Teaching Concept

Tobias Fiebig

Abstract

This document describes my personal teaching concept. I present my general approach to teaching in Section 1. Subsequently, I provide two case-studies of my previous teaching experience in Section 2. I conclude the document with an outlook on my planned future teaching activities in Section3. Specifically, I introduce four different course models, an introductory and advanced course for each, master's and bachelor's level, students.

Contents

1 Teaching Approach

My personal approach to teaching has been heavily influenced by my own experiences as a student. I enjoyed the privilege of doing my BSc and MSc in programs with distinguished teaching concepts [Reuer et al., 2003, Begnum et al., 2015, van der Ham, 2015]. Both programs use a high-interaction approach, which integrates students into the departmental teaching and research as well as academic live very early on. The focus of both programs in on an independent acquisition of concepts, without disregarding the gradability of individual students. In both programs this is done by a tight integration of theory and practice.

In Germany, academic teaching in general follows the ideas of Humboldt, even though he has become critically acclaimed in newer works [Stock, 2017]. Still, even in the light of the Bologna Process, the Humboldtian model of higher education is still a core element of the German academic culture [Horneber and Penz, 2014]. Hence, my personal views on higher education follow this concept as well, with minor limitations similar to [Krull, 2015]. In more modern terms, this entails that teaching has to be interdisciplinary to achieve ideal outcomes [Iver, 1990]. Following [Nikitina, 2006], interdisciplinary teaching for me is the applied teaching of context and concepts above facts learned by heart.

Above this, I want to impart more knowledge than pure facts and concepts (see [Schimank et al., 2010] as presented by [Krull, 2015]). Instead, I hold the competence to independently identify interrelations as the most valuable educational goal. Of course, this is no skill students can acquire by themselves. Instead, I see it as a Universities task to transfer this skill to students. Furthermore, this skill is invaluable for students' future careers, irregardless of them pursuing a scientific or industry career. To facilitate this, I also want to increase the interaction between students, a concept which has been proven to significantly increase learning outcomes in the past [Stadelhofer and Carls, 2002, Reuer et al., 2003].

A high interaction between students is especially useful to put sufficient demand on fast learners, while appropriately fostering weaker students. Loosely citing Dr. Koymans, one of my teachers at the University of Amsterdam, when I asked him if I could skip class, as I already knew the topic: *"Either you already know this subject, or you don't. If you don't, you have to be here to learn. If you do, you have to be here to help your fellow students. If you can't help them, you obviously do not yet know enough about the subject."* While this statement frustrated me back then, it now illustrates my personal opinion on learning in a university context. I personally strive to create an environment, in which a group of peers in the "quest for knowledge" tries to learn from each other. This approach, following a *"Society of Peers"* has certainly been influenced by my experiences in the dutch academic system. There, the egalitarian concepts of calvinism have been detached from religion, to be transferred to the academic culture [Wolters, 1983, Maassen, 1996, Benschop and Brouns, 2003].

Even though I envision a high degree of interaction between students, and want to focus on teaching skills instead of plain facts, grading is an important matter. Students have to have a clear understanding of what is expected from them [Kirk, 2004]. I try to realize this by formulating a foundation of facts and specific, learnable skills that are sufficient to pass a course. Based on this, I then create further requirements necessary to obtain better grades. For example, in a course on configuring networked systems, the base requirement would be being able to correctly configure all network systems discussed in the course in standard situations. Those, who can also address non-standard situations then get the next better grade, up to those who can also perform complex transfer tasks, e.g. apply knowledge obtained in the course to new problem fields. This concept can be implemented using a check-list for the final grading, leading to an objective assessment of individual students' work. I provide a case-study of such an approach in Section 2.

I realize that my concepts do require more personal involvement than classical teaching concepts [Aschersleben, 1999]. However, I am convinced, that may approach ultimately leads to a better education of students, which leads to better results in teaching *and* research. This conviction mostly stems from my bachelor, where students are involved into the research of the institute relatively early on [Reuer et al., 2003]. At the same time, courses also cover current research topics, partly adjusted to cater towards the needs of bachelor students. This results in students realizing already in introductory courses which practical applications the teaching material has, a concept long since known in pedagogics [Riemer, 2001].

In general, motivation is *the* central element of good teaching. Sadly, Students do not necessarily share the motivation and enthusiasm of a teacher. A course may be compulsory, and therefore students may not be that enthusiastic about the course. Other students may lack the basics of the field to be sufficiently motivated for a complex course. The assumption, that students do not have to be motivated and are as enthusiastic for a topic as oneself is a dangerous error. Sadly, I had to make this mistake myself, before realizing its impact, see Section 2. Since then I try to motivate students for a subject, independent from my personal enthusiasm for the subject.

Another challenge I initially overlooked are the different prerequisites students—especially on a master's level—have. Especially forma foundations tend to be an issue for many students joining from more applied schools. However, in my experience students are usually willing to catch up on these topics. Even though it is impossible to tutor every single student, as a teacher one should provide sufficient material for the students to find a starting point for catching up. For example, as presented in my first case-study in Section 2, while I found that students commonly have issues with correctly citing literature, providing them with a brief syllabus significantly reduced the students' problems with this in subsequent years.

In summary, I consider teaching as good teaching, if it finds a good balance between demanding and fostering students. The ultimate goal should be teaching students how they can independently acquire new knowledge. At the same time I realize that teaching is a dynamic process which has to be open for

suggestions and improvements. Hence, as a teacher, I want to facilitate consistent feedback from the students. Good opportunities to receive feedback are discussions with the student body and the anonymous course evaluation tools commonly offered by universities. Furthermore, it can be useful to anonymously test students progress, e.g., using tools like Pingo[1], a tool developed for this specific use-case.

2 Teaching Case-Studies

In this section I describe two examples from my prior teaching experience. Thereby I focus on how my teaching philosophy and strategy have influenced me in these cases. The examples used in this section stem from: (a) The Computer Security Seminar of the Security in Telecommunications research group at TU Berlin open for bachelor and master students, and, (b) A master thesis I advised at the Beuth Hochschule in Berlin.

2.1 Case-Study I: Computer Security Seminar

The Computer Security Seminar of the Security in Telecommunications research group at TU Berlin aims at teaching students the necessary skills for reading and writing scientific documents. Besides the methodological skills, students are also supposed to obtain a broader understanding of IT security, as well as a deeper understanding of a specific area of IT security. Due to the international focus of TU Berlin's master programs, the course is held in English.

2.1.1 Initial State

Bevor I redesigned the course, it had the following structure: At the start of the semester, all PhD students of the research group sent topic suggestions to the seminar coordinator. A topic suggestions consists of one to three publications and a related research question, which can be answered by literature research. During an initial appointment, the PhD students present their topics to the seminar's attendees. The attendees then sent a prioritized list of these projects to the coordinator, who then distributes them to the supervising PhD students. Subsequently, the attendees start to work on the assigned task.

In the middle of the term, an additional meeting takes place, where the attendees review each other's works and provide feedback to their fellow students. Feedback from the supervisors can be requested by the attendees at any time. In the end, every attendee has to hand in a term paper of unspecified length, and present the conducted work in a brief talk. These talks are held as a block course, commonly spanning up to three days. Grading is done weighted, based on the grade for the term paper and the talk, usually following the grading recommendations of the immediate supervisor.

2.1.2 Identified Challenges

The presented seminar has various advantages. The existing structure posed limited overhead on the supervisors as well as the PhD students. However, I identified several items that held opportunities for improvements.
Specifically, these challenges were:

1. **Insufficiently specified scope:** The seminar's scope is insufficiently defined. Before enrolling, students do not know what they can expect. This may lead to students being confronted with assignments, for which they lack the necessary requirements. Indeed, I faced this problem when participating in the seminar as a supervisor. A student from the math department joint the course to work on a project around theoretical cryptography, offered by one of my colleagues. However, as too many attendees applied for that project, the student was assigned to me, offering a project with an applied focus. As a mathematician, the student lacked the required basics of that field and dropped the course. She re-enrolled in the following year, and was able to obtain a slot with my colleague and passed the course at the top of her class.

[1] `http://trypingo.com/`

2. **Insufficient breadth of the topics:** Due to the specific topics offered by individual PhD students, attendees had to focus on a small aspect of computer security, instead of obtaining a wide overview of the subject. This could also lead to a limited set of topics being available, depending on which PhD student groups handed in topics. Furthermore, due to the attendee numbers, it was commonly the case that not all people attended all final talks.
3. **Not consistently gradable:** The high diversity of topics and possible supervisors makes fair and consistent grading impossible. This is further worsened by missing objective criteria and the different individual tasks. This lead to students with objectively easy topics handing in four page term papers, while those working on complex cryptographic algorithms easily exceeded 20 pages. As both were graded under the grade suggestions of their supervisors, this resulted in the same grades for different workloads. Under these conditions it is impossible to convey students that grading is fair.
4. **Inconsistent prerequisites in students:** When grading the submitted term papers, it became apparent that the foundations of academic writing (citing, consistent structure etc.) and reading (comprehending an article) are not evenly distributed among the attendees. Depending on the focus of their prior (bachelor level) education, a high variance was observed.

I discussed these challenges with the chair of the research group. While he agreed in general, he found himself to have not enough time to re-design the course. Hence, he allowed me to create the following concept, and subsequently apply it to the course.

2.1.3 Redesign

To address the identified challenges I redesigned the seminar along the lines of those courses I attended while studying cognitive science. To provide an easy introduction to the field, I choose "a brief history of IT security" as the overarching topic for the seminar. Under this premise, I selected the—in my opinion—15 most relevant papers from the last decades, one for each seminar appointment during the semester. Correspondingly, the seminar schedule switch to weekly meetings.

The seminar start with an initial meeting explaining the concept of the seminar and basic rules, e.g., on plagiarism, to the students. Furthermore, they receive an introduction to academic reading and writing. The slide set on this topic is also provided to the students, to level out their inconsistent prerequisites. Subsequently, each attending student gets one of the 15 publications assigned. If necessary, multiple students (up to three) can work on one publications.

All following appointments follow the same structure: First the responsible students have to present the paper for that session. In this presentation they should not focus on a deep understand of specifics of the work, but rather on the overall context of the presented paper. For example, for the paper "A method for obtaining digital signatures and public-key cryptosystems.", Rivest, R. L., Shamir, A., and Adleman, L. (1978) students to not have to develop an in-depth understanding of the used mathematics. Instead they should briefly present the rough concepts of the underlying technique. The focus of their presentation, however, should be on questions like: "Is this technology in practical use *today*?", or, "Is this algorithm still considered secure?"

After the presentation the students are supposed to lead a discussion on the topic. If this is impossible, the curse conductor is supposed to take over this role.

The term paper of the seminar is again supposed to cover "A Brief History of IT Security" The students receive clear guidelines on the minimum and maximum length of these papers. Furthermore, they are instructed that a simple reproductive summary of all presented papers, adhering to the seminars structure, constitutes the minimum passing requirement. To improve the work over the minimum requirements, they would have to, e.g., reflect on the used works, and other possible papers which should have been included in the seminar, evaluate what we can learn from these works today, or, reason about an alternate ordering/composition of these works, etc.

Gradescale	Talk	Report
1.0-1.7	Independently structured presentation of the assigned publication, with reflections on the scientifc context, using additional literature. Integration of points to lead the subsequent discussion or a distinguished transfer of knowledge for the concepts of the presented work.	Production of a paper on the provided topic, using publications presented in the seminar and further relevant scientific publications. Independent discussion beyond the topics suggested in the seminar.
2.0-2.7	Independently structured presentation of the assigned publication, with reflections on the scientifc context, using additional literature.	Production of a paper on the provided topic, using publications presented in the seminar. Independent discussion based on the topics suggested in the seminar.
3.0-3.7	Simple reproduction of the assigned publication with simple reflections on non scientific publications or publications referenced in the seminar.	Simple summary of the papers presented in the seminar, without simple introduction/connecting text/conclusion.
4.0	Simple reproduction of the assigned publication without further reflection.	Simple summary of the papers presented in the seminar, without any introduction/connecting text/conclusion.

Table 1: Overview seminar grading scale (German system).

2.1.4 Connection to current research

In the presented form, the seminar is not directly connected to current research. Instead, the focus is on a wider understanding of past research. In turn, this makes current research topics and the field itself more accessible to students.

However, the presented concept can be easily adjusted to focus on current research. Instead of using a publication roaster focusing on the history of IT security, the conductor has to select a set of papers on a current topic. In doing so, the conductor has to make sure that the seminar retains a consistent topic, i.e., there should be an overarching story/topic in the selected papers. This ensures that the scope of the seminar remains predictable for the students.

2.1.5 Grading

The biggest challenge of the existing seminar concept was the absence of a consistent grading schema, preventing objective grading of individual students. The new seminar model approaches this by subjecting all students to the same tasks under the same requirements. Thereby the term papers cover exactly the same topic, while the presentations do cover different works. However, as the underlying tasks in the presentations, establishing of and presenting on the context of a given scientific paper, is the same, this does not pose a significant issue. Following this, I developed a grading schema, see Table 1. The variance in the major grading blocks, e.g., a 1.7 instead of a 1.3, should be based on the overall editorial quality and execution of the task.

2.1.6 Summary

In summary, the restructuring of the course made it more practical. The clear set of rules and topics known before the course makes it more predictable for the students. While the interaction ratio between lecturer and students has increased, the amount of work required for the course was reduced, as not every year brings a new set of topics to be supervised. Subjective aspects in grading have been reduced by a clear and objective grading schema. Furthermore, following my personal conviction on good teaching, the course caters towards reflection and interaction between the students. However, to guide the students to the field of IT security, a broad approach is necessary, which does not tightly connect into current research. Yet, this is acceptable for an introductory course, even at a master's level. Furthermore, the concept can be easily adjusted to focus on a single, advanced topic. By exchanging the used publications for ones that deal with, e.g., quantum cryptography, the seminar can be converted to an advanced master's level course.

2.2 Case-Study II: Masterthesis

The second case-study is about the master thesis of a student from the Beuth university of applied sciences in Berlin, which I currently advise. This allows insights into how I direct advanced students and integrate them in my current interdisciplinary research.

2.2.1 Description

I was approached by a student from the Beuth university of applied sciences, who wanted to write a master thesis on the level of a research university. She approached me, as she was specifically interested in the current research I conduct with collaborators from TU Berlin [Kraus et al., 2015,Fiebig et al., 2016]. In their master thesis, students of the study program "media and computer science" should demonstrate that they are able to investigate a new research question using scientific methodology with the assistance of an advisor.

More specifically, the student is supposed to investigate the human factor in the operation of distributed systems. The focus hereby is on the experience of operations personell with security misconfigurations. For this, the student has to develop a questionnaire which can be used in a quantitative evaluation. This questionnaire has to be rooted in a focus-group/interview based qualitative data set. To ensure dissemination within the operations community, the student also has to participate in industry conferences on the topic of operations.

This is important, as the thesis topic does not only hold academic, but also practical relevance. By introducing the student to representatives of the industry early on she can obtain a first-hand impression of the practical requirements in the field. I know from my own experience, that this is an invaluable asset for a future career in academia as well as in the industry. Furthermore, this follows my personal idea of good teaching, i.e., the integration of theory and practice.

2.2.2 Connection to current research

As initially mentioned, this work tightly connects with current hot-topics in IT security. The basic motivation originated in my own interdisciplinary research, e.g., [Kraus et al., 2015, Fiebig et al., 2016]. Furthermore, various authors already discussed topics related to this issue, e.g., [Redmiles et al., 2016b, Redmiles et al., 2016a] and [Acar et al., 2016]. Nevertheless, the core-topic of this work has so far not been scientifically evaluated. Hence, this thesis also holds the potential of being transformed into a successful publication. In accordance with my views on teaching this provides additional motivation for the student, a key aspect of good teaching. Indeed, she can directly observe the practical impact of her work on current issues in academia and industry. Furthermore, I am able to connect my student with relevant researchers in the same area, due to my professional international network.

2.2.3 Promotion of independence

Note that the range of tasks in the presented thesis exceeds that of a classical master thesis by far. Especially the connection to current research and the integration of industry conferences induce significant overhead. Therefore, I as the advisor have to significantly support the student in those tasks that are not essential for the graded thesis. For example, I established connections to relevant partners in the target population, and assisted in the acquisition of the travel grant for attending the industry conference.

Hence, even if the student's contribution to those aspects that are not part of her thesis may be limited, she obtains knowledge in these processes, like preparing presentations, applying for funding, and establishing a professional network. These skills will become invaluable in the students later career. Hence, in summary, the thesis design introduces a wide field of opportunities, where the student can be iteratively introduced to more independence.

In addition, the scope of the work is tightly sketched by the selected empirical methodology. This allows a setting in which the student can independently start to explore the methodology, starting from a provided basic reading list.

2.2.4 Grading schema

The grading schema for the master thesis follows the major mark steps in the German system. See Table 2 for an overview. The goal of this construct is a clear and objective grading scale. It is based on the current state of the art grading schemes for thesis in Germany, e.g., [Lorenzen, 2002] or [Bänsch and Alewell, 2013].

Gradescale		General criteria	Sub criteria
	1.0	Above-avarage execution of the given task, with correct use of established methodology. Expressed reflection on the applicability of the selected methodology with further validation and critical use of existing literature. Extensive evaluation using established methodology.	Distinguished report following the requirements of scientific writing. Extensively connecting the work within the scientific context, with additional reflections on other authors' works. Use of visualizations that improve the comprehension of the evaluated data. Use of established validation/evaluation methodology with an additional comparative discussion of the results, exhibiting firm familarity with the techniques.
1.0-1.7	1.3		Excellent report following the requirements of scientific writing. Connecting the work within the scientific context, with additional reflections on other authors' works. Use of visualizations that improve the comprehension of the evaluated data. Use of established validation/evaluation methodology with an additional comparative discussion of the results.
	1.7		Very good report following the requirements of scientific writing. Connecting the work within the scientific context. Use of visualizations that improve the comprehension of the evaluated data. Use of established validation/evaluation methodology with an additional discussion of the results.
	2.0	Execution of the given task, with correct use of established methodology. Expressed reflection on the applicability of the selected methodology with further validation and critical use of existing literature.	Good report following the requirements of scientific writing. Connecting the work within the scientific context. Use of visualizations that improve the comprehension of the evaluated data. Use of established validation/evaluation methodology.
2.0-2.7	2.3		Report following the requirements of scientific writing. Use of good visualizations. Presentation of established evaluation methodology.
	2.7		Report following the requirements of scientific writing. Use of good visualizations with minor issues. Limited presentation of established evaluation methodology.
	3.0	Simple execution of the given task, with correct use of established methodology. Expressed reflection on the applicability of the selected methodology without further validation. Uncritical use of existing literature. Simple data evaluation with reasonable conclusions.	Report following the requirements of scientific writing. Use of appropriate visualizations.
3.0-3.7	3.3		Report following the requirements of scientific writing without significant issues. Use of appropriate visualizations with only minor presentation issues.
	3.7		Report following the requirements of scientific writing with minor issues. Use of appropriate visualizations with limited issues.
4.0		Simple execution of the given task, technically correct use of established methodology without reflecting on its applicability. Superficial data evaluaton, uncritical use of existing literature. Weak figures and visualizations.	

Table 2: Grading schma master thesis

This is done by defining a minimal set of requirements, constituting the minimum passing grade. Based on this, requirements for the major grade steps are established based on content (methodology, quality, literature work, etc.) as well as form (citations, presentation, illustration). Within those major categories, sub-categories establish the specific grade.

2.3 Conclusion

The presented case-studies allow insights into my previous teaching efforts. The focus of my past teaching has been on providing the students with broad insights and skills. At the same time, especially in the individual projects, I focus on providing students with a perspective on current research and into real world industry requirements. Therein, I consider it as important to provide the students with topics that cater towards their personal goals, especially for their future after they finished their degree. For example, in the presented case-study for a master thesis, the student was not sure if she should pursue a career in academia, doing a PhD in the context of Human Computer Interaction with an IT security focus, or in the industry. Hence, I selected a research intensive master thesis scope, which, at the same time, allows her to collect a network of industry contacts.

3 Future teaching activities

In this section I present four different courses I could immediately teach. Specifically, these courses address bachelor's and master's level students. For each degree level I present an introductory as well as an advanced course.

3.1 Introductory bachelor course

Introductory courses in computer science usually cover algorithms and the acquisition of the first programming language. Therefore, these courses are usually relatively large, with hundreds or up to thousands of attending students. Successfully conducting such a course is hardly possible just after joining a university, as it requires a solid foundation of tutors and teaching assistants.

However, there is a slightly edited form of these courses, which are feasibly teachable, even without extensive support by teaching assistants. Introductory courses commonly present a significant obstacle for students. Sometimes they are even considered a feasible "sieve" to "weed out" students who are not fit for the study program. However, these courses also provide an obstacle for students that are technical able to pass the course, but can not do so due to unexpected incidents. This may be having to move during the first semester, issues in the application process for student funding (BAföG), etc. This commonly affects students from lower income and non-academic households as well as minorities stronger than other students [May and Chubin, 2003, Rankin and Reason, 2005, Carter, 2006]. Hence, introductory courses also create an unintended *filter* for the diversity in the university system, presenting a significant challenge for universities.

However, these effects can be mitigated by providing a dedicated "catch up" course in the semester following the introductory course, accessible only to students that failed the prior course. This was, for example, successfully done in the University of Osnabrück, when the more applied sciences (Computer Science, Physics, Coginitive Science) realized, that the introductory math course provided by the math department hat a filtering effect on their students.

Hence, I suggest teaching such a tandem course for the introductory lecture in computer science. The course's contents would naturally have to mirror that of the corresponding winter term course. This determines the used programming language and the topics of individual lectures. In addition, I would use the following techniques to make the course more accessible for students:

1. **Personal presentation of homework assignements:** Following Prof. Dr. Vornberger, recipient of the Ars legendi-award for distinguished teaching, I would try to have students present their homework to a tutor each week. This allows tutors to directly react to specific aspects of the work which challenge the students most.
2. **Use of tutors that did the course in the previous semester:** As mentioned before, I want to integrate students into research and teaching from an early point in their studies. Hence, I would like to specifically recruit tutors from those students that passed the course in the previous year. Especially students who were just challenged by a topic tend to be more empathic for the problems one encounters.
3. **Direct interaction with students:** In Germany, higher education teaching usually creates a wall between students and the teacher. During the lecture, the professor teaches. Thereafter, all interaction is handled by teaching assistants and tutors. My experiences from the University of Amsterdam, however, tell me that it benefits students if the professor is directly accessible. By personally interacting with students, replying to questions via email and being to a certain degree engaging, an introductory course can loose its kafkaesque atmosphere.
4. **Interactive lectures:** Topics become more comprehensible, if they are taught in an interactive manner. A simple example would be explaining sorting algorithms by sorting students by size. Inducing "runtime" due to the communication between students needed to establish who is taller, one can easily convey concepts like "divide and conquer" or bubble sort. Furthermore, tools like Pingo[2] developed by the University of Paderborn allow teachers to directly receive opinions and guesses from students.

[2] `http://trypingo.com/`

Nr.	Lecture content	Homework
1	Foundations of python as an interpreter language, loops and conditionals.	Simple arithmetric code examples, string manipulation.
2	Datatypes (lists, dictionaries, etc.) and their manipulation.	Tasks on the manipulation of lists and dictionaries.
3	Reading datasources, stdin, JSON, CSV, etc.	Reading data, performing sort and filtering operations on read data.
4	Basics of visualization, boxplots, scatterplots, histograms. Basics of visualizations (scales, colors etc.)	Determining the ideal visualization for various example data sets.
5	Plots with matplotlib: First steps, how to accomplish last weeks' lecture's examples?	Implementing the plots from last week with matplotlib.
6	Guest presentation I; Me, the Data-Scientist. Data analysis in the industry.	-
7	Working with small and large numbers. Use of special number types with SciPy, log-scale and outliers.	Visualizations on datasets with very small/large numbers and outliers.
8	Filtering, splining, norming and transforming data with SciPy.	Tasks from selected real-world datasets, which become more readable using these techniques.
9	Network visualization, techniques for visualizing topologies and other networking related datatypes.	Visualizing various real-world network datasets.
10	Security and forensic data visualization, with a focus on memory visualization in a forensics context.	Tasks in a forensics context.
11	BigData on the CLI. Techniques for analyzing large datasets on the commandline/with Python/Matplotlib. Pittfalls in storing, sorting, and indexing data.	Plotting large public datasets, for which the techniques presented in the lecture are necessary.
12	BigData with distributed databases, using ElasticSearch as an example. Indexing data with ElasticSearch and plotting it with matplotlib.	Using ElasticSearch to perform the same tasks as last week.
13	Presentation of data sets which can be used in the final project. Presentation of the requirements of the final project.	Start of final project.
14	Guest presentation II; Me, the Data-Scientist. Data analysis in the industry.	Final project.
15	Feedback round for the final project.	Final Project.

Table 3: Overview of the lectures for the advanced bachelor project.

3.2 Advanced bachelor course

Computer security in distributed systems is, in general, an advanced topic. The required prerequisites easily often exceed what can be expected in a bachelor course. In addition, bachelor courses commonly focus on conveying skills that are essential for the field.

My course suggestions is based on the assumption that advanced bachelor students have already acquired the foundations of programming. However, they commonly lack applied knowledge, i.e., basic skills in statistics, measuring, evaluating, and plotting data. Hence I suggest an applied course that utilizes practical examples to teach students how to handle, process and plot measurement data.

Data analysis techniques are not only relevant in academia. Computer engineers regularly have to deal with problems, which they can only use by analyzing large datasets. To give the students an impression of the practical importance of data analytics, I will integrate presentations from real world engineers. These can present examples, on how they solved real challenges using visualization techniques.

Based on my personal tool chain used in my research, the course would use Python [Van Rossum et al., 2007] and Matplotlib [Hunter, 2007]. An overarching course book is "Applied Security Visualization" by [Marty, 2009]. To support students with the technical parts, "Programming Python" by [Lutz, 2010], as well as the "NumPy Cookbook" by [Idris, 2012] and the "matplotlib Plotting Cookbook" by [Devert, 2014] are viable choices. An overview of the course contents for a semester with 15 lecture appointments can be found in Table 3. Instead of using a classical exam to grade the course, a final project should be conducted, which spans the last three weeks of the course. In such a project, students have to analyze and visualize a public dataset.

3.3 Introductory master course

Contrary to bachelor programs, master programs usually aim at a greater, individual, breadth of topics for students.Therefore, an introductory master courses should provide students with an overview over the field. Hence, to motivate students for my research, I should offer such a broad course, which illustrates the differ-

ent facets of my field. The seminar described in Section 2.1 is ideal for this purpose. However, to connect the course tighter with current research, the used publications should be updated on a yearly basis.

3.4 Advanced master course

While progressing in their studies, students should start to independently work on challenges. A master project provides a sufficient context for this, without carrying the same restrictions as a master thesis. It allows students, to independently work on a meaningful project, without placing to many formal burdens on them.

For this, I will implement a concept developed at the University of Osnabrück, which drafted a collaborative study project, in which multiple students work together towards a common goal [Reuer et al., 2003]. The experiences from professors at the University of Osnabrück demonstrate the advantages of this approach. At the same time, it is well acclaimed by students. Note, that the results of these student groups regularly exceed what could naturally be expected during a master, without students being unable to cope with the workload. This demonstrates, that the study project format is well suited to implement my idea of "demand and foster", to introduce students to complex topics.

Following [Reuer et al., 2003], as praraphrase of the study regulations of the cognitive science program in Osnabrück, a study project takes two semesters. during this time, students should *"fully solve a task (from conceptualization to implementation). Successful attendance entails active participation over two semesters. The individual contributions of each student have to be specifically identified in a final report. It is suggested that students take the course in the second and third semester. This allows them to start their master thesis, possibly on a topic they got introduced to during the project, right after the project."*, [Studienordnung Cognitive Science, 2002, p. 63], following [Reuer et al., 2003, p. 188]. Please consult [Reuer et al., 2003] for an in-depth discussion of the concept.

Furthermore, in their publication, the authors remark that the study project is ideal to: (i) Prepare for future demands when working in the industry, (ii) Teaching the skill of independent, live-long learning, (iii) make studying more efficient, and, (iv) increase students enthusiasm [Reuer et al., 2003].

Indeed, they find that *"the students showed more commitment during the execution of the projects, which exceeded the level found in normal courses. As the students can, in most parts, determine the topic on their own, and because they are themself responsible for the project, we find huge enthusiasm over the major part of a year."* translated from [Reuer et al., 2003, p. 190]. Hence, I plan to conduct similar projects during my future teaching career. The topics of these projects will be driven by my own research, topics provided by industry partners, and—of course—by the ideas of the students.

References

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