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Cross-disciplinary Communication among Ph.D. Candidates: How to Make it Work

Abstract

Cross-disciplinary research settings are highly challenging for young scientists. In our research centre, Ph.D. candidates with various disciplinary backgrounds are expected to cooperate. To support cooperation, we designed a Ph.D. programme that fosters cross-disciplinary communication. The programme uses an innovative teaching format that aims to broaden the participants' understanding of technical basics and to improve their academic teaching skills.
Being faced with dissatisfaction among the Ph.D. candidates at first, we introduced a targeted feedback process that paved the way for successful cross-disciplinary communication and cooperation.

Keywords

Ph.D. programme, cross-disciplinary communication, satisfaction, academic teaching

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1 Introduction

1.1 Cross-disciplinary Communication and Academic Teaching in Ph.D. Education

As cross-disciplinary research emerges, the skill to work in such a manner is nowadays seen as a key competence (DERRICK, FALK-KRZESINSKI, ROBERTS & OLSON, 2011; National Academy Press, 1995; VURGUN, 2016). To engage in cross-disciplinary research, an understanding of the involved disciplines and communication with scholars from other disciplines are required (FIORE, 2008; JAKSZTAT, PREßLER, & BRIEDIS, 2012). Although cross-disciplinarity in research increases, disciplinary structures at universities counteract the requirements such as time and space (BODEN, BORREGO & NEWSWANDER, 2011; EHRENBERG & KUH, 2009; GOLDE & GALLAGHER, 1999; HOLLEY, 2013). The challenge in cross-disciplinary Ph.D. education therefore is to facilitate the access to the respective knowledge needed by offering advantageous settings.

The use of academic teaching in Ph.D. education offers a possible starting point. A systematic development of teaching skills is generally neglected in the German Ph.D. education system. Poor preparation in teaching has been shown for Ph.D. candidates in Bavaria (BERNING & FALK, 2006). However, skills in academic teaching provide several benefits even in research-intensive environments, e.g., improved conceptualisation of subject matter and methodological research skills, acquisition and refinement of communication skills, positive influence on tenure decisions, and increased potential for funding (BUSKIST, 2008; FELDON et al., 2011; LESSER, 2016). Therefore, the need for basic training of teaching skills is even more apparent.

1.2 The Integrated Research Training Group in CRC 986

One aim of Collaborative Research Centres (CRC) funded by the German Research Foundation (DFG) is to foster interdisciplinary research. In CRC 986, engineers,

chemists, physicists, and materials scientists jointly work on the development of multi-scale materials. Even though all participants have a science or engineering background and therefore share certain epistemology beliefs, their subject matter knowledge differs widely due to their specialised background. Consequently, we assumed an impeded scientific communication and incorporated a specific programme for the Ph.D. candidates (Integrated Research Training Group, IRTG) to overcome this challenge. IRTGs should counteract the disadvantages of individual doctorates, e.g., the lack of an integration in interdisciplinary research environments and insufficiently trained key competences (DFG, 2011; KEHM, 2012). The fundamental idea of our IRTG was to facilitate cross-disciplinary research through the broadening of relevant technical basics in an ongoing, interactive learning format conducted by the participants themselves. Since the participants only have limited – if any – prior experience in teaching, our IRTG also addresses academic teaching skills.

The acquisition of technical basics and teaching skills are mostly fostered in monthly meetings (MM), where the participants come together to learn about their fellow Ph.D. candidates' projects. At each MM, one of the participants presents his or her project in an interactive workshop. This format was implemented to allow the participants to better understand projects from other disciplines, as interactive learning scenarios have been shown to facilitate learning and understanding better than classic lectures (DESLAURIERS, SCHELEW & WIEMAN, 2011; FREEMAN et al., 2014; HAKE, 1998). The specific teaching strategy is based on a pedagogical approach that was found effective in physics education in use with students of heterogeneous backgrounds (MCDERMOTT, SHAFFER & ROSENQUIST, 1996). The interactive workshop consists of a qualitative worksheet ("Tutorial") and a talk. Both are designed by the respective Ph.D. candidate with the aid of an IRTG coordinator with academic teaching expertise. The expertise is needed, as the design of high-quality teaching material is nontrivial for untrained instructors since multiple aspects have to be considered (e.g., determination of the degree of difficulty, and target group orientation). In the design process, the IRTG coordinator and the presenting Ph.D. candidate meet for approximately six

times for about two to four hours. These meetings include a step-by-step analysis and reflexion of the fundamental principles of the research topic to be treated.

In the MMs, the participants work on the tutorial in interdisciplinary groups of three or four. At times, whenever necessary, the presenting participant gives additional guidance to the groups.

Besides the MMs, the participants do not attend regular lectures to learn fundamental principles relevant for CRC 986. (However, annual retreats and meetings of CRC subprojects take place.) Therefore, the MMs are practically the only possibility for the young scientists to regularly communicate across disciplines. In addition, the IRTG programme includes summer schools and the obligation to submit annual progress reports.

Although structured Ph.D. programmes funded by DFG were found to have a positive effect on Ph.D. education, dissatisfaction may arise (BERNING & FALK, 2006; ENDERS & KOTTMANN, 2009).

While at first the participants were unsatisfied with the IRTG programme, we were able to improve their attitudes through a transparent feedback format and the implementation of their suggestions. In this workshop report, we illustrate this process and give recommendations to coordinators in similar settings. We also demonstrate the positive effect that our approach had on cross-disciplinary understanding and the development of teaching skills.

2 Methods

2.1 Participants

The IRTG started its activity four years ago and consists of an open cohort of approx. 12 Ph.D. candidates (at different stages in their studies) and 3 postdoctoral researchers. In total, 30 Ph.D. candidates have so far attended or completed the programme.

As the Ph.D. education in Germany generally does not include courses or lectures, no exams on subject content are given. We therefore made use of self-reported data to assess the outcome of our programme.

2.2 Measures and Procedure

The evaluation of the IRTG was conducted via three different feedback formats. The MM were evaluated through a qualitative method called One-Minute Paper (Waldherr & Walter, 2009). At every MM, each participant is asked to provide written comments guided by three questions ("*What I have learnt.*" "*What I have not understood.*" "*Other comments I would like to make*.").

To evaluate aspects of cross-disciplinary understanding and academic teaching, we used a mixed methods approach that provided qualitative and quantitative data. A survey was given to Ph.D. candidates who had presented their project. The response rate of the survey was 50 % (i.e. 15 participants). After presenting their project a second time, the Ph.D. candidates were interviewed (3 out of 3 Ph.D. candidates).

3 Results & Discussion

In this section, the feedback of the Ph.D. candidates will be presented and discussed. We focus on the heterogeneity of the group, the satisfaction of the participants, the acquisition of teaching skills and the broadening of technical basics. Comments given in English [e] are presented literally; those in German were translated to English [g].

3.1 Heterogeneity and Implications for Teaching Approach

Due to their differing backgrounds, we expected the Ph.D. candidates to have heterogeneous knowledge on materials science. This issue arises in feedback gathered through One-minute Papers, such as the following:

> *"For a chemist, most […] is tough to understand, while the engineers seem to find it ridiculously easy."* (2 nd MM) [e]
>
> *"Not everybody is fit in mechanical properties."* (2nd MM) [e]

These comments indicate that our anticipation of the heterogeneity in the group was correct and support may be needed to enable the Ph.D. candidates to communicate professionally. Not only does this heterogeneity also seem to be clear to at least some of the participants as the preceding comments point out; they also recognize some implications regarding successful teaching as the subsequent comment demonstrates:

> *"It needs to be clarified that when you know something you don't simply state it as correct, but you [have to] explain it calmly to the others. A lot [of learning material] is quickly gone through and novices are left behind."* (2nd MM) [g]

3.2 Overcoming Dissatisfaction through Transparent Feedback and Modification

Even though some awareness of the heterogeneity existed among participants, the necessity for the given support in cross-disciplinary communication was not clear to them. This circumstance led to dissatisfaction among some group members as the following quotes indicate:

> *"I'd rather learn new complex interrelations in an expert talk than refresh school knowledge in a time-consuming manner."* (3rd MM) [g]
>
> *"Great waste of time, waste of human resources ⇔ waste of money […]."* (3rd MM) [g]

Dissatisfaction may arise due to two reasons in teaching scenarios: either the given content is too difficult to understand or it is already known and therefore leads to boredom. In our IRTG, both scenarios coexisted as the subsequent comments on the *same* talk demonstrate:

> *"I enjoyed the talk. Its academic level was just right for everyone to understand important concepts."* (9th MM) [e]
>
> *"In my case, my own background was just too low."* (9th MM) [e]

The statements show clearly the extreme divergence of the existing knowledge levels and the resulting misjudgement regarding appropriate levels of presented information. To overcome this dissatisfaction, we decided to confront the group with their heterogeneity. Starting with the 8th MM, we revealed selected anonymous quotes that relate to the accrued problems (as e.g. the two comments above), and commented on them if necessary. Additionally, the structure of the MMs was optimized following various suggestions by the participants:

> *"Perhaps a little more smooth introduction on the subject [...]."*
> (2nd MM) [e]
>
> *"Maybe it would make sense to make the contents a little deeper and more strongly connected to the topic."* (3rd MM) [e]
>
> *"Highlight the major important findings from the worksheet e.g. what is the main finding of each section."* (4th MM)] [e]

Based on these suggestions, we changed the structure of the MM from *tutorial and talk* to *feedback–introduction–tutorial–summary–talk*. We also paid attention to a better alignment of introduction, tutorial and talk. After these modifications, more positive feedback was given:

> *"I liked this tutorial much better than the last one → seemed closer to the topic of the talk."* (4th MM) [e]
>
> *"So the introduction is definitely helpful."* (Interview) [g]
>
> *"Most of the [recommendations] you have really already put into practice."* (Interview) [g]

Our response to the feedback and the measures described above helped to improve satisfaction with the interactive workshop format and increased the motivation to

participate. This experience aligns with observations in similar teaching scenarios (ANDERSON, HUNT, POWELL & DOLLAR, 2013; DAVIS, 2009; WINKELMES et al., 2015). We therefore recommend to coordinators dealing with dissatisfaction in similar settings to gather feedback on the programme, communicate transparently and change parameters accordingly if reasonable and feasible.

3.3 Enhancement of Cross-disciplinary Understanding

A general understanding of mutual research topics is required for successful communication across disciplines. We therefore gathered information on the perceived enhancement of understanding as a result of the IRTG participation. As fig. 1 shows, the majority of the Ph.D. candidates state they are acquiring relevant fundamental principles of the CRC through the IRTG events. A majority also claims that they are more able to follow presentations at CRC meetings that take place every year.

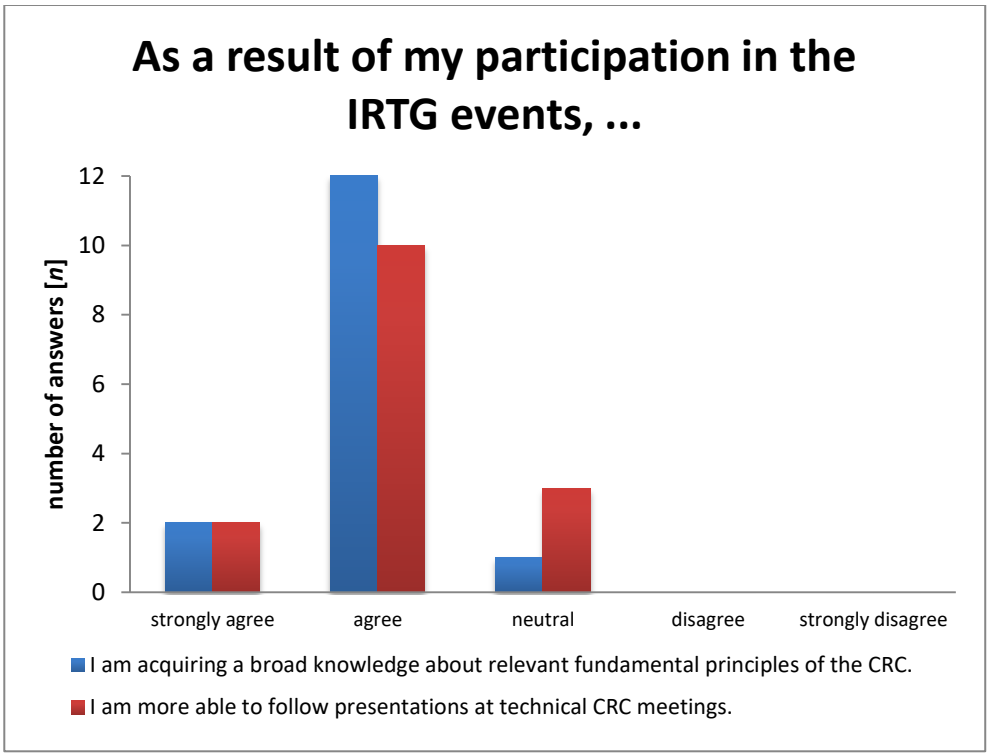

Fig. 1: Results of the survey on technical understanding (n = 15)

Similarly, the beneficial effect of the MMs was also expressed in interviews:

> *"I understand […] what the problems and tasks of the others within the CRC are. And […] one can talk about topics and tasks and possible collaboration."* (Interview) [g]

In summary, the results show that our programme enhances cross-disciplinary understanding and provides a basis for collaboration.

3.4 Enhancement of academic teaching skills

As mentioned above, academic teaching is highly challenging, especially for untrained individuals. In our setting, the challenges are to recognize the diversity of the audience and to take this into account when designing teaching materials as the following comments illustrate:

> *"I learned that it's not easy to create a tutorial for ALL knowledge levels. […]"* (23th mm) [e]
>
> *"I think I had an idea about the general aspects that are important for the understanding of my project, but I did not know how to make questions out of these."* (Survey) [e]

When asked about how the tutorial would have turned out without the help of the IRTG coordinator, two Ph.D. candidates answered:

> "*[The tutorial] would have been much too long and complicated. Like a semester-long lecture compressed to some 90 minutes."* (Survey) [e]
>
> "*[…] The hints how one writes a question target-oriented and [how to] lead to the next [question] were very helpful."* (Survey) [e]

As the participants struggled with the structuring and formulation of questions, and the appropriate length and clarity of the teaching material, it became obvious that the assistance given by an IRTG coordinator was needed for its development.

With the implementation of the feedback process mentioned in 3.2, the written feedback from the One-Minute Papers on the specific session was forwarded to the presenter after the MM. He or she was asked to answer selected open questions in the subsequent MM. Furthermore, an IRTG coordinator provided an opportunity for the presenter to reflect on his or her presentation in a subsequent meeting.

When asked about their acquisition of teaching skills as a result of their participation in the IRTG, half of the participants agreed or strongly agreed to the item (fig. 2). Doctoral candidates that checked "neutral" or "I disagree" mostly respond-

ed to an open question that they were already familiar with the tutorial format or had gained teaching experience before.

Considering the qualitative and quantitative data presented, we conclude that essential aspects of teaching, such as target group orientation, development of learning objectives, and reflection on teaching (materials) are fostered in the participants.

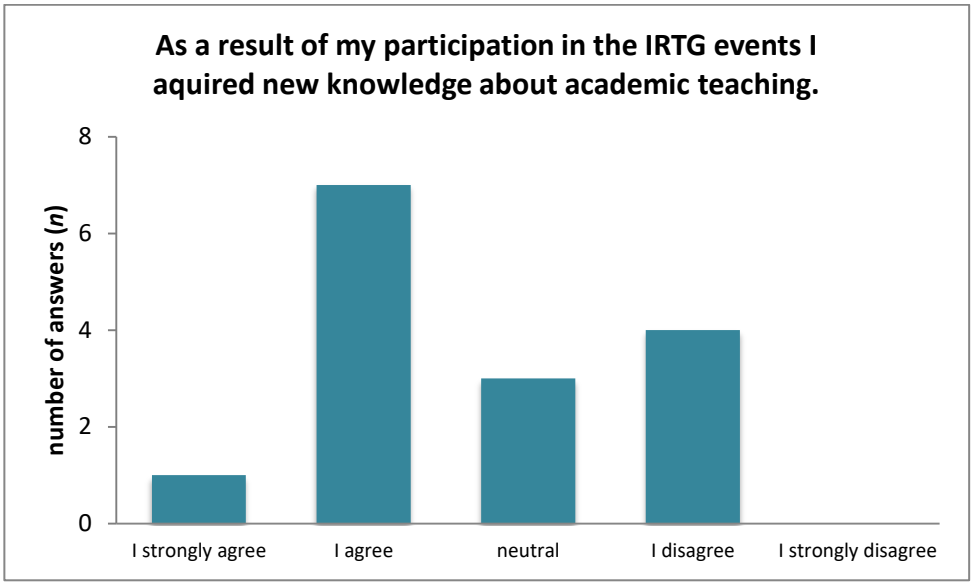

Fig. 2: Results of the survey on academic teaching (n = 15)

4 Conclusion

In the present workshop report we demonstrate the heterogeneity of the participants in our cross-disciplinary programme and their need for support in communicating successfully about science.

As the necessity of the support was not clear to all participants, dissatisfaction with the chosen teaching format arose. To overcome this dissatisfaction, we confronted the participants with their heterogeneity and implemented suggestions gained from qualitative feedback that led to modifications in the structure of the technical meetings held monthly.

While we are aware that the small number of participants does not allow for definite conclusions, we believe that our programme enhances cross-disciplinary understanding and academic teaching skills in the participants.

Due to the observed impediments to communication, we recommend that participants in cross-disciplinary Ph.D. programmes be supported by an expert in higher education or research communication while engaging in scientific discourse with one another.

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