

How to survive a PhD – using Design Thinking methods and the Business Model Canvas

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Abstract—Graduate students face great non-technical challenges during their PhD. Also supervisors can struggle in effective multi-PhD management. The present study explores the utilization of Design Thinking and business canvas approaches in different phases of a PhD to address these challenges. The state-of-art is summarized and the Business Model Canvas – as most common Design Thinking method in industrial practice – was evaluated in workshops with students and was subsequently translated to PhD terminology. The study closes with recommendations for students and supervisors showing how these methods can help them to survive the PhD - e.g. in topic identification, innovation management or research communication.

Index Terms—Graduate education, research project management, Business Model Canvas, Design Thinking, PhD

I. INTRODUCTION

Graduate education and PhD work often challenge the students with novel tasks such as structuring work items, project management and self-management. For example, grad students need to acquire grants for funding their own work in the beginning of the graduate research work, promote research results at conferences and their PhD defense as well as need to advertise themselves to potentials employers after the PhD. In all cases the students need to "sell" their ideas and achievements to expert and non-expert audiences. It is not unexpected that the success of innovations significantly depends on how well the ideas are communicated and "sold".

The PhD is a genuine time experience which can be understood as a "phase" in the life of the student [1]. However, also separate parts of the PhD can be seen as individual phases, e.g. the thesis writing process [2]. This seems to be especially true for engineering education, where the "PhD phase" can be broken down into several phases with different aspects to be handled by the student. Picture 1 provides an exemplary overview of the phases of a PhD.

These challenges are also common to industrial practice. There, R&D managers and strategists are making use of structured approaches, one of them being Design Thinking [3] in general and in particular the Business Model Canvas [4] (BMC). Although business models are mostly a recombination

of existing business models [5], visually structuring methods – often in the form of canvases, e.g. the BMC or the magic triangle [5] – became an established tool in industry used for business development, marketing and even research and development. The BMC is a navigation instrument that helps to systematically develop, document and visualize the value of a product (or project) and it forces to take different perspectives. Once done, it significantly helps to convince stakeholders, as it highlights key ingredients and corner stones of the idea.

A. Goal

The goal of this qualitative study and experience report is to make graduate lecturers and PhD supervisors aware of Design Thinking methods and business canvases, as well as point graduate students to suitable tools for the different phases of their PhD. The paper describes how to translate the BMC into PhD terminology and how to use it to systematically explore, understand and sell own PhD ideas in communication with supervisors, project partners or a conference audiences.

In industry, the BMC helps customers, investors, or managers to classify and prioritize the need for a development more quickly. In education and research, professors can better classify and assign the doctoral ideas of their PhD students and check them for consistency and unwanted overlaps with other students' PhDs.

Overall, the goal of this paper is to show how Design Thinking and the BMC can help PhD students and supervisors to survive a PhD.

B. Approach

To achieve the above-mentioned goals, a four-fold approach was taken. 1) Existing research work on the topic of using business canvases and Design Thinking methods in graduate engineering education and PhD work was screened by the means of a literature search (Section II-4). 2) The BMC as the most common Design Thinking tool in industrial practice was evaluated with a group of graduate engineering students in two sessions in order to proof the applicability to PhD project work (Section III-A) and subsequently 3) translation of the BMC terminology into PhD terms (Section III-B). 4) Further good practices were collected from industrial practice by conducting unstructured industrial expert interviews as well as taken

The authors acknowledge the financial support by the Federal Ministry for Economic Affairs and Climate Action of Germany (BMWK) within the innovation platform "KEEN - Artificial Intelligence Incubator Laboratory in the Process Industry" (grant number 01MK20014T).

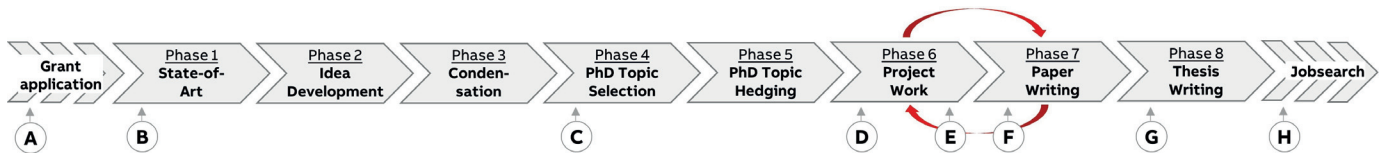


Fig. 1. Phases of a PhD in which the Business Model Canvas can be beneficial as described in Section III-C. Circled letters refer to other useful Design Thinking methods as described in Section III-D.

from personal experience working in industrial research and business model innovation for several years (Section III-D).

II. FUNDAMENTALS

In this section the fundamentals of Design Thinking and two selected canvas approaches are briefly described as background information for readers not familiar with the concepts. The state-of-art for their application in a PhD is summarized.

1) *Design Thinking*: Design Thinking comprises several methods and processes to design concepts for e.g. machines, products or business processes. They have in common that the user or customer is in the center of the innovation ("user-centered design/development"). In many cases Design Thinking processes involve collaborative working between different stakeholders ("co-innovation"), e.g. designers, users, engineers and business managers. This is done in face-2-face or virtual workshops collaboratively filling canvases with sticky notes. Although Design Thinking tends to oversimplify solution approaches, it can aid tremendously in clarifying goals, requirements and consequences of a solution approach. Examples for Design Thinking applications in industry are digital service scenario exploration [6], business and market environment analysis or Service Blueprinting [7]. However, the most widely used Design Thinking technique in industry are the BMC as well as stakeholder analysis.

2) *Business Model Canvas*: The BMC [4] is a nine-field matrix canvas describing a complete business model on a high-level. In the center of the BMC stands the "value proposition" (2 in Fig. 2). This is the clearly formulated value (not marketing slogan) the solution provides to different "customer segments" (1 in Fig. 2). As the clear formulation of the value propositions is in most cases very challenging, there are support-methods like the Value Proposition Canvas [8], which concentrate only on identifying the value proposition of a solution. The right-hand side of the BMC describes the customer segments and the relation to them ("Customer Relationships", "(Marketing) Channels"). This is the starting point of filling out the canvas ("user/customer-centred design"). The left-hand side of the BMC describes everything you need to do to fulfill your value proposition, e.g. which "Key Partners" you need (3 in Fig. 2), what your "Key Activities" need to be and which "Key Resources" you rely on. The right-hand side is filled after the customer segments and value propositions have been formulated. The bottom summarizes the business value (right-side) and cost (left-side) of your business model.

3) *Stakeholder Analysis*: When beginning to develop a new business model for a given innovation, the first step is to de-

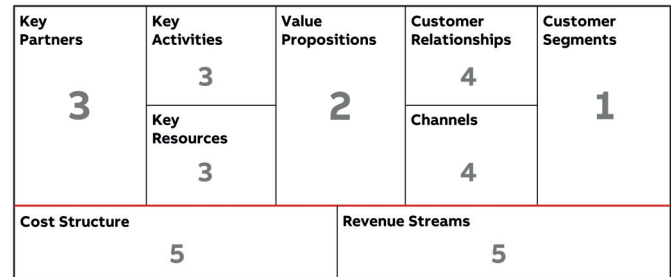


Fig. 2. Business Model Canvas [4] template. Numbers indicate the recommended order to fill the fields for a use during the PhD (see Section II-2).

termine potential customer segments and key partners. For this a power/interest matrix (for an example see [9]) can be used. This four-quadrant matrix is used to classify stakeholders of low/high interest and low/high influence (power) on a business model. Stakeholders with high interest but low influence you need to keep informed. Stakeholders with low interest and high influence you need to keep satisfied. Stakeholders with both high interest and influence contain your key partners and key customers. Figure 3 shows an example of such matrix, as outcome of a workshop (Section III-A).

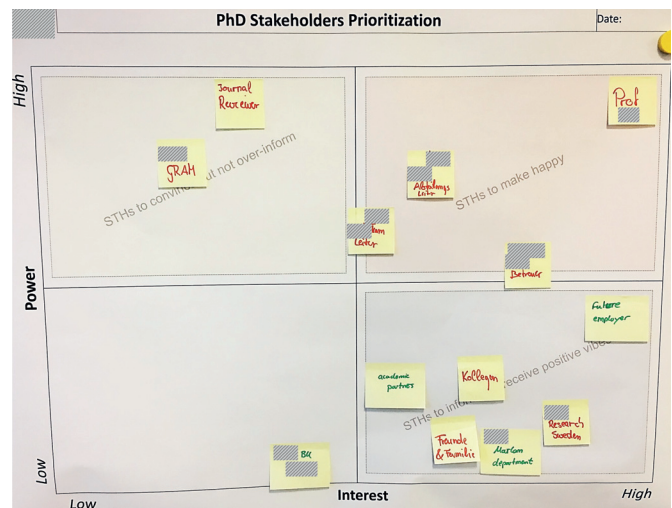


Fig. 3. Example of a filled out stakeholder prioritization map from a PhD student, who was co-supervised from university and industry. Names and affiliations were anonymized. Reproduction with consent of the student.

4) *State-of-Art - BMC for surviving the PhD*: There are several reports on how students can "survive" the PhD [10], [11]. However, these contain little to no pointers to formal

methods to use during the PhD in order to "survive" it. There are studies suggesting to use canvases to structure education itself [12] as well as advice how to structure a graduate student's life [13]. The BMC is also already used in various aspects of university teaching. It is e.g. used in business education, especially to teach students how to incorporate various scientific information resources into their projects, and may be expanded to other disciplines where project planning plays a role [14]. Furthermore, it is used in business literacy education for entrepreneurs [15]. There have also been ideas to create Canvases specifically for getting started with the PhD [16] as well as adaptations of the BMC for the use in research projects [17]. However, these were never described in peer-reviewed scientific literature.

III. OUTCOMES

A. BMC and Stakeholder Workshops with Students

Two workshops were conducted, one for a PhD student individually, one for a group of four PhD students from different institutes and disciplines. The workshops lasted about two hours and were structured as 1) a short introduction to BMC and stakeholder matrix (Section II), 2) selection of a PhD project and working on the BMC and stakeholder matrix and 3) presentation of further methods for other phases of the PhD (Section III-D). The workshops were followed up twelve months later with questions to the participants about the leanings of the workshop. Figures 3 and 4 show exemplarily the outcome of the workshops.

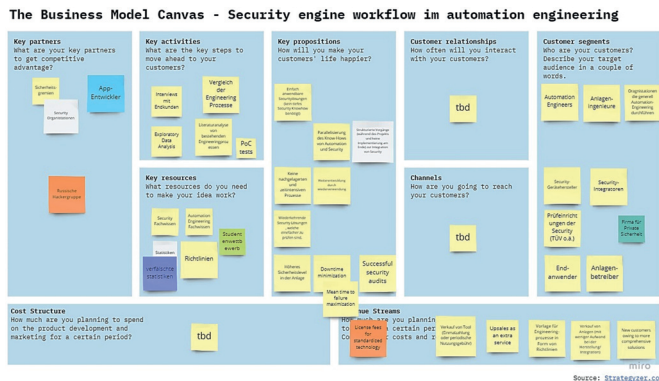


Fig. 4. Business Model Canvas as filled out in one of the workshops collaboratively by a group of PhD students for one technical project within a PhD. Reproduction with consent of the students.

1) *Feedback from Participants:* The testing of the BMC with PhD students revealed that the canvas was partially already known to the students, but not used by any participant to tackle their individual challenges. All students very quickly understood the usage and benefit of the tool and were able to design "business models" for their technical work within less than an hour.

Four of the six participating students provided feedback twelve months after the workshops to the authors. The students were asked 1) if their work benefited from the workshop, 2) if they revisited the workshop outcomes again, 3) if and where

they would apply the methods (again) in their PhD and 4) if they used further Design Thinking approaches in their PhD.

All students had positive memories of the workshops and found the methods inspiring for their work. However, none of the students actively used either the BMC or stakeholder matrix for their PhD in the twelve month period, but three of four said they now wanted to test it again triggered by the feedback request. Two students mentioned that the way of thinking of the BMC (customer first, value proposition) persisted in their work since the workshop. Three students mentioned that the BMC in its original format is rather complicated to understand for a technical PhD students and expressed the wish for a "translated" BMC to fit a technical PhD. For this reason the authors translated the BMC to PhD terms (Section III-B, Table I).

B. Translation of the BMC to PhD terms

The BMC systematically questions the soundness of an approach and immediately allows separating a good from a bad idea. The BMC terminology is however very business related, asking for customers, cost and revenue streams. However, the mindset behind is very useful for PhD students.

1) *Key partners:* Key partners are two groups. On the one hand external partners: e.g. key research groups in your domain. A PhD student should know all relevant research teams worldwide which are active in the specific research field of the PhD, as they may be source of inspiration, valuable references, but also competition. On the other hand, key partners are project members, partner companies, and all other stakeholders that are related to your PhD, especially your supervisor.

2) *Key activities:* These are the key steps to achieve the research goal and to answer the research questions. It is a basic project plan. A detailed one is not required, but be aware of the major steps to go.

3) *Key resources:* Key resources are what you need to successfully achieve your PhD, e.g. software, hardware, access, knowledge, books, labs, colleagues and undergrad students, etc..

4) *Value proposition:* The value proposition is the holy grail and the center of the BMC. In a PhD context, the value proposition asks for the pain points in the state-of-art, the research questions or research theses to investigate. It asks the key Design Thinking question: imagine you would have found the answer, what would improve? What is the value of the potential results? How could it improve somebodies live? The value proposition is an excellent exercise of Design Thinking: don't think about the problems to solve but imagine the future. Predict the future. If you have carefully solved this, you become an interesting conference speaker and research partner.

5) *Customer relationship:* The customer relationship asks for how to establish the exchange with potential receivers of the PhD. Examples are monthly meetings with your supervisor, quarterly meetings with other research groups, surveys with study participants, interactions with potential companies or

TABLE I
TRANSLATION OF THE BMC FIELDS TO PhD TERMS

Terminology in the BMC	Translation to PhD related terms
Key partners	Key research groups in your domain, separated in indirect partners (external groups) and direct partners (PhD partners)
Key activities	Key steps to achieve your research work. A detailed work plan could be referenced.
Key resources	What do you need to successfully achieve your research?
Value proposition	What are the pain points in your concrete research? What are the concrete research question? What would improve if you successfully find a good solution?
Customer relationships	If your PhD is related to future users, how to you establish the exchange with them?
Channels	In which way could you explain your research to the future users of your research?
Customer segments	Who are potential future users of your research? This might be colleagues, researchers, companies, associations, committees etc.
Cost structure	Qualitative or quantitative costs of transforming your research into innovation. This does not mean a detailed funding or investment plan, but a rough estimation of effort needed. Make a proposal.
Revenue streams	What values does your research create for potential users?

other stakeholders. If you have answered the key partners section, you already know your stakeholders well.

6) *Channels*: Channels are the ways to reach your audience and your stakeholders, in order to discuss your PhD, to convince partners or to gain feedback. Channels might be studies with study participants, talks at conferences, writing of invention disclosures, publication of papers, personal contacts etc.. Which are the best ones, which are most beneficial for your PhD?

7) *Customer segments*: Customer segments are categories of potential receivers of a PhD. These might be colleagues, research teams, established companies or startups, associations, committees, conferences, the general public, a specific public and maybe even your family.

8) *Cost structure*: The cost structure describes qualitative or quantitative costs of transforming your research into innovation. This does not mean a detailed funding or investment plan, but a rough estimation of effort needed. Think about real cost as money, material, people, time, machines, marketing etc., but also think about non-material costs like persuasion work. Make a proposal.

9) *Revenue streams*: The revenue streams asks for all ways in which your research potentially creates values for potential receivers. This might be material values as money, but in research, this also might be non-material values as knowledge, findings, new theses, new ideas or conviction. Be as specific as you can.

C. BMC in different phases of PhD

The BMC serves the PhD student. It is filled in step by step. A common method to discuss the BMC is a workshop

with stakeholders. The BMC provides a guideline that takes PhD students from the comfort zone, it is a refreshing way to think and to look at the PhD, to discuss and to see a PhD work. It is a great communication layer between a PhD student and relevant stakeholders, especially the supervisor and conference audiences. The BMC is a living document, a platform that helps to gain confidence in the own PhD work. Typical applications of the BMC are (cf. Figure 1):

1) *Phase 1: state of the art investigation*: The BMC can be used to judge other researchers' work and to navigate in the state-of-art. It helps to read scientific publications not only from the lens of methodology and science, but from the lens of value creation and relation. It opens the eyes to get the key ideas of scientific papers and to ask the right questions in discussion with their authors. And finally, it helps to identify gaps and white spots of the state of the art.

2) *Phase 2: developing PhD ideas*: This is a critical and time-consuming phase of any PhD. Create one BMC per each idea. The BMC helps to compare and to explain the ideas from different perspectives and allows to find an appropriate balance between effort and impact.

3) *Phase 3: condensation phase*: By means of the BMC of different ideas, select the most promising ideas and refine the BMC of these in order to gain confidence. Performing a PhD workshop with the supervisor helps to refine the BMC.

4) *Phase 4: PhD topic selection*: As part of the condensation phase, the final PhD topic must be chosen, and its BMC should be further refined. The BMC helps to precisely formulate the values and relations of the final PhD topic.

5) *Phase 5: topic hedging*: Once the PhD topic is identified, the BMC helps to sell the idea to the identified channels. Keep the BMC up-to-date over time since the answers may change.

6) *Phase 6: project work*: During the project work, the BMC helps to keep the confidence, to motivate undergraduates to contribute, to follow the predefined path and to not forget any of the stakeholders.

7) *Phase 7: writing papers*: Beside the scientific content of a paper, the BMC helps to keep the value-based thinking alive and to write a promising and valuable text that inspires the readers.

8) *Phase 8: writing the thesis*: A PhD thesis has a high demand for scientific depth, and most of the PhD core chapters will not be BMC related. However, the BMC helps to not forget any stakeholder, and will contribute to create a sound introduction, motivation and summary chapter. It trains PhD students to be able to quickly switch from the deep-dive within the PhD topics to a bird-view that can be understood by any audience.

D. Further Design Thinking Canvases applicable to PhD

For different tasks during a PhD, more specific methods might provide additional benefit to the PhD student. This section provides a not exhaustive list of examples for such specific methods. The letters in parenthesis refer to Figure 1. Stakeholder analyses (Section II-3) are useful to determine

the the addressees of grant applications (A) and the overall PhD (C) and can be used as a starting point to any BMC exercise (Section III-C). To identify a thesis topic, it might be useful to analyze the environment - from market push/pull to determining what competing research groups in the field are doing (B, C) - by using e.g. an "Environment Scan Canvas" (platforminnovationkit.com/). To find suitable application cases for a newly discovered technology the "persona" concept in Design Thinking might help to create a better understanding of the later usage by instantiating user scenarios or analysing specific user-behavior using scenario canvases [6] (C, D). When developing technologies for specific markets, e.g. industrial production, it might be useful to include the specific market mechanisms into the BMC, e.g. by using an Industrie 4.0 Canvas [18] (D, E), or to assess the technology against common requirements, using e.g. the Toolbox Industrie 4.0 [19] (E). If the outcome of a PhD might be included into an industrial service, it might be helpful to create a "Service Blueprint" to assure service quality [7] (E). As communicating about your research is essential to successfully complete a PhD [10], it might become handy to use develop a sound "story" about your work, e.g. using a storytelling canvas [20] (F, G). When struggling to find a suitable job towards the end of a PhD (H), the "Business Model You" canvas [21] can help to identify the value proposition a student can offer to future employers. The Lean Canvas [22] also takes the technical solutions as well as the differentiation to competitors into account. Such approach might come handy for students struggling to position their work against competing research groups or want to start their own business after the PhD (C, H).

IV. DISCUSSION

There are different ways to fulfill the prerequisites of a PhD. These will vary between disciplines, countries, university and even supervisors. There has been research on some of these options, e.g. on building the PhD on publications [11]. However, this study tried to stay agnostic of the chosen way to pursue the PhD.

The BMC has known and well-researched strengths, but also weaknesses [23]. Furthermore, similar yet different approaches have been proposed by other research groups, e.g. the magic triangle [5] or a triple-layer business canvas [24]. From the experience of the authors, the BMC is the most straightforward to understand method and the most widely adopted method in industrial practice. Building a complete business based on the technical results of a PhD will require more holistic and detailed methods, e.g. innovation playbooks [25].

The presented methods will help to navigate through the PhD, but there is a risk of over-emphasising the business perspective over the (technical) research questions.

For supervisors it is equally important to manage the expectations of PhD students towards all phases of the PhD. Although we did not structurally investigate this topic, there are formalized tools and frameworks to e.g. support students

in the early phase of their PhD by providing transparency on the thesis examination [26].

In industrial practice, Design Thinking approaches also find broad application in the ideation phase of projects, e.g. utilizing structured co-innovation approaches [27], standard processes for data science projects [28] or data-driven ideation approaches [29], and even more complex innovation approaches for service design [30]. From the perspective of the authors, these methods are not required to survive a PhD, and might only help in very specific cases.

A. Limitations

One limitation of the study is limited the size of the cohort of students used to evaluate the BMC and stakeholder analysis. Also, the adaption of the BMC to the PhD was done after the student workshops. The workshops showed the general applicability and benefit of the methods on a PhD, and the adaptation of the BMC was based on the direct feedback of the participants.

The presented methods are likely applicable for PhDs from a broad range of disciplines. However, they were developed, tested and adapted from the view of engineers and computer scientists working or having worked in industrial research. Students from other disciplines like social sciences or humanities might find it more challenging to apply the business-driven thinking to their PhDs.

B. Outlook

Working with the BMC is very compatible to digital education concepts which further simplify their application and collaboration with other people. It can be used during remote teaching in order to discuss topics with the audience and to document the discussion results in a generic way. Together with online white boards (e.g. mural.co, miro.com, canvasgeneration.com) which provide BMC templates will further improve its application. Online tutorials may help to introduce the method and to give examples of its application and interpretation, e.g. via combination with remote teaching.

V. RECOMMENDATIONS

The study found good potential of Design Thinking methods and business canvases to help students and supervisors to survive the PhD. The authors would recommend to engineering educators and PhD supervisors to make students aware of the identified methods, try the methods out themselves and encourage students to make use of the methods during their PhD.

A. Recommendations for PhD students

The clear recommendation for PhD students is to not be afraid of the proposed methods and approach. There is nothing to do wrong. However a PhD student will interpret the canvas-fields, it will be beneficial to foster the understand of the value and potential usage of the research outcome. PhD students should feel free to adapt the BMC and other methods to their own needs, e.g. putting more emphasis on actions than partners or leaving out the cost/revenue aspects.

The second recommendation is to collaboratively work on canvases. Invite fellow PhD students, post-docs and collaborators, maybe even non-expert friends, to jointly fill out stakeholder matrices and BMCs. It is very much helpful to get other perspectives on the PhD, to fully grasp the (positive) impact of the research.

PhD students can also use the BMC to determine the value of the overall PhD to their "customers", e.g. their supervisor, the examination committee, potential employers or society. Using the BMC not for a single technological development but for the complete PhD might reveal further actions that will aid the student to successfully complete the PhD, e.g. strategically publishing papers with "customers".

See the proposed methods generally as an intermediary between your research and a potential (or real) business receiver. However, it is important to keep in mind to not oversell the research results. Use the BMC to gain your research, but not to suppress it. Maintain a spirit of "ideas and knowledge are values for itself".

Use the BMC to switch perspectives, especially when moving towards industrial research & development. In industrial practice, use-cases are the starting point of an investigation, and then the best suitable technical solution for them is to be found. This stands in contrast to academic research, where a new solution method is in focus and the PhD student looks for use-cases to apply the new method to.

B. Recommendations for lecturers and managers

The value for lecturers or managers comes from simplifying the management of multiple research theses or projects. The BMC is a helpful common interface between PhD students and supervisors and explicitly forces PhD students and supervisors to establish a common mindset. Recommendations for lecturers and managers are: (i) Translate and communicate the meaning of BMC and its business perspective with the language of your domain. (ii) Actively request the BMC from your PhD students: it forces avoiding white spots in the research work. (iii) Help PhD students to understand the BMC questions. (iv) Use existing BMCs in order to introduce, "warm up" and inspire new PhD researchers. (v) Use work-in-progress BMCs to spot research issues. (vi) Use existing BMCs to organize multiple research work, to update yourself about actual research questions and research groups, to find unwanted research conflicts, to identify common questions, to highlight proven methodologies, to find synergies and new research questions. (vii) Develop best practice recommendations from the BMC application in your domain and share them with your PhD students. (viii) Feel free to adapt the BMC to your domain and terminology. (ix) Keep the freedom of research alive: ideas and knowledge creation is a value for itself. It is not all about money. Many ingenious inventions and inventors do/did not have a commercial motivation.

VI. ACKNOWLEDGEMENTS

The authors would like to express their sincere thanks to the PhD students who participated in the workshops.

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