Medizin (Modellstudiengang Medizin). Aachen: Institut für Medizinische Informatik, RWTH Aachen 2006.

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Weßel C. Moderation II. Curriculum Neue Medien, Kommunikation, Didaktik in der Medizin (Modellstudiengang Medizin) - Seminarskript Wintersemester 2006/2007. Aachen: Institut für Medizinische Informatik, RWTH Aachen 2006.

Weßel C. Projektmanagement I. Curriculum Neue Medien, Kommunikation, Didaktik in der Medizin (Modellstudiengang Medizin) - Seminarskript Sommersemester 2006. Aachen: Institut für Medizinische Informatik, RWTH Aachen 2006.

Weßel C. Projektmanagement II. Curriculum Neue Medien, Kommunikation, Didaktik in der Medizin (Modellstudiengang Medizin) - Seminarskript Wintersemester 2006/2007. Aachen: Institut für Medizinische Informatik, RWTH Aachen 2006.

Weßel C. Wissenschaftliche Literaturarbeit. Einige Hinweise und Tipps. Vorlesungsfolien. Seminar: Methoden der projektbasierten, interdisziplinären Forschung und Entwicklung in der Medizinischen Informatik (Diplomstudiengang Informatik, Anwendungsfach Medizin) Aachen: Institut für Medizinische Informatik, RWTH Aachen 2005.

Weßel C. Evidenzbasierte Medizin, Digitale Patientenakte und Datensicherheit. Vorlesungsfolien. Vorlesungsreihe: Querschnittsbereich EBM - Vorlesung und Praktikum Evidenzbasierte Medizin (Modellstudiengang Medizin). Aachen: Institut für Medizinische Informatik, RWTH Aachen 2005.

Weßel C. Qualitätsmanagement. Vorlesungsfolien. Vorlesung / Praktikum Querschnittsbereich Gesundheitsökonomie, Gesundheitssystem, Öffentliche Gesundheitspflege (neue Approbationsordnung) Aachen: Institut für Medizinische Informatik, RWTH Aachen 2005.

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