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A Teaching Framework for the Methodically Versatile DSR Education of Master’s Students

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A Teaching Framework for the Methodically Versatile DSR Education of Master's Students

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ABSTRACT

Design Science Research (DSR) has become a widespread paradigm in the Information Systems (IS) discipline to design and evaluate novel artifacts for relevant problems in a scientifically rigorous manner. With its potential to complement the traditional IS curriculum, DSR education is gaining popularity in academia, despite still being in its infancy. Our contribution applies DSR for designing and evaluating a DSR teaching framework (TF) derived from reused and expanded design principles from literature. Our approach mediates the paradigm's methodical versatility to master's students, empowering them to evaluate and create their own DSR projects interactively. We evaluated our DSR TF in a workshop with DSR educators from three countries and six universities to discuss its applicability for reuse. Additionally, we surveyed former course participants to gather their feedback and reflect on their experiences.

Keywords: Course development, Design specification, Higher education, IS education research, Teaching framework

1. INTRODUCTION

Design Science Research (DSR) has largely gained popularity, especially in the Information Systems (IS) domain but also in many other disciplines (Geerts, 2011; vom Brocke et al., 2020), due to the way that its design-oriented and paradigmatic nature complements traditional research approaches (Thuan et al., 2019). The DSR paradigm has evolved extensively and makes a transdisciplinary contribution by adding economic and societal value (Gregor & Hevner, 2013; Winter & vom Brocke, 2021). It manifests its strengths by combining scientific rigor with practical relevance (Hevner, 2007). In contrast, the teaching of the DSR paradigm is still strongly underrepresented in academic curricula, so the potential of a well-founded scientific education in the DSR methodology remains largely unexplored (Winter & vom Brocke, 2021). This poses a problem, as systematic and context-adapted DSR training is essential to continuously drive research on design science education with high-quality contributions while solving increasingly complex real-world problems at the intersection of rigor and relevance.

Moreover, due to its wide scope of applications, the DSR paradigm's capability of adapting to fast-paced environments might complement the traditional IS curriculum, as learning and teaching have been changing noticeably in recent years (Abdullah et al., 2022; Goldkuhl et al., 2017). For instance, a shift from knowledge-based teaching to experience-based, interactive learning is taking place (Finster & Robra-Bissantz, 2020; Pettersson, 2021). It provides opportunities for educators and learners but also requires the curricula to adapt and evolve with their underlying teaching frameworks (Antunes et al., 2021; Thuan & Antunes, 2022; Winter & vom Brocke, 2021).

DSR holds relevance in academic education. Undergraduate students can learn to apply DSR as a tool for innovation and problem-solving, preparing them to tackle real-world challenges (Goldkuhl et al., 2017; Thuan & Antunes, 2022). Graduate students, including master's and doctoral candidates, apply DSR to develop versatile research skills and problem-solving strategies (Novak & Mulvey, 2021; Thuan & Antunes, 2022).

We aim to equip DSR educators with design knowledge to supply master's students with a comprehensive understanding, guided application, and strategic planning of DSR as a preparation for their thesis and future careers. Our approach draws upon the three-cycle view of DSR by Hevner (2007). This paper focuses on developing a DSR teaching framework (TF) for master's students as an artifact, ensuring research and practice relevance as well as scientific rigor by building on existing knowledge (e.g., design requirements and principles for DSR course design). In this course, we instantiate the derived design knowledge in a DSR course to verify its practicality in real-world settings and subsequently evaluate it with experienced DSR educators. Our ultimate goal is to enhance the potential of DSR in academic learning and foster further collaboration between educators and researchers to promote the transferability of our findings to other courses and contexts. We pursue this by applying DSR in the development and provision of a DSR TF.

Our paper is structured as follows. First, we develop a knowledge base on teaching DSR and theories of learning and education (section 2). We then present our research design (section 3) for constructing and evaluating the DSR TF for graduate students (sections 4-5). Finally, we conclude with a discussion of the results (section 6) as well as a summary and outlook (section 7).

2. RESEARCH BACKGROUND

2.1 Teaching DSR

Considering the innovative problem-solving nature of DSR, its teaching has the potential to broaden education, especially in IS curricula (Goldkuhl et al., 2017; Thuan & Antunes, 2022). For that reason, teaching and learning DSR for students is starting to attract attention (Goldkuhl et al., 2017; Winter & vom Brocke, 2021). In this respect, the planning and design of DSR projects play a key role in high-quality education and should therefore open up a versatile perspective on that educational branch of research (Thuan & Antunes, 2022). Educators must master a repertoire of methods and tools to adapt the DSR process individually and contextually to the problem at hand (vom Brocke et al., 2020) as well as to convey to students that it is not a straightforward process that should be worked through in a recipe-like manner. Instead, the problem and solution space must be constantly re-explored and iteratively adjusted (Carstensen & Bernhard, 2019). Additionally, the current understanding of a problem is iterated and captured through the perspectives and feedback of other stakeholders (Abraham et al., 2014).

The field of DSR education already has established approaches, with some authors proposing design knowledge in the form of design principles or guidelines. However, these authors either target undergraduate students (Sjöström et al., 2016; Thuan & Antunes, 2022) or Ph.D. candidates (Hevner, 2021), or have a specific focus on writing a master's thesis in collaboration with industry (Knauss, 2021), but do not provide a comprehensive TF (Winter & vom Brocke, 2021). Additionally, some authors do not specifically address the development of prescriptive knowledge for DSR teaching (Apiola & Sutinen, 2021), rather establish methodical requirements for conducting DSR (Herselman & Botha, 2015), present a checklist for creating DSR presentations (Cahenzli, 2022), or discuss IS education in general (Goldkuhl et al., 2017). Other contributions limit their findings to specific disciplines such as medical radiation (Mdletshe et al., 2021), management (Keskin & Romme, 2020), or engineering (Carstensen & Bernhard, 2019). While Thuan and Antunes (2022) present DSR as an initial learning tool, we aim to further contribute to the field by proposing a DSR TF that balances methodical diversity with specific knowledge (Antunes et al., 2021) on teaching DSR to master's students. Through a practical evaluation of our framework in an established DSR master's course, we aim to provide a tangible example and bridge the identified research gap in design knowledge for DSR education at the master's level.

Figure 1 summarizes related work by highlighting each study's goals, strengths, and limitations in comparison to our contribution at hand. We also indicate the education level considered, and exemplify practical cases of DSR courses mentioned in the referenced literature.

2.2 Theories of Learning and Education

To design our TF and course instance rigorously, we draw on theories from learning and education research in addition to existing evidence on the teaching of DSR. We regard competencies as the abilities and skills individuals use to solve specific challenges and apply solutions successfully and responsibly in varying situations to master real-life (Koeppen et al., 2008; Weinert, 2001). Thus, competencies are relevant to applying DSR due to its problem-solving character. Competence-oriented learning often follows the concept of constructive alignment (Biggs & Tang, 2011), which suggests matching learning aims, teaching or learning activities, and assessment forms.

Authors (year)	Goal of the Study	Strengths & Limitations (compared to our study)	Curriculum Level	Practical Example of DSR Courses (if available)
This Contribution	Contributing design knowledge for DSR teaching as well as a teaching framework for master's students	not applicable	Master thesis	DSR seminar for students majoring in Technology-oriented Management
Thuan & Antunes (2022)	- Positioning design science as a learning tool - Contributing a process on how to integrate DSR into course designs for undergraduates - Proposing design principles for undergratudate design science courses	(+) Substantial first approach to positioning design science as an educational tool rather than a research tool, and exposition of a process instantiated in multiple contexts for teaching DSR. (-) No focus on master level & no systematic mapping of design requirements, design principles and design features for DSR teaching	Undergraduate	- Product design course (arts students) - Design Science Studio (business major, IS minor) - Systems Analysis and Design (engineering and ICT)
Cahenzli (2022)	Deriving a checklist supporting the presentation of DSR studies/artefacts	(+) Good solution to the practical problem of better presenting results from DSR research projects (-) Presentation of a supporting tool for DSR teaching instead of a Teaching Framework or Course Design.	Not defined	Not defined
Mdletshe, Oliveira, & Twala, B. (2021)	Showcasing the applicabilaty of the DSR methodology in medical radiation science education	(+) Illustrating the applicability of DSR in a specific discipline (-) No focus on designing a DSR course	Undergraduate & Graduate	-
Winter and vom Brocke (2021)	- Deriving design knowledge for DSR courses on master as well as PhD levels - Listing different artifacts to support DSR teaching (e.g., reading list, DSR grid)	(+) Deriving design knowledge by reflecting on many years of experience teaching DSR in 20 different countries and outlining multiple tools to support DSR teaching. (-) No derivation of a concrete teaching framework	PhD & Master	Experiences from DSR teaching courses in different domains and countries
Apiola & Sutinen (2021)	Showcasing how DSR and design science education intends to foster different skills (e.g., creativity, critical thinking) based on four different case studies	(+) Detailed presentation of skills fostered by conducting DSR projects such as 21st century skills (-) No derivation of concrete design knowledge to DSR teaching	Undergraduate & Graduate	Different DSR Cases from a Finnish and a Tanzanian university
Hevner (2021)	Presenting a didactic approach to learning DSR for PhD students.	(+) Detailed analysis of a set of challenges in conducting DSR and exposition of a comprehensive semester curriculum at PhD level. (-) No focus on the master's level and no focus on a view of DSR as a learning tool	PhD	DSR PhD course (Fall 2020)
Knauss (2021)	Proposing guidelines on how to write DSR-related master theses in collaboration with industry	(+) Very practical and concrete guidelines for the application of DSR in master theses together with the industry (-) Focus on joint research with industry on writing a master thesis instead of a preparatory master course	Master thesis	-
Herselman & Botha (2020)	Contributing requirements of conducting DSR studies based on a literature review and experiences from South African post graduates	(+) Structured literature review to identify elements of DSR Methodology and evaluation with postgradutes. (-) No specific focus on DSR teaching & no reference to design of a master's level course	Postgraduate	-
Keskin & Romme (2020)	Deriving a taxonomy and a framework for design science education and teaching for management students	(+) Detailed reflection on the utilization of DSR for management students (-) Specific focus (management) and no derivation of prescriptive knowledge on how to conduct a DSR course	Undergraduate & Graduate	Design science courses for management students at Eindhoven University of Technology
Carstensen & Bernhard (2019)	Gaining an understanding on how to use DSR for technical subjects like engineering	(+) Detailed reflection of a DSR project in an engineering context and systematic derivation of a model for learning a complex concept. (-) Focus on engineering education & no exposition of design principles, but derivation of a model/methods	Undergratuate	Engineering Course at the School of Engineering, Jönköping University
Goldkuhl et al. (2017)	Deriving Principles for Information Systems Education	(+) Comprehensive overview of general IS Educational principles. (-) No focus on a specific course design for teaching DSR & focus on undergaduates	Undegraduate	-
Sjöström et al. (2016)	Deriving design principles for DSR based curriculum development	(+) Specific guidance on how to integrate DSR in curriculum design (-) No focus on designing and planning a DSR course and only brief description of the principles (extended abstract)	Undegraduate	Reflection of curriculum at Uppsala University and Campus Gotland

Figure 1. Related Work

To specify desired learning goals, we must first define these before designing teaching and learning activities closely linked to their achievement (Biggs & Tang, 2011). We formulate learning goals following Bloom's (1956) taxonomy, revised by Krathwohl (2002), by structuring them in a knowledge dimension (*factual, conceptual, procedural, metacognitive, strategic*) and a cognitive process dimension (*remember, understand, apply, analyze, evaluate, create*). In the context of competence orientation, learning goals for both undergraduate and graduate students follow all taxonomy levels. However, undergraduate students mainly learn to simply apply methodological basics to solve problems using fixed procedures or methods, preparing them for tasks in the workplace or for further studies (Topi et al., 2010). In contrast, master's students build upon this procedural knowledge, combining different methods they have learned to abstract and transfer more intensively. Thus, the dimensions *evaluate* and *create* are more in focus on the advanced study level. They must independently conduct DSR with different foci and systematically combine new findings.

One challenge, arising from the shift to digital learning compared to traditional face-to-face instruction, is to ensure a high level of learner engagement and interaction. This requires many different learning activities and methods that offer variety to students (Kibler & Eckardt, 2018; Olney et al., 2015). According to Chi and Wylie's (2014) ICAP framework (an acronym for *interactive, constructive, active*, and *passive*), learner engagement with supportive material can range from passive to active and constructive to interactive and results in improved learning outcomes with rising levels of engagement across the four modes. Whereas in passive engagement, learners merely consume or receive the learning material (e.g., listening to a lecture), in active engagement, students actively tackle the learning content (e.g., by answering quiz questions). In the two most engaging modes of interaction, learners deepen their interaction by, for example, comparing the learning material with their prior knowledge (constructive engagement) or even discussing it with others (e.g., teachers or peers) while reflecting and transferring content reciprocally in the group through interactive engagement (Chi & Wylie, 2014). Each mode of the ICAP framework involves different types of behaviors and learning processes that imply learning outcomes augmenting the engagement level (Chi & Wylie, 2014; Wambsganss et al., 2020). In this view, the idea of the ICAP concept is very similar to constructivism, where learners are actively involved in the learning process and thus encourage activities such as experiential learning. In doing so, it describes learning as "*the process whereby knowledge is created through the transformation of experience*" (Kolb, 1984, p. 38). These activities are reflected in the active, constructive, and interactive forms of learning. The key difference between ICAP and constructivism is that ICAP differentiates the activities promoted by constructivism more concretely (e.g., in terms of behaviors and learning outcomes), and constructing in ICAP is a means of gaining understanding through interpretation or the integration of prior knowledge. It is not about constructing this knowledge oneself (e.g., through experiential learning) (Chi & Wylie 2014).

Therefore, in our work, we have chosen ICAP as a theoretical foundation together with constructive alignment, in which learners independently discover the meaning of learning content in the learning processes (Biggs & Tang, 2011), e.g., through experiential learning. Accordingly, learning activities must be engaging as well as multifaceted, and aligned with the achievement assessment for the formulated learning goals following Bloom (1956) and Krathwohl (2002).

3. RESEARCH DESIGN

We intend to apply DSR for **designing** and **evaluating** a DSR TF for master's students following Hevner's (2007) three-cycle-view on rigor, relevance, and the actual design along the DSR paradigm. In the introductory section, we elaborated on the gap of and relevance of DSR teaching guidance at the master's level to enthuse students about DSR while teaching competencies up to the highest level (*create*) of Bloom's (1956) taxonomy. We plan to reuse approved design knowledge for DSR education and therefore rely on the knowledge base introduced in *section 2* within the rigor cycle to then build thereupon. In this course, we align established design principles (Winter & vom Brocke 2021) centered around our own practical requirements for teaching DSR that we collected from our teaching experience. Our core contribution is a level 2 artifact in the form of moderately abstracted design knowledge (Gregor & Hevner, 2013) meant to be reused by other DSR educators (section 4). We match its components with desired competence levels in learning (Bloom, 1956; Krathwohl, 2002) and exemplify the coverage of each level with sample design features. We then follow Möller et al. (2020) to navigate from the TF's rather high abstraction to a specific course design for master's students as an expository instantiation. Along the process, we intertwine the trifecta of design requirements, principles, and features as proposed by Drechsler (2021) and Meth et al. (2015) in comparable educative application contexts by reusing existing knowledge whenever possible before expanding it towards aspects that have not yet been taken into account. In the subsequent evaluation (section 5), we assess our DSR TF and an associated course instantiation (section 4.3) in two parts, which we have successively improved in (so far) four iterations up to the current version.

To **evaluate** our more **abstract TF** as the core of our design knowledge contribution, we organized a two-hour workshop with 12 DSR teachers (three professors, six postdocs, and three research associates) from three countries teaching DSR at six different universities, as well as three former course participants. The workshop attendees evaluated the introduced TF, especially concerning its potential transferability for reuse (Elshan et al., 2022) in other contexts (e.g., different competence levels), possible weaknesses from a didactic perspective as well as prerequisites and impulses for adaptation. We recruited a heterogeneous workshop panel to integrate different perspectives and broad DSR teaching experiences: All participating educators have a high DSR expertise from research and teaching (2-15+ years) since all of them published DSR papers, most teach DSR courses regularly, and nine of them presented at least once at the International DSR Conference DESRIST. The workshop was held digitally and facilitated by an experienced moderator.

After the participants' introduction, the workshop facilitator initiated a group discussion to identify challenges and opportunities for DSR teaching in four iterations pairing each time with other DSR experts in break-out rooms, while synthesizing the results on a commonly shared digital whiteboard. Then, we presented our abstracted DSR TF (cf. section 4.2) and our specified master course design before all participants constructively discussed implications, potential reuse in their courses, and room for improvement. The reflection draws on the panels' DSR experience in teaching while also embedding insights from students who had participated in the course instantiation. We embedded the five dimensions of accessibility: *importance*, *novelty*, *actability, guidance*, and *effectiveness* for light reusability evaluation, in the discussion of our DSR TF (Iivari et al., 2018). The DSR researchers then commented on the potential reusability of the presented TF for their own DSR courses. Since the point of view of the student participants is fundamentally different, we asked them to reflect on their motivation, facilitation of DSR learning during the course, and whether they intend to apply the DSR paradigm in future settings (cf. section 5.1).

To evaluate the achievement of our teaching goal from the student's perspective, we collected their feedback on the course design and perceived learning gain through an evaluation survey and reflective discussion at the end of the course. The questionnaire was answered by 18 out of 22 students in winter term 2021 and covered the following open questions (translated from German): *a) What did you particularly like about the course? b) What should be improved in the course, and what additional information has been missing to understand the DSR paradigm better? c) What other suggestions do you have?* In addition, we surveyed them on a 7-point Likert scale for the learners' perceived fulfillment (ranging from 1 = not fulfilled at all to 7 = particularly well fulfilled) of the eleven derived design principles for the course design, the suitability of the chosen project challenge (cf. section 4.3) for teaching DSR, and their gained knowledge on applying the DSR paradigm. Their insights enabled us to evaluate whether our course design and, implicitly, the DP behind it effectively empowered them in fulfilling the learning objectives.

4. INTRODUCING OUR DSR TEACHING FRAMEWORK FOR GRADUATE STUDENTS

Section 4 summarizes DSR knowledge at different abstraction levels. In 4.1. we present design requirements (DR) that emerged from several years of teaching DSR. Its numbering indicates the design principle (DP) the request links to. For example, DR8.3 is the third request that leads to DP8. Following Gregor et al. (2020, p. 1623), we view DP as "*prescriptive statements that show how to do something to achieve a goal.*" We align our DR with approved DP and expand these regarding blind spots that currently remain unconsidered. In section 4.2, we introduce our abstracted DSR TF before instantiating it as an expository master course design in section 4.3.

4.1 From Design Requirements to Design Principles

In this section, we compare DR for teaching DSR from our experience with the related design knowledge that we had accumulated in the rigor cycle (cf. section 2.1, Figure 1). Since we found our DR and the envisaged advanced study level especially well aligned with the design knowledge from Winter and vom Brocke (2021), we decided to reuse their DP. Additionally, we enrich them with supporting literature and formulate three additional DP as illustrated in Figure 2.

In accordance with **DP1** from Winter and vom Brocke (2021), we recommend choosing real-world problems for the students to work on **(DR1.1)**. This arouses their interest and motivation in the projects. Moreover, allowing students to set their own priorities and integrating their personal experiences and insights **(DR1.2)** contributes to their engagement in the design process (Thuan & Antunes, 2022). The course should foster a creativity-enhancing environment through the use of appropriate methods **(DR2.1)** while providing regular written and oral feedback on progress **(DR2.2)** as an encouraging learning environment **(DP2)**. Challenging deadlines **(DR3.1)** and forced idea exchange sessions **(DR3.2)** among teams encourage students to develop and iterate their ideas quickly, as highlighted in **DP3,** to prevent procrastination. As our primary objective is to educate students on the DSR paradigm and its strategical usage, we must actively empower them to create artifacts they design themselves with a purpose for usage beyond the learning purpose **(DR4.1)**. Doing so facilitates the student's learning when the project at hand brings in an

	Design Requirements (DR) and Design Principles (DP)	Supporting Literature
DSR Course Design based on Winter and vom Brocke (2021)	**DR1.1** choose a real problem; **DR1.2** have students set priorities to best contribute their prior experiences **→ DP1: Spark a fascination for real-world contributions**	Cahenzli (2022), Carstensen & Bernhard (2019), Goldkuhl et al. (2017), Hevner (2021), Keskin & Romme (2020); Thuan & Antunes (2022)
	DR2.1 foster creativity; **DR2.2** provide empowering feedback **→ DP2: Create an encouraging learning environment**	
	DR3.1 set challenging deadlines; **DR3.2** foster knowledge exchange in quick cross-team reviews **→ DP3: Get students to speed up quickly**	
	DR4.1 have students create their own artifacts; **DR4.2** accessible probands for empirical studies **→ DP4: Involve students in their own DSR projects**	
	DR5.1 serve as coach in research by motivating and facilitate learning **→ DP5: Provide continuous mentoring**	
	DR6.1 implement a trial-and-error process for continuous improvement **→ DP6: Iterate and progress in richness**	
	DR7.1 schedule assignments transparently from early on; **DR7.2** assign individual and team challenges with transparent grading scheme **→ DP7: Ensure a professional course management**	
	DR8.1 discuss the structure of published DSR studies and the research process beyond; **DR8.2** provide methodical guidance; **DR8.3** introduce an appropriate (digital) tool set for empirical studies and prototyping **→ DP8 Provide supporting material**	
Added Design Principles	**DR9.1** teach future skills; **DR9.2** level up in Bloom's taxonomy; **DR9.3** reflect on lessons learned and gained competencies **→ DP9 Enable competency-based learning**	Abraham et al. (2014), Apiola & Sutinen (2021), Bloom (1956), Krathwohl (2002), vom Brocke et al. (2021), Chi & Wylie (2014)
	DR10.1 have students critically discuss findings and interact with peers; **DR10.2** experiment with prototypes in interactive course sessions **→ DP10: Foster interactive and experiential engagement with the learning content**	Biggs & Tang (2011), Chi & Wylie (2014)
	DR11.1 contrast different methodologies used in the teams; **DR11.2** strategically plan out potential research designs for future studies **→ DP11 Promote methodical versatility**	Biggs & Tang (2011), Chi & Wylie (2014), Herselman & Botha (2015), Wambsganss et al. (2020)

Figure 2. Design Requirements Aligned with Design Principles and Supporting Literature

accessible target group for empirical studies **(DR4.2)** (Vargo, 2008; Weinert et al., 2022). This aspect is implied in **DP4**, even though it does not explicitly mention engaging future users as co-creators in the design process (Billert et al., 2020; Teo & Triantafyllou, 2020).

In line with **DP5**, we have found positive results in assigning experienced DSR researchers as coaches to each team project and ensuring continuous mentorship **(DR5.1)**. However, as they move up the competency ladder (Krathwohl, 2002), it becomes more important to give increasing decision-making latitude and responsibility to students. The experiential engagement with the learning contents should be set up like an iterative trial-and-error process **(DR6.1)** that is enriched over time to promote a better assessment of the conditions under which a method proves to be particularly helpful or, on the contrary, less suitable **(DP6).**

Structuring course management with transparently scheduled deadlines **(DR7.1)** and alternating between individual and team assignments **(DR7.2)** support a well-organized learning process **(DP7)**. The provision of supportive material **(DP8)** requires the structured mediation of tangible DSR publications **(DR8.1)**, methodical guidance **(DR8.2)**, and an appropriate toolset (e.g., for creating artifacts) **(DR8.3)**.

Although this initial set of eight DP (Winter & vom Brocke, 2021) proves to be very suitable to many of our requirements, they miss some aspects that we view as central as well. Our approach goes beyond teaching the pure application of the DSR paradigm, as we aim to enable students to enrich their competencies from understanding the terminology to interactively creating strategically planned DSR projects. In **DP9** we thus suggest competency-based learning that requires the mediation of future skills like critical thinking, creativity, and collaboration **(DR9.1)**, comparing, reflecting, and transferring methodical learnings among DSR teams **(DR9.2)** to then form competencies constructively aligning with each competence level up to the creation stage **(DR9.3)**.

Regarding **DP10** to catalyze strong learning outcomes through vivid interactions (Chi & Wylie, 2014), a toolbox and approved didactic approaches to foster interaction and to experience the appropriateness of different methods are useful **(DR10.1)**. Finally, the likely most innovative requirement for our intended approach is to have students reflect on the versatility of the DSR paradigm by working on the same DSR challenge but with contrasting methodological approaches **(DR11.1)** to then *understand, apply, analyze, and evaluate* their respective overlaps, differences, and challenges along the projects to be finally capable of *creating* a strategic plan for future usage of the paradigm **(DR11.2)**. **DP11** highlights the opportunity that methodical versatility offers for DSR education to combine appropriate methods when teaching the DSR paradigm strategically.

In conclusion, these eleven DPs ensure that the course effectively teaches students the DSR paradigm and its implications while touching on all levels of the taxonomy of learning competencies (Bloom, 1956; Krathwohl, 2002).

4.2 Introducing Our DSR Teaching Framework

Our TF is built around the previously introduced eleven DPs and covers five phases - *understand (1), apply (2), analyze (3), evaluate (4), and create* - as referenced in Krathwohl's taxonomy for the cognitive process dimensions of learning, while also referencing the knowledge category (*e.g., factual or strategic*) (Krathwohl, 2002). Figure 3 depicts the scope of each phase in our TF and aligns it with corresponding DP and competence levels while also exemplifying design features.

4.2.1 Phase 1: Understand the Three Cycles of the DSR Paradigm and Its Terminology. The first phase of our TF aims to impart *factual knowledge* of the DSR paradigm by familiarizing students with its three cycles (Hevner, 2007) and their interplay. To illustrate key steps in a DSR project, we use published DSR studies as reference materials **(DP8)**, enabling students to recognize recurring patterns and structures. Additionally, we introduce students to a well-defined problem that they can relate to **(DP1)** and encourage them to design solutions that have practical implications beyond the learning experience **(DP2)** and the research question they refer to (Thuan et al., 2019).

4.2.2 Phase 2: Apply the DSR Paradigm to a Real-World Problem. In the second phase, we empower student teams (ideally 4-6 members each) to progress rapidly **(DP3)** in the application of *conceptual knowledge* through practical means. We collaboratively work out an individual methodical process with each team. We then guide them step by step from problem formulation to the instantiation of prototypes, including the periodical evaluation and adaptation of their artifacts **(DP4)** that we commonly elaborate on in the course. A digital learning platform terminates due dates, provides supplementary material, and offers features for idea exchange **(DP7)**.

4.2.3 Phase 3: Analyze the Versatility of the DSR Paradigm. We aim to provide students with *procedural knowledge* on how to work methodically within the DSR paradigm by differentiating various approaches. To achieve this, we have students select a methodological focus (literature-based, quantitative, or qualitative study) within the DSR paradigm while still allowing room for them to independently detail their methodical approach within their team **(DP11)**. This allows them to gain a deeper understanding of the relationship between the three cycles of the DSR paradigm and how they relate to one another. By re-organizing results after each iteration and successively enriching the progress of their projects **(DP6)**, students can attribute an overall structure and purpose to the cycles. Ultimately, each team will apply the entire DSR process and produce artifacts as expository instantiations (Gregor et al., 2020).

4.2.4 Phase 4: Evaluate Iteratively. We encourage all teams to collaboratively judge the findings and derived design knowledge to learn from each other to constantly improve **(DP10)**. Students bring in their own experiences and expertise from various undergraduate programs and thus check and reflect on the cross-group findings in the plenary from heterogeneous perspectives - we place the exchange of experiences and competencies above the mere acquisition of knowledge **(DP9)** to also emerge *metacognitive skills* (Krathwohl, 2002). We recommend mingling students with diverse professional backgrounds in each team, as it leads to differences, often initiating enriching discussions. Along the iterative DSR process, students are closely supervised by a mentor with expertise in DSR projects from research and practice **(DP5)**, who also supports the process of making judgments on the other teams' methodical approaches to then

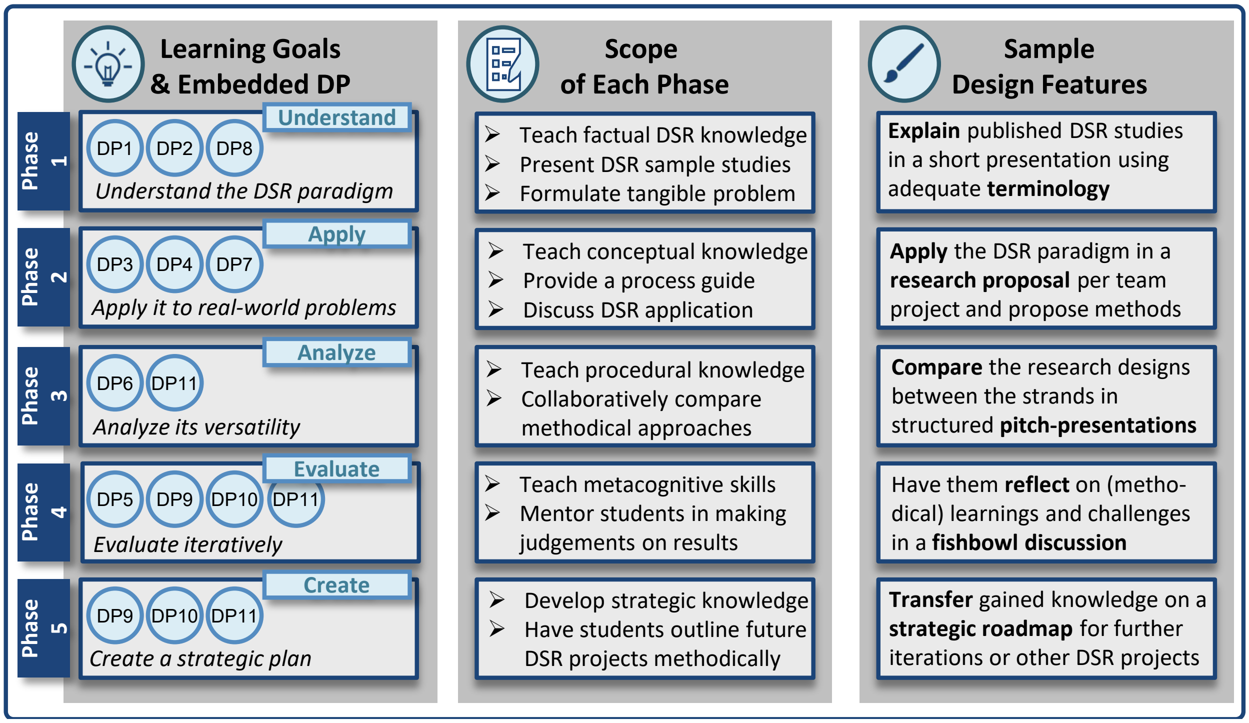

Figure 3. The DSR Teaching Framework

reflect on their potential in comparison or even triangulating them **(DP11).**

4.2.5 Phase 5: Create a Strategic Plan for Future DSR Projects. Achieving the highest competence stage (*create*) of Bloom's taxonomy **(DP9)** requires students to develop *strategic knowledge* on their own by combining the versatile methods and techniques from the different teams **(DP11)** in a novel way to then plan them out in a strategic manner for a newly emerging methodical path. Students actively experience the iterative nature of the DSR paradigm in this phase, as they must collaboratively progress in cross-group discussions **(DP10).** This final step goes far beyond simply following a DSR procedure and repeating what they have learned. Instead, students demonstrate their ability to think critically and generate new methodical pathways for DSR projects to come. The newly added DP9-11 is crucial to reach the highest competence levels, namely, *evaluate* and *create*.

In the following section, we provide an expository course design instantiation that highlights sample design features applied to our instantiated course design. Figure 4 on the next page shows a mapping diagram that aligns DR, DP, and DF.

4.3 An Expository Instantiation: Sample Course Design
To more tangibly demonstrate our abstracted TF and related design, we instantiate a specific course design of a DSR seminar that we teach every semester to approximately 20 master's students majoring in Technology-Oriented Management at our university. In *phase 1*, we introduce the graduate students to Hevner's (2007) original DSR publication **(DF8.1)**, explaining its three cycles and the mindset behind the paradigm (DF8.1 indicates that this is the first DF relating to DP8). We then assign each student team a DSR publication **(DF8.2)**, chosen from AIS conference publications for their appropriate scope and level of abstraction and ideally related to the DSR problem under consideration. The teams analyze the papers' structure, scope, and content, which we then discuss in class, and jointly develop a team-individual guide **(DF3.1)** along the three DSR cycles by Hevner (2007) for deriving design knowledge.

We encourage students to choose topics from a pool of options that both teachers and students find fascinating **(DF1.1)**. For example, in our last course, we examined the design of a supportive learning companion (LC), which is becoming increasingly relevant in education research and practice. An LC is a text- or speech-based dialogue system that interacts with users through natural language to support learning and foster a trustworthy long-term relationship (Khosrawi-Rad et al., 2022). As the students themselves can easily empathize with the target group in Design Thinking sessions **(DF2.2)**, while acting as co-creators (Weinert et al., 2022) of the developed solution **(DF2.1)**, a scientifically grounded LC design is particularly appropriate, as they might be future users themselves and have a peer network to acquire participants for their empirical studies.

After assigning each team a focus strand (quantitative or qualitative research or systematic literature review), the teams write and present a research proposal **(DF4.1)** outlining the planned methodical approach to the joint DSR project challenge (e.g., *"How to design an LC to facilitate learning in higher education for students who are not motivated to learn?"*). Guided discussions in class **(DF5.1)** allow all students to collaborate and reflect on their planned studies, experiencing the versatility of the paradigm and gaining new insights for their own research. Educators should prepare guiding questions and methodically supportive materials (e.g., a handbook on methods and their advantages and limitations) **(DF11.1)** or provide a canvas to outline a strategic roadmap for the DSR challenge and projects to come **(DF11.2)**

When conducting their studies, each team will find that despite the heterogeneous methods, there is usually a large overlap in the requirements gathered from literature, quantitative surveys, or qualitative interviews. For example, both the empirical studies and the systematic literature review may highlight similar requirements for the desired LC's motivational support (e.g., encouraging and proactive communication), which the class collects on a joint digital whiteboard **(DF6.1)** along with specific instructions from the syllabus **(DF7.1)**. At the same time, the triangulated approach also reveals differences in several pitch-presentations **(DF6.2)** of interim results. It thus emphasizes the importance of conducting context- and target group-specific research (van der Zandt et al., 2021) to adapt the research methodology and resulting artifacts accordingly. For instance, in our sample course, students contrasted the challenges with time management highlighted by further education students (team A) with the need to overcome language barriers or promote social integration prioritized by international students (team B) and tried to incorporate specific needs into their prototypes supported by digital tools like Figma **(DF10.2)**. If necessary, students revise their guiding process steps **(DF3.1)**, which are exemplarily illustrated in Figure 5.

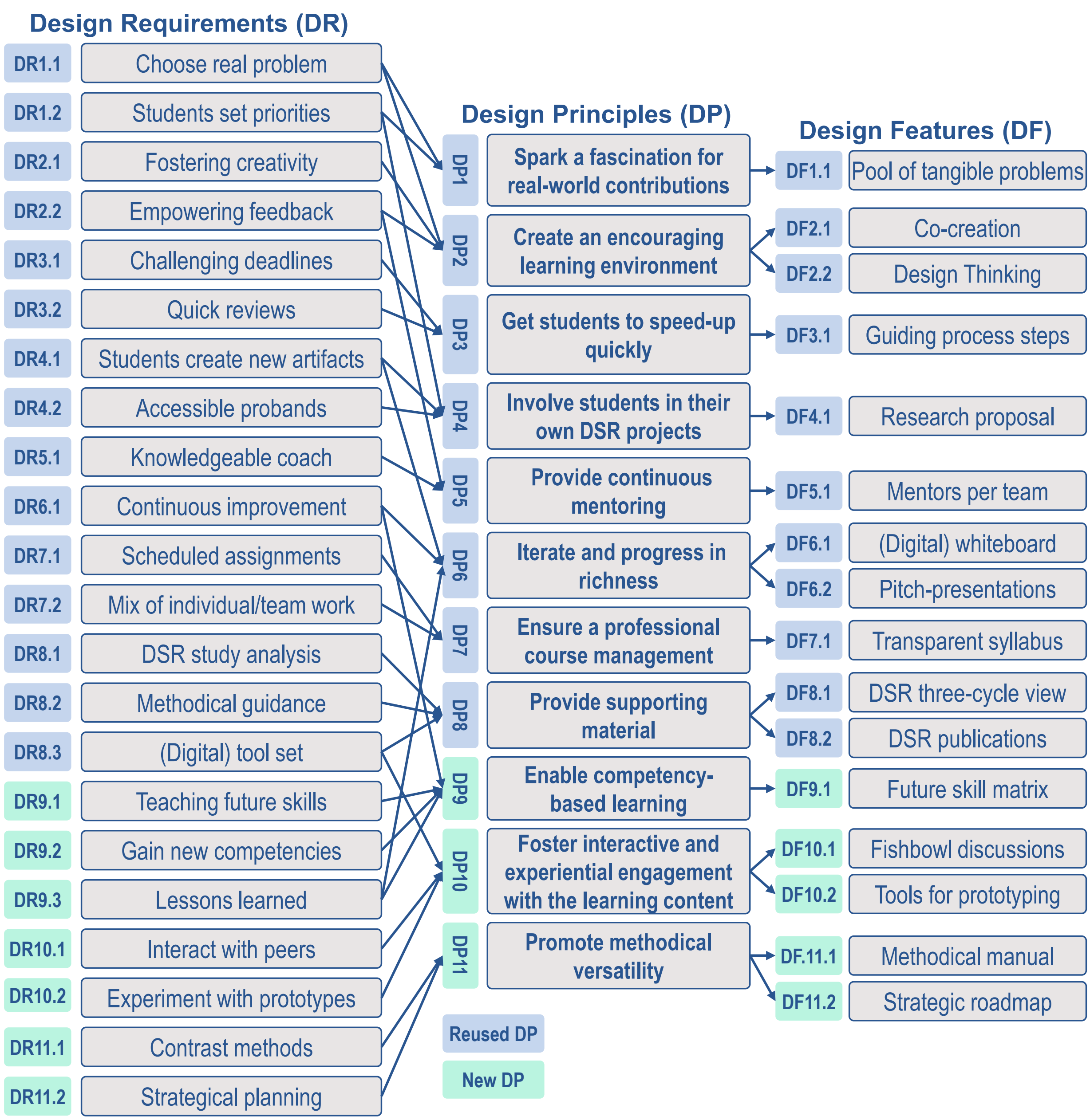

Figure 4. Mapping Diagram Illustrating the Trifecta of DR, DP, and DF

The fishbowl method **(DF10.1)** proved helpful for organizing vivid group discussions on interim results in *phase 4*. This approach involves splitting the students into two circles and having those in the inner circle reflect on findings, derived design knowledge, and individual learnings before rotating. That way, students gain various competencies quickly, such as social skills in collaboration or *procedural knowledge* in comparing empirical methods (Venkatesh et al., 2016). We visualize these on a future skill matrix (a map showing gained competencies in the project) **(DF9.1)**. In *phase 5,* we instruct students to strategically outline future iterations or create a visualized methodical roadmap **(DF11.2)** for their upcoming master's thesis and empower them to give advice mutually.

5. EVALUATION

The evaluation of our TF in a workshop (section 5.1) and by a student evaluation survey (section 5.2) yielded many valuable insights, covering both arising potential for DSR education and suggestions for improvement.

5.1 Workshop Insights

During the initial discussion on DSR teaching experiences, workshop participants emphasized the importance of introducing DSR as a foundational way of thinking about the generation of prescriptive knowledge. Understanding DSR as a paradigm (as opposed to a stand-alone method) and as a design-oriented epistemology revealed essential. In this context, teachers should emphasize various scientific methods applicable to the DSR paradigm. According to the experts, the balance between relevance and rigor in DSR should be thoroughly demonstrated to highlight its roots in engineering or design (Simon, 1996). Despite its prevalent use in various fields (Winter & vom Brocke, 2021), the lack of scientific rigor in DSR has been a long-standing issue (Markus et al., 2002). The basic concepts of DSR, such as the definition of an artifact as a human-made object of various forms (Simon, 1996), thus must be mediated to students from early on. Workshop participants pointed out that DSR has not yet received adequate scholarly recognition in some domains due to its perception as merely a problem-solving approach without adequate scientific rigor. Thus, experts advocate that DSR education should prioritize the balance between relevance and rigor while emphasizing the potential of a design-oriented approach in accordance with *phase 1* of our TF.

After the discussion, we presented our TF and its underlying DP for a thorough evaluation by the workshop participants. The latter highlighted several aspects of the framework's design. Firstly, they noted its capability to facilitate playful learning of DSR through hands-on application, due to its concrete steps that align with learning operators. Secondly, the participants recognized its adaptability to different levels of competence (from undergraduates to Ph.D. students) by gradually transferring more responsibility to the students as they progress in their academic careers and require less explanation.

Students perceived the DSR course to be engaging as it promotes a design-oriented approach to learning and fosters interaction and knowledge transfer among them through collaborative exploration of various methods and their respective advantages and disadvantages in a short period. They highlighted that the framework prioritizes hands-on, experience-based learning, resulting in the participants feeling confident in its applicability and envisioning its use in their own

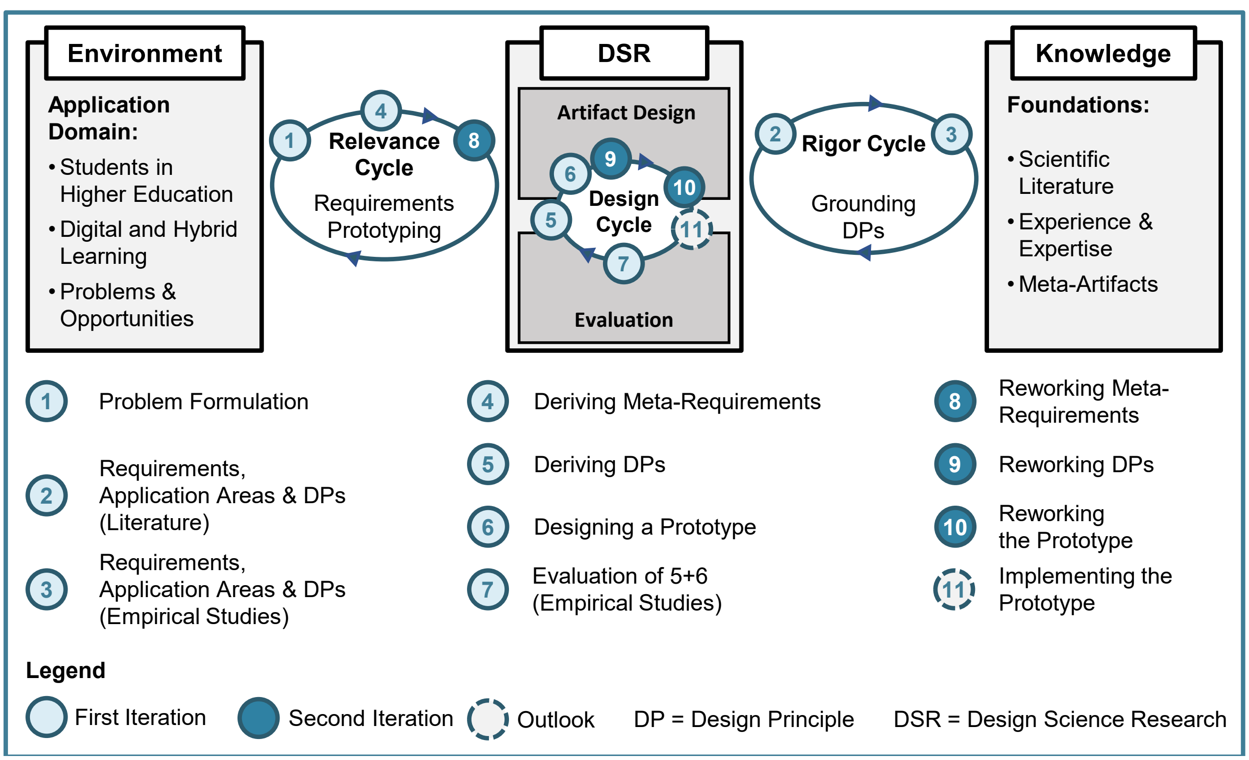

Figure 5. Sample Guiding Process Steps Elaborated between Mentor and Team

teaching. Our supplemental aspects on fostering competencies, interactive and experiential engagement, and methodical versatility, as outlined in DP9-11, were thus particularly well received by the participants. They emphasized the framework's strength in terms of learning in successively augmenting competence levels. The significance of interactive and experiential engagement was confirmed by both the students' and DSR educators' experiences. Wrapping the versatility of methods into the TF was acknowledged as the key aspect of novelty, as educators admitted to generally teaching different DSR challenges using similar methods so that they rarely achieve the highest competence levels (*evaluate* and *create*) in DSR graduate courses.

DSR educators identified areas for improvement in the seminar, particularly in regard to reducing the scope and expectations for submissions (research proposals, presentations, design knowledge artifacts). They suggest focusing on fundamental aspects and overall understanding of DSR as a paradigm, limiting the variety of methods to avoid students being overwhelmed. At the same time, they recommend making the context of the DSR project more open-ended so that the problem and solution space are not predetermined. The high volume and time commitment of the course were also voiced as an issue, with some participants suggesting increasing the number of credit points awarded (currently 5 ECTS, equivalent to 150 hours per student). Educators expressed concern about the difficulty in fair course evaluation due to the heterogeneous empirical approaches used, but our experience shows that the scope and difficulty can be adjusted through factors such as the quantity and depth of analyzed papers in the literature review, scope of empiricism, and support through digital tools in artifact design and evaluation. Despite the demanding workload, students valued the investment of time and effort, as they learned substantially. Experts consider the high teachers' effort as crucial for a positive learning experience and outcome.

The workshop participants identified the constant evolution of DSR as a challenge for its teaching. The paradigm's complex and constantly evolving nature, along with the need for multiple design and evaluation cycles in a typical DSR project, creates a high barrier to entry and increases the challenge of teaching it within short semester time frames. Selecting specific methods to work with the DSR paradigm adds to its complexity. The majority of the workshop participants concluded that DSR teaching should primarily be offered in doctoral courses due to its abstract nature, with the design knowledge and generalization of the created artifact being (allegedly) too high for undergraduate or master's students. This may explain the limited DSR course design guidelines for these target groups. However, this concern is contradicted by our experience and the feedback from former course participants, who found the course concept very helpful and tangible. Students also commented positively in the evaluation workshop on applying various scientific methods quickly, including best practice transfer. They did not perceive it as an overwhelming burden. They welcomed the experiential learning and claimed that the seminar had prepared them well for pursuing a master's thesis. Other positive comments were related to the fishbowl discussion, which was overall considered very enlightening and conducive to sharing best practices and also to integrating otherwise quieter students. However, for events with more than 25 participants, the current setting becomes challenging since it is more difficult to align the increasing variety of different approaches to one common project topic. We applied our TF in both physical and digital teaching contexts (sometimes even supported by sessions in a virtual world), and it always resulted in interactive and versatile learning.

5.2 Evaluation Survey Results

Students evaluated the structure of the course, the clear outline, and the schedule, as well as the feedback from the lecturers as especially supportive. When looking at Figure 6, it becomes apparent that, on average, the fulfillment of DP1-11 is perceived to be above average by the 18 students taking the survey but with quite high standard deviations (see light blue whiskers). We combined DPs 4 and 5 in our survey as one item since, despite working on their own DSR projects, students were always closely supervised and guided by a mentor. Hence, a joint assessment of the interwoven DP appears appropriate.

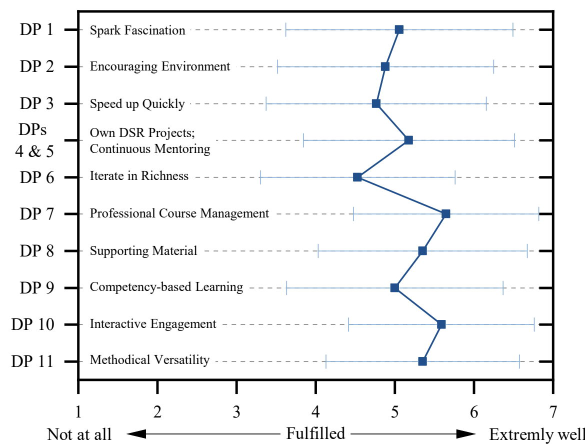

Figure 6. DP Achievement Evaluation from the Learners' Perspective

In line with the workshop feedback, former participants praised the mixture of scientific guidance by a mentor and the freedom to concretize a relevant problem within the project team as very positive, which fits into the duality of rigor and relevance and problem-oriented design as captured in the frameworks of Peffers et al. (2007) or Kuechler and Vaishnavi (2012). Half of the respondents also highlighted creative teamwork, cross-group interactions, the mutual support and use of different perspectives, and the related learning of interpersonal and empathic skills. For example, one student summarized (translated from German): "*It was great to compare different methodical approaches by reflecting on the research designs with other groups, especially in the fishbowl. We really learned a lot along the way.*" Thus, our added DP9-11 revealed to be especially supportive to achieve the intended learning goals. As in the workshop, the topicality of the problem posed and the supportive material provided were also rated positively in our evaluation survey.

In the open text fields for improvement, the students critically encouraged that terms and concepts (such as artifact, DP, meta-requirement, or instantiation) should have been defined more profoundly initially and the basic paradigm should have been explained more simplistically using basic examples. This is in line with the recommendations from our workshop experts. However, all surveyed students felt confident applying these terms correctly by the end of the course. They also encouraged embedding more modern teaching and learning support through explanatory videos and application tips (e.g., short tutorials) or digital software tool introductions. In addition, two-thirds of the respondents suggested that more DSR publications should be analyzed together in class by exploring their structure and design knowledge derivation process. We have applied these suggestions for improvement in our current course iteration and are seeing positive results.

Besides, congruent with the educators' view from the workshop, students claimed they had invested more than the required 150 hours into the course but suggested increasing the credit points earned instead of scaling down the course itself since they see value in its complexity to foster learning by iterative design and evaluation. Finally, our TF shows promise in producing conclusive results, as some student teams published their results at international conferences.

6. DISCUSSION

Our DSR teaching framework for an interactive university seminar represents an example of conveying the DSR paradigm's versatility in graduate-level academic teaching. It was evaluated in a workshop with DSR educators and feedback from former seminar participants. The collaborative DSR teaching design, which applies different methods in an interactive process, helps make the versatility of the paradigm tangible and simultaneously increases the multi-faceted consideration of a DSR problem. Our experience is that, at least for master's students, solid guidance is helpful in DSR projects to demonstrate how different methods lead to a prototypical solution starting from the same problem. Therefore, we propose to exemplify the generalizable character by presenting solved DSR problems and use cases from literature or students' white papers from previous semesters. The selection of adequate examples depends heavily on the instructors' research areas and the course participants' interests and knowledge levels. This multi-perspective view adds value, especially in the case of problems touching various disciplines or participants from interdisciplinary study backgrounds.

In addition, our approach shows an opportunity of designing prosperous artifacts with learners as co-creators, as illustrated by our course instantiation on LCs. In our dual role as educators and researchers, we also gained creative impulses from the students, and some of the DSR projects led to scientific contributions published in peer-reviewed outlets. Consequently, not only do the learners benefit from the competence gained in the course supported by the DSR paradigm, but also, as instructors, benefit by bridging research and practice while generating valuable insights and research outputs.

We thereby contribute to meta-research in DSR education by offering guidance on teaching different methodical research strands within the same course. With our specific exemplary implementation and the resulting DSR teaching framework, we contribute to existing research on DSR education (e.g., Goldkuhl et al., 2017; Winter & vom Brocke, 2021) by focusing specifically on how to teach DSR to master's students.

We admit several limitations. First, although the proposed DSR learning process leaves freedom for adaptation, it has only been operationalized for master's students from the same German university majoring in Technology-Oriented Management. Our future work aims to adapt the approach in further iterations for different study levels, so that our TF proves applicable to undergraduate and Ph.D. courses for DSR education and other institutions. To this end, we gathered initial input in the evaluation workshop with educators from six different universities. Second, we must also examine the impact of the DSR approach on the overall curriculum and learning outcomes achieved (Thuan & Antunes, 2022) and match them with the competency profiles that the labor market expects. Here we see both a tension and an opportunity to make ostensibly scientific education at (German) universities more practice-oriented without losing scientific rigor. We admit the third limitation might emerge from a possible bias, as the evaluation workshop was accompanied by the educators who conceptualized and tested the TF. However, we endeavored to counteract this by having educators from three countries participate in the critical reflection. Further workshops that systematically compare other TFs and DSR course designs might also be insightful.

7. CONCLUSION

In our paper, we presented our experiences in teaching DSR by introducing a TF derived from literature-based course DP and implications for interactive learning with methodical versatility. Our approach promotes experiential learning to build metacognitive skills to generate strategic knowledge in a master's seminar with a joint DSR challenge. Highlighting the methodological versatility of the DSR paradigm catalyzes the *evaluation* of methodical approaches and the *creation* of novel pathways (Bloom, 1956; Krathwohl, 2002). Our contribution includes a TF that reflects our experience in DSR education at a German university and is intended to stimulate further exchange between teachers and researchers for transferability to other courses and contexts.

In future application contexts and for more heterogeneous target groups, we see further potential in involving our TF and adapting it accordingly. For example, many universities host entrepreneurship weeks, where real-world problems (e.g., from regional companies) are worked on in interdisciplinary student teams, and innovative solutions are transformed into business models (e.g., Eager & Cook, 2020). These could be accompanied scientifically along the DSR paradigm with our TF to strengthen the bridge between research and practice cross-disciplinary even more.

Since our paper presents a specific use case (LC design for and by students), the individual empirical methods selected and their fit to the individual application context and students' competence levels should be further explored. More repetitions of the course setting at different universities are necessary to make scientifically substantiated statements about the effect of the didactic elements. Vivid discussions in the evaluation workshop with DSR teaching experts were fruitful in uncovering blind spots of our approach (cf. section 5.1) and initiated impulses for further research. We see future avenues of investigation in particular in the following three areas: First, the transferability of our DSR teaching approach to new contexts (e.g., entrepreneurship education), an adjustable scope adapted to competence levels (from undergraduates to Ph.D. students), treated problems, and teaching formats (e.g., mass lectures), for which an application and reflection in case studies would be interesting. Secondly, the scientific development of a methodical meta-catalog, which gives well-founded recommendations for selecting methods to be used, seems desirable. Thirdly, the positive feedback from participants at least suggests that the perceived learning gains are challenging, but we suggest conducting further strongly scientifically grounded studies, which measure the gained learning outcome more objectively.

Following the DSR paradigm, we contribute with our DSR teaching framework to combine practical experience and scientific knowledge transfer in an interactive and methodically versatile setting to initiate further research and discussion to anchor DSR education in (IS) curricula in the long run.

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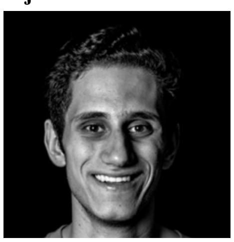

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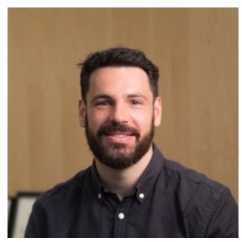

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