Lecture Notes to Course INFPHD453EN-N
v1.1

Research Design & Research Strategies

Eötvös Loránd University (ELTE) Budapest

Doctoral School of Informatics

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Short Description of the Course

The course discusses diverse research strategies and their application to the participants' actual work. Participants, in group-workshops with coaching, strategically structure and classify their existing / planned research results and co-create a set of new research proposals in their respective field. The course is based upon an innovative framework for classifying research designs and for developing new research designs based on a set of archetypical strategies and templates. The concept was scientifically developed by the course lecturer and previously introduced in PhD seminars with international universities from Switzerland, Germany, Hong Kong, and including selected participants from ELTE. It is now offered as a regular course in the ELTE Doctoral School of Informatics.

The concept will be presented first in an introductory lecture. After approximately four weeks the PhD students submit a 1-page summary (described in Section 5) of their current research and when possible already the whole PhD with role-model-papers for their planned or potential research designs. The submission will be followed by a full day hands-on workshop with participants' presentations, peer-coaching, and assistance by the professor. Participants should join well prepared to share their questions, reflections, and criticisms with the professor and their colleagues. Using feedback from the workshop the participant submit their updated 1-pager as the final deliverable. The course will finish with a review seminar where the participants present and discuss their PhD research design and research strategies in a plenum.

This course targets PhD students after their 1st year or more advanced, but is also open to participants that are earlier or later in their PhD progress. It is limited to 15 participants.

1 Introduction to Design Science

The concept that this course follows is based on Design Science. Whenever we build something useful that fulfills some envisaged functionality we speak of a *design* and we call the result an *artifact*. In Computer Science such artifacts could be e.g. a system design, a method, a language or notation, an algorithm, a guideline, requirements, a pattern, or a metric (Offermann, Blom, Schönherr, Bub (2010)). In the scientific world, design science research focusses on building new artifacts and systematically documenting the individual design decisions and showing why an artifact is new and proves more useful in attaining given goals than any other related and existing artifact. Whenever we design new artifacts in Computer Science, there is an overlap with Engineering Sciences. However, also in other disciplines like medicine, law, and business administration, just to name a few, there exist many different kinds of design artifacts. That is, whenever humans are scientifically building something artificial, useful, and novel, we are scientific designers creating artifacts. Design Science is not an exact science like mathematics or natural sciences that show single and irrevocably provable solutions to a problem with empirical evidence, but leaves many paths open how to attain goals and solutions in different environments. But the research path and its documentation has to follow both scientific rigor and practical relevance as summarized e.g. in (Hevner et al. 2004).

Nobel Prize laureate Herbert A. Simon (1916-2001), one of the founding fathers of Computer Science and Artificial Intelligence, was advocating for an equal academic standing of Design Science (or "Sciences of the Artificial") next to natural sciences:

- The natural sciences are concerned with how things are.
- Design is concerned about how things ought to be, with devising artifacts how to attain goals.

According to Simon, academic education and research face the challenge to target *both* artificial and natural sciences at a high intellectual level. Design Science Research has its roots in Engineering and the Sciences of the Artificial as described by Simon (1996). In this seminal work Herbert A. Simon states that historically and traditionally, it has been the task of the natural science disciplines to teach about natural things: how they are and how they work. On the other hand, it has been the task of engineering disciplines to teach about artificial things: how to make artifacts that have desired properties and how to design them. Consequently, engineering is a Science of the Artificial that is, however, mainly taught and scientifically exploited by mathematics and natural sciences. While the use of many useful exact scientific methodologies from these natural science and mathematics is desirable, the decisive and inherent contributions in an engineering and innovation process would have to be left out scientifically without applying a design science approach, especially in complex innovation tasks. Devising a design science approach towards the engineering of digital innovation helps to overcome these limitations.

We agree to this point of view and advocate to use exact sciences and empirical evidence wherever it is possible and reasonable. However, a big part of scientific work can only be argued using design science which offers an elegant, or even necessary way in following rigorous scientific progress and documentation that would otherwise remain undocumented and lost. The goal of this course is not a full introduction to Design Science Research, however the given readings and the references included in these readings could give you a good starting point.

2 Your PhD as a Design

Whenever you are devising an experiment, writing a publication, or your PhD thesis you are also designing. Even if you are following purely mathematics or natural sciences, the combination and argumentation of your PhD research steps will be most probably a design even if you have not been explicitly aware of it so far. (In a way, the planning of your university studies and even of your whole life are designs. You will agree that these plannings are subject to too many uncontrollable influences to be called exact, but that their design and iterative improvement can be very useful to attain goals.)

- This course is about the application of design strategies to designing your PhD thesis, i.e. the structure and planning of your PhD is subject to such a design, not the content itself.
- In this course you will learn to structure and formulate your existing and planned research as a design and use it to focus your ideas, communicate, and also pivot, and find new research ideas.

3 Research Strategies

In Offermann, Blom, and Bub (2011) we have analyzed how design knowledge is created and also, how it can be derived from existing designs or how a new design can be re-used for other designs. In order to address the problem of systematic creation and re-use of design knowledge we adopted the concept of "generalization" and "transfer" from other disciplines. Here, "generalizability" suggests different levels of knowledge and "transferability" a lateral movement between settings.

In this context we defined a three-level separation of design abstraction (*narrow-*, *mid-*, and *wide-range*) and showed how knowledge generation and re-use strategies operate between and with them, as well how they relate to generalization and transfer (*Table 1*). The ranges mean different levels of theory relative to their distance to empirical observations. In Offermann, Blom, and Bub (2011) we introduced these three different levels of ranges of design as abstraction layers and discussed how generalization and transfer happens between different design ranges[1]. We identified distinct strategies to navigate between or within these ranges for knowledge creation, generalization, transfer, and re-use in a three step search process. First, we generated candidates based on the three types from *Table 1*. Then, we tried to find at least one published example for each candidate. In the last step, we pruned the candidate list of those strategies for which they could not find an example. This ensured that both the

[1] These ranges we originally labeled as *short-*, *mid-*, and *long-range*, but changed the wording later to avoid confusion with time-domain expressions.

types of design and the identified strategies are not merely theoretical constructs, but can be found in research. Please read this publication for further details.

Design type	Definition	Role in design
Narrow-range design	Design for a specific setting	An instance (system implementation, method enactment) can directly be derived from the design
Mid-range design	Design for a specific type of setting	The design can be used to create a narrow-range design for a particular solution of the same problem domain
Wide-range design	General insights about a type of design approach	Educational, as a starting point for dealing with a problem, illustrating a particular design "world-view"

Table 1: Types of design according to range of scope.

In Offermann, Blom, Schönherr, and Bub (2011) we added further reflection to Offermann, Blom, and Bub (2011) and identified additional strategy types based on a literature search based on the 148 papers of the proceedings of the leading conference on design in information systems and technology (DESRIST) from 2006 to 2010. This led to the identification of further strategies as well as further empirical grounding of the previously found strategies as the final set to be used by the framework which is depicted in *Figure 1*. We have also drafted abstract templates for each of these strategies that are listed in the *(Table 2)*. The empirical basis to create these strategies consists of scientific publications, i.e. the concept targets primarily research designs, although also transfer to non-scientific, practical design problems seems to suggest itself.

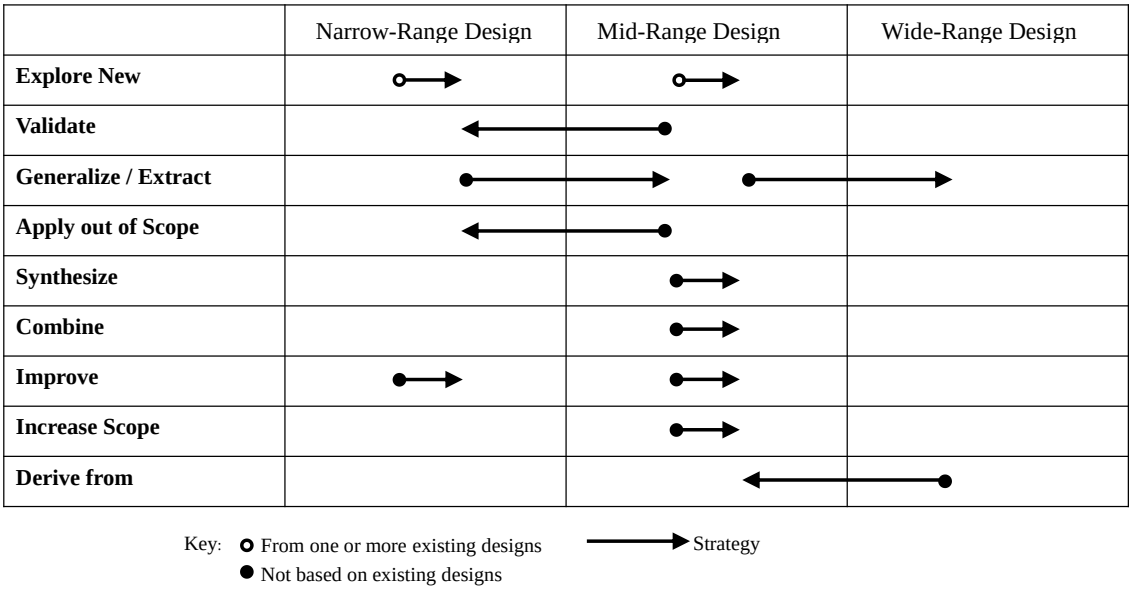

Figure 1: Strategies based on Offermann, Blom, Schönherr, Bub (2011).

The value of these strategies lies in consciously documenting, communicating, and educating about the scientific design, as well as in evaluating critical parts in a new or unfamiliar design. They make creative steps of the designer explicit and document them in a common structure. Moreover, they help researchers in identifying and performing design science and engineering research projects as they offer criteria to categorize their design. They help to make re-use of design knowledge more efficient. The "producer" of knowledge has a reference against which the work

can be described. The "consumer" of knowledge can describe the information need in a more standardized way. It enhances transparency and maturity of the design process and its subsequent communication – be it for scientific publications, project documentation, strategic reflection or educational purposes.

Strategy	***Abstract Template***
Explore new	In the field of [field of research], the problem of [problem description] has not yet been solved. In this paper, we propose a solution to the problem in form of [artifact type]. The solution is a [narrow|mid-range] design [solution name] that is applicable to [scope]. (We validate the utility of the design by applying it to [evaluation setting]. [Result of evaluation])
Validate	In the field of [field of research], a mid-range design in form of [artifact type] has been proposed to solve the problem of [problem description]. In this paper, we validate the design by [evaluation]. [Result of evaluation]
Generalize to / extract	In the field of [field of research], many [narrow|mid-range] solutions in form of [artifact type] exist to solve the problem of [problem description]. We look at the existing designs, identify commonalities and idiosyncrasies and propose a more general [new range] design. The new design can be used to inform [enlarged scope].
Apply out of scope	In the field of [field of research], the mid-range design [existing design] is usually used to [current scope]. In this paper, we evaluate if the design can also be used for [new scope] to [new problem]. [Result of evaluation]
Synthesize	In the field of [field of research], the problem of [problem description] can be solved by different designs. Available designs are [existing designs]. All of these designs have advantages and disadvantages. We analyzed the designs and propose a synthesized design that combines the strong points of the existing designs while overcoming their weaknesses.
Combine	In the field of [field of research], the problems of [problem description 1] and [problem description 2] often occur together. The first problem can be solved by [design 1], the second problem by [design 2]. We analyzed both designs and propose a combined design with an enlarged scope that addresses both problems at the same time.
Improve	In the field of [field of research], the problem of [problem description] is usually solved by [state-of-the-art designs]. All of these (narrow|mid)-range designs have shortcomings, because [shortcomings]. We propose an improved design that overcomes these shortcomings by [improvements]. (We validate the utility of the design by applying it to [evaluation setting]. [Result of evaluation])
Increase scope	In the field of [field of research], the [existing mid-range design] is meant to be used to [current purpose] for [current scope]. In this paper, we propose extensions to the design so it also can be used for [new scope].
Derive from	In the field of [field of research], the idea of [wide-range design] proposes solutions to [set of problems]. Based on these concepts, we developed a new solution to the problem of [problem] in form of a [artifact type] mid-range design.

Table 2: The templates for the abstracts for all strategies from Figure 2.

4 Case Study: Tailored Call Center Process

We will demonstrate the applicability of the approach in a case study (Bub 2019). It is structured as proposed by vom Brocke and Mendling (2017) in the following sections: Situation Faced, Action Taken, Results Achieved, and Lessons Learned.

Situation Faced.

An incumbent telecommunications company faced the problem of too high operational costs in the call center when compared to the competition. The decision was taken to set up an innovation project to introduce cost savings to automate part of the work of call center agents by means of automatic speech recognition resulting in an interactive voice response system (IVR). The company uses commercial off-the-shelf modules, but also has the skills to differentiate from the competition by developing additional new own modules. A project team was set up lead by the innovation process manager of the company internal innovation lab and business stakeholders. During innovation workshops, it turned out that a main pain from the stakeholders is the high costs per call due to tedious manual interaction of live call center agents. As a matter of fact, an automation of manual process steps would yield a high benefit (efficiency business case). Likewise, new value added services for target groups (gender and age dependent) would offer additional marketing and business opportunities at the call center customer front end.

Recognition of non-verbal features like age and gender beyond speech-to-text from a speech signal has been a topic that had only just emerged at the time of the project with no commercial off-the-shelf recognizers available. It was goal of this project to use classification of such non-verbal features in parallel to recognizers that convert speech to text in a call centers to make skill-based routing and market analyses in call centers possible. These features had to be developed individually in an innovation project.

Action Taken.

In this context emerged the idea to tailor the IVR call process flow according to age and gender of the caller. This would enable the call center agents to save time for pre-classifying the caller and automate part of the dialog script. This would result in saving time and effort and thus reducing the costs per call as the human interaction is the most cost intensive.

The researchers identified the research design problem of Age and Gender recognition in the domain of speech recognition. Knowledge of literature yielded several approaches, but none of them ready for immediate use on the problem. The second research question was how to best tailor the IVR dialog given knowledge of age and gender in order to achieve the goals.

Thus, the research design strategy followed in two steps. First, the team contributed to science with the design and comparison of four different approaches for age and gender recognition and the subsequent comparative empirical evaluation in a laboratory experiment (Metze et al. 2007) on the same speech database. The recognition task was to differentiate 7 groups for age and gender: children of 13 years and younger, young people between 14 and 19 years (male/female), adults between 20 and 64 years (male/female) and seniors of 65 years and older (male/female).

The best performing method was an adapted design based on an existing Parallel Phone Recognizer (PPR) (Zissmann 1996). For easy tasks its precision is comparable to human performance. PPR was originally developed to recognize languages (like English, German, Hungarian, etc.), not gender and age. According to the classification from *Figure 1* the design adhered to the strategy *Increase Scope* as the scope was increased from language identification by recognition of age and gender of the speakers. For more details of the recognizer please refer to System A in (Metze et al. 2007).

In the second design step the team combined commercially available recognizers that are used for speech-to-text tasks with our own PPR classifier for non-verbal speech used in parallel on the same speech signal. In the classification exhibited in *Table 2* the chosen innovation design is *Combine* because the innovation is based on a novel combination of existing designs.

For the Gate 2 presentation the design strategy was stable according to *Table 3*.

Design Contributions	Applied Design Strategy	Artifact Type	Description of Implementation
Design Step 1: Create innovative module for recognition of age and gender	*Increase Scope*	*Algorithm*	Use PPR recognizers from Language ID scope and increase their scope to age and gender recognition task.

Design Step 2: Create new tailored IVR dialog	*Combine*	*System Design*	Use existing COTS recognizers / IVR tools and combine with new module for age and gender recognition

Table 3. Research Design for Case Study, applying the design strategies from Figure 2.

The corresponding abstract templates form the *Table 2* are deployed accordingly as follows:

Applied Design Strategy	Adopted abstract of Design Strategy
Increase Scope	"In the field of Automatic Speech Recognition, the PPR (Parallel Phoneme Recognizer) is meant to be used to recognize languages for language identification in ASR systems. In this paper, we propose extensions to the design so it also can be used for age and gender identification."
Combine	"In the field of Interactive Voice Response Systems, the problems of Speech-to-Text and Age and Gender Recognition often occur together. The first problem can be solved by Commercial-of-the-Shelf recognizers, the second problem by the increased scope of a PPR. We analyzed both designs and propose a combined design with an enlarged scope that addresses both problems at the same time."

Table 4. Adjusted abstracts for the chosen Design Strategies

Results Achieved.

The empirical evaluation showed improvements of mean opinion scores of live users and average ratings of users when compared to a conventional routing (Metze et al. 2008). Yearly efficiency gains could be quantified with 42 Million Euros.

Lessons Learned.

On the one hand it works well in order classify the actual design work and thus document better the actual innovation steps. It could be used for the analysis of a wealth of past engineering projects and make their results available for the DSR body of knowledge.

5 Creation of a 1-pager

The plan for a set of publications or the whole PhD can be decomposed into a set of basic research strategies using the abstracts from *Table 2*. As a preparation work for the core workshop you will be asked to create such a 1-pager for your existing publications, envisaged publications, or any other thought on how you would like to design (modules of) your PhD thesis. If already possible, design your whole PhD outline with all necessary modules and prepare one publication per design strategy. If you already have scientific workshops, conferences, or even journals for publication in mind you can name them and plan them on a timeline.

Example from an earlier course (courtesy of cand. PhD Anna Reale):

Author: Anna Reale, <student number>, <version number>, <date>, Supervisor <name>
General PhD Topic Description Distributed Computing in 5G Mobile Networks is a potential requirement for certain applications that depends on low latency and information sharing. My research revolves around 5G and Edge computing, how to divide and deploy applications in these infrastructures, keeping in mind user and network node mobility, resource availability and usage costs.

Ranges of the Work

Narrow	Mid	Wide
Performance tuning of an existing AR application deploying it correctly on a 5G Edge network.	Tool to suggest division and deployment of applications on a 5G Edge network.	Framework for deploying, migrating and organizing applications on the 5G network.
Existing AR application divided in containers that can be run in different nodes of the network.	5G network context discovery, 5G network modelling, 5G network resource planning	5G network orchestrator

Previous Work

The whole work is based on applying findings from two different scopes: Virtual Networks Functions and Cloud Computing. After synthetizing the state of the art of both fields, we selected what solution where closer to the 5G infrastructure scenario and combined them.

Synthesize mid-range (Survey on computation offloading and framework proposal)
In the field of Distributed Computing the problem of computation offloading can be solved by different designs. Available designs are concentrated on frameworks for adapting and optimizing how to autonomously compose the partitioned application with some basic model for managing context delivery. CloneCloud concentrates on offload optimization and service availability. The limit of this approach is that it ignores the fact that different optimal partitioning solutions can be found for different inputs. Pedrosa et al. suggests to improve by adding awareness of the complexity associated to the inputs. There are also hybrid approaches as those proposed by Verbelen et al. All of these designs have advantages and disadvantages. We analyzed the designs and propose a synthesized design that combines the strong points of the existing designs while overcoming their weaknesses.

Apply mid-range out of scope (Path computation and Function Placement applied to application deployment on 5G)
In the field of and Virtual Networks Function (VNF) the mid-range design for the Path Computation and Function Placement Problem (PCFP) is usually used to solve service placements problems. In the paper “Application partition placement for mobile cloud”, we evaluate if the design can also be used for planning placement of applications to 5G Edge computing mobile network. The result is a promising simulation satisfying user requests. For our specific set up and our AR application, there is a possibility to implement a distributed scenario with a reasonably low overhead.

Combine mid-ranges (Application partitioning and Service deployment combined in a tool to simulate 5G network)
In the field of Cloud and Mobile Computing, the problems of Application Partitioning and Service deployment often occur together. The first problem can be solved by modelling the application as a graph and applying a multilevel version of the KL algorithm, the second problem by a fractional relaxation of the PCFP-problem. We analyzed both designs and propose a combined design with an enlarged scope that addresses both problems at the same time.

Possible future work

Increase scope mid-range (From AR application framework to generic 5G application framework)
In the field of Edge Computing for Augmented Reality, the framework for computation offloading we developed is meant to be used to support application migration and reduce latency of AR applications. In this paper, we propose extensions to the design, so it also can be used for any latency sensible application.

Explore new narrow-range (Find a way to orchestrate 5G edge and fog network)
In the field of Fog and Edge Computing, the problem of resource orchestration has not yet been solved. In this paper, we propose a solution to then problem in form of a tool to simulate distribution of network and computational resources. The solution is an had hoc network of nodes deploying Docker containers design that is applicable to simulate and make orchestration decisions for Fog and Edge. (We could validate the utility of the design by applying it to an existing ML application confronting its distributed and the sequential version). [Result of evaluation]

Validate as narrow-range (Validate the choice of containers for 5G application migration)
In the field of Fog and Edge computing, a mid-range design in form of container-based infrastructure has been proposed to solve the problem of applications and services migration. In this paper, we validate the design by simulating its performance with different applications and user interaction scenarios. [Result of valuation]

Derive from wide-range to mid-range (apply algorithm from Ad-Hoc network theory to a fog network simulator)
In the field of Ad-hoc networks, the idea of Heterogenous Resource Algorithms proposes solutions to resource sharing and communication between nodes. Based on these concepts, we developed a new solution to the problem of handling code offloading in form of a simulation tool applying HRA to fog networks orchestration mid-range design.

6 Task Assignment

6.1 Before Introductory Lecture

- Must: read Offermann P, Blom S, Bub U (2011) and Offermann P, Blom S, Schönherr M, Bub U (2011).
- Optional: read Bub (2019) before introductory lecture.

6.2 Before Core Workshop

- Prepare 1-pager of your research, submit one week before Core Workshop. It will be distributed to the other participants.
- Study 1-pagers of participants as preparation for your feedback to your peers.
- Prepare presentation, e.g. poster. Ready at Core Workshop date.

Please include your names on your one pagers as well as the name of your supervisor. Please assign a version number and the date as you will create at least one update before the final workshop.

6.3 Core Workshop

In plenum:

- Use 5 slides to present yourself, your general work (name your topic, supervisor, also private aspects that help to understand you as a person).

In breakout sessions:

- Choose a presentation format you prefer to use in a breakout group of maximum 4 people, e.g. a poster. Use the concept of Design Ranges and Design Strategies as a format for discussion: structure, focus, present, compare, discuss, normalize, get feedback, pivot, experiment. Identify the core of novelty of your work and make it explicit.
- Rotate within one breakout group: i.e. listen and give feedback to the presentation of your peers.
- Everybody should present at least twice in different breakout groups.

6.4 Finalization of 1-Pager and Review Seminar

A final review workshop will be organized (approximately one month after the core workshop) where the final 1-pager will be presented and discussed in a plenum.

- Submit updated 1-pager based on feedback that you have gathered during the core workshop *one week* before the final review seminar.
- Your 1-pagers will be made available to your peer participants. Review also these 1-pagers of your peer participants in order to be able to discuss and give them feedback during the final workshop.
- Present your updated 1-pager and/or updated presentation at final workshop (plenum). The format of the presentation can be chosen by the presenting participant (e.g. poster, slides (ppt), plain 1-pager, flipchart, etc.). Experience from past seminars suggests either a poster or slides presentation formats as best choices.
- For 15 participants the workshop will last a full day. At the end of the day all participants understand the design and the strategies of their peer co-participants. Count for
    - 10 min. of presentation
    - 10 min. of questions and answers, comments
    - 10 min. of buffer

6.5 Advice to fill out tasks

- Design Ranges are not equivalent to a research plan and do *not* describe activities and milestones on a *time horizon*. Design Ranges are an abstraction level that can be used to model your research activities as a movement within or between these abstraction levels.
- However, Design Ranges and the Design Strategies can be used as a component to describe the research plan.
- It is thinkable that in your field, more than three design ranges can be argued - or also only two of them. As a designer, you should come up with a proposal of three rages that are most useful for this exercise, not with a holistic approach to structure your whole field.
- Your Design Strategies do not necessarily have to address all three Design Ranges. (Addressing all three Ranges within one PhD is rather an exception in my opinion.)
- Use nouns for the description of Design Ranges, not verbs. The Design Strategies themselves, however, describe an action to navigate between the ranges from *Table 2* and are phrased by verbs ("validate", "explore", "combine", etc.)
- It is possible that more archetypes than the presented ones exist for research design. Please indicate and we will check if the expansion of the concept by introduction of a new strategy is useful.
- Usually, a PhD exists of a series of designs (sometimes nested). Very often, it is advisable to package one design in one publication (conference or workshop).
- Abstraction levels (aka Design Ranges) are important in research, as well as moving between them

7 Organization and Rules

We will create break-out groups of three plus one note taker. We will rotate, so that every participant can present at least two times to times to a different set of peers.

You will get the credits for the course only if you have

- submitted your 1-pager one week before the Core Workshop.

and

- participated in the Core Workshop with your presentation and as a peer reviewer of your colleagues' presentation.

and

- submitted the final version that is updated using the feedback from the core workshop before the review seminar.

and

- presented your research design.

It is expected that you participate actively in the discussion of your peer participants. You have to consent that all participants will have the reading rights to your 1-pagers and workshop presentations.
The content and quality of your PhD work itself will not be subject to grading of this course nor will it be challenged. Only your PhD supervisor and the specialized scientific community in your field of research should do that. The focus will be the design of your overarching research strategy, using the individual building blocks from your field (i.e. one abstraction layer higher than your research field) and the active and constructive discussion of it.
If you find a new strategy that is not covered by the existing 12 ones from Table 2 then please suggest so. The presented concept does not claim to be complete or holistic.

8 Conclusions from earlier courses

A selection of feedback and advice from ex-participants:

- "It is needed early on to have in mind at least one narrow-range Design and a mid-/wide- one related to your PhD. They can help panning concrete research activities and keep the work structured."

- "Templates can be used also as a starting/common point of discussion with peers when approaching a new publication. Also good to win over white page block." (overcome writer's block)

- "Using the templates helped me to focus a publication project by rewriting the abstract draft. The paper was subsequently submitted and accepted by the conference."

- "Designing a future publication forced me to plan ahead in details. This consequently shortened the time I spent from ideation to publication."

- "Having to present your ideas early on in the research helps interiorizing your work and discovering possible future collaborations."

- Especially useful in contributing to my learning success were
    - "Having the opportunity to talk about my research ideas and getting direct feedback".
    - "To give feedback to other students and to get feedback from students and professors".
    - "Experimenting and pivoting several strategies in the feedback sessions. Although not all new ideas proved finally feasible, it helped me to form and underpin my own approach better."
- "I received valuable inspiration from other research communities than my own one." (outside-in view)

- "The course has provided very useful insight on safer ways to structure the potential future advancements of my PhD endeavour (such as a research "track"), especially considering the narrow-/mid-range planning."

Additional comments about the joint format with the Dotoral School of Management of the University of St. Gallen, Switzerland, which can take place in an off-site setting with participants from multiple disciplines:

- "OffSiter Atmosphere helped to freely tackle the problems in my thesis development."

- **"**Offsite location and exchange with professors" [was especially useful in contributing to my learning success]

- "The workshop with the University of St. Gallen has been a very useful experience, especially in regards to the interaction with researchers belonging to different academic fields. The necessity of adapting the way I explained my research topic and plans helped me to look at my work with a different point of view and the feedback I received was extremely valuable."

Let us close with the remark that the presented concept serves as one further tool to shape your PhD. At the same time we do not want to overload the concept by expecting that you use it for all of your future research designs. The course has been already successful if it has helped you to make progress to your work and to open your mind for further ideas. After the course it will be your own decision what concepts to follow up with and with which ones not. Let me wish you best of success with your further PhD studies!

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