Chapter 12
The Socialization of Doctoral Students in the Emergence of Structured Doctoral Education in Germany

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Doctoral education and training attracts increasing attention of scholars and policy-makers because of the role doctoral graduates play for the future of academic research as well as for knowledge transfer from academia to other sectors (Enders & De Weert, 2004; Roach & Sauermann, 2010; Sauermann & Roach, 2012; Thune, 2009). Reforms designed to improve efficiency and to increase the value to society have therefore addressed the training of doctoral students around the globe (e.g., Golde & Walker, 2006; Nerad, 2004). In Europe, the Bologna Declaration of 1999, which aimed at the creation of a more integrated European Higher Education Area, and the Lisbon Strategy of 2000 to strengthen the European Research and Innovation Area, played important roles. At the national level, countries have addressed the challenges related to the implementation of the policy agenda using a number of instruments (Kehm, 2006a, 2007; Park, 2005).

This chapter discusses developments in doctoral education in Germany since the 1990s where substantial reforms and initiatives have affected the organization of how junior researchers pursue their doctoral training (Ambrasat & Tesch, 2017; Guth, 2006; Kehm, 2006b). The support of Research Training Groups (RTG) and Graduate Schools (GS) accompanied by a substantial increase in funding for them by the German Research Foundation (DFG) is particularly interesting because it involves a fundamental change in the role and conception of doctoral education in Germany.

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Germany is an interesting setting to study reforms in doctoral education because since the first establishments of Research Training Groups in the late 1980s, structured doctoral education has evolved from nearly non-existence to the promotion of Graduate Schools as a pillar of the "Excellence Initiative," a public policy initiative, first implemented in 2005, to strengthen the German higher education system in order to catch up with the global research elite. As a response to concerns about the country's competitiveness regarding science and technology, the federal government committed in 2005 to providing additional funding to scientific institutes in order to establish elite research centers. This initiative constituted a substantial step away from the policy of egalitarianism of opportunity and research funding that characterized German university policy since the Second World War (Kehm, 2006a). Following the example of doctoral education in the USA, RTGs and GS not only offer a more structured and systematic doctoral training, but also increase the transparency of the overall process: starting with a selection procedure according to standardized criteria and regulations for joint determination of the goals of the dissertation and an agreed upon statement of supervision (Baldauf, 1998; BuWiN, 2017; Kehm, 2007).

This chapter addresses initiatives directed at reforming doctoral training and their possible implications for the socialization of young researchers, with a specific focus on Germany. Socialization of early career researchers typically occurs in institutions in which they work such as the department or research laboratory (Antony, 2002; Gardner, 2007; Golde, 2005; Hottenrott & Lawson, 2017; Tierney, 1997; Weidman & Stein, 2003; Weidman, Twale, & Stein, 2001). In particular, the professional relationship to the supervisor(s) has been identified as having an important formative influence on the values and perceived opportunities of their graduate students (Lee, 2008; Mangematin, 2000). Socialization processes have been shown to be crucial because they affect research performance (Hall, Mairesse, & Turner, 2007), attitudes towards knowledge transfer and commercialization (Bercovitz & Feldman, 2008) as well as teaching (McDaniels, 2010). They eventually also shape career decisions (Austin & McDaniels, 2006; Fuhrmann, Halme, O'Sullivan, & Lindstaedt, 2011; Weidman et al., 2001).

In the following, we first present the developments in doctoral education in Germany over the past decades before discussing the implications of these changes for the socialization of young researchers, drawing from the framework proposed by Weidman et al. (2001). We formulate expectations regarding the consequences of the shift towards structured doctoral education through the implementation of RTGs and GS by deriving implications for the socialization processes experienced by graduate students.

We conclude that continued promotion of structured doctoral education in Germany provides a wide set of benefits, but that structured doctoral education complements rather than substitutes chair- or research group-based training. Finally, besides the changes in doctoral education, reforms affecting institutional culture, working conditions, research funding, and (international) collaboration of academia in Germany may likewise contribute to improving conditions for young scholars at universities.

## Structured Doctoral Education as a Paradigm Shift

Research Training Groups – A Success Story

The traditional higher education system in Germany was characterized by a one-on-one relationship between PhD students and a supervising professor (a quasi-parental relationship referred to as *Doktormutter* or *Doktorvater*). Being enrolled as a doctoral student and employed at the university, a research institute, or in the private sector, the process of obtaining a doctorate was not very formalized and highly depended on the individual supervisor.

Unlike in the UK and the USA, doctoral education in Germany was not considered a separate stage. It was rather a form of professional work in a research environment with a doctoral candidate pursuing a research project "on the side". Doctoral students were usually employed as junior members of staff under a chair and were expected to complete their thesis in a maximum of 6 years after which this contract could, for legal reasons, not be prolonged. Doctoral education was also rather informal and highly tied to the chair under which candidates were employed (Baldauf, 1998). Moreover, PhD students were usually not obliged to take additional courses and the training of young researchers was usually taken care of by the supervising professor, commonly holder of the chair of employment, in a one-on-one fashion.

Disadvantages of this approach compared to doctoral training in Graduate School settings were identified as early as in the late 1980s, but inflexibility in work contracts and examination rules resulted in little change to the established system until the reforms that led to the Bologna and Lisbon agendas at the European level (European Commission/EACEA/Eurydice, 2015). Both sets of reforms paved the way for structural changes also in doctoral education (Enders, 2001). These reforms also recognized the importance of PhD supervision with the objective of "improving the supervision of PhD candidates, particularly through better training and monitoring of supervisors" and of "enhancing quality control and evaluation of PhD programmes" (European University Association 2008).

In an attempt to offer young researchers a more structured and more transparent doctoral training, reducing the sole dependency on a single supervisor, Germany introduced its first Research Training Group (RTG, *Graduiertenkolleg*) in 1985: "The idea was to move away from traditional individual doctoral training, encourage early independence and make doctoral programmes more structured as well as shorter" (DFG, 2010, p. 6). RTGs should provide young scholars with an excellent research environment while being supervised by a team of professors, pursuing also non-university collaborations with partners in industry or other public sector organizations. Due to the high demand and positive feedback, since then many more RTGs have been established and funded by the German Research Foundation (DFG) in all relevant fields of science, i.e. engineering sciences, life sciences, natural sciences as well as humanities and social sciences (see Fig. 12.1).
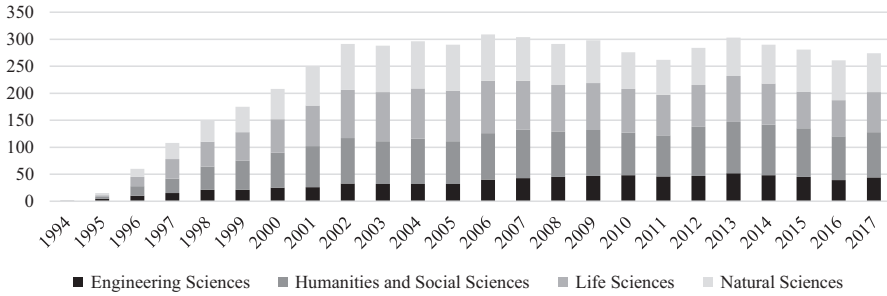
Source: DFG, own representation.

Fig. 12.1 Research training groups and graduate schools by discipline (# Ongoing). (Source: DFG, own representation)

RTGs typically consist of 20–30 doctoral students, have a narrowly defined research program, and try to create and foster a culture that allows intensive scientific exchange and practice orientation. *Anselm Fremmer*, DFG program director, hence describes the focus of RTGs as follows: "Topics shouldn't be defined so narrowly that everybody ends up working on the same project, yet they should be specific enough to allow doctoral researchers to communicate with each other at a scientific level" (DFG, 2010, p. 8). RTGs also encourage the interdisciplinary and international exchange, as so-called 'International Research Training Groups' have been introduced since 1999.

Graduate Schools – Another Success Story?

In order to further strengthen the higher education system in Germany and to promote top-level research, the German government launched the so-called "Excellence Initiative" in 2005.[1] The goal of this science policy program was to enhance Germany's competitiveness and catch up with the global research elite. As with the establishment of RTGs, the German government again broke with its traditional (egalitarian) approach and introduced three competitive funding schemes within the higher education sector: (1) 'Graduate Schools' to promote young researchers, (2) 'Clusters of Excellence' to promote topic-specific research and (3) 'Institutional Strategies' to develop top-level university-wide research agendas (DFG, 2013a). Organized by the DFG and the German Council of Science and Humanities (WR, *Wissenschaftsrat*), a total of 2.7 billion euros were provided in two phases (2005–2012 and 2012–2017) by the Federal and State Government to fund successfully submitted projects. The largest fraction of funding has been distributed to the third category, the Institutional Strategies. In order to qualify for this funding line, a university must have presented a long-term strategy detailing its approach to improving its research environment and researcher quality in the long run. However,

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[1] See Kuratko and Menter (2017) for a more in-depth description of recent public policies in Germany, especially the Excellence Initiative.

to be eligible for funding in this category, universities must also have obtained a financial commitment in both of the other two Excellence Initiative categories. The initiative engendered a great deal of attention, both nationally as well as internationally, and triggered a self-selection process among German universities (see Abbott, 2017; Menter, Lehmann, & Klarl, 2018; Schiermeier, 2017).

Graduate Schools (GS) can be thematically broader than RTGs and are meant to complement RTGs. *Annette Schmidtmann*, head of the DFG Department Scientific Affairs, thus notes that "not least because of the Excellence Initiative, universities have been using their experiences with Research Training Groups to sharpen their profiles and restructure their doctoral programs" (DFG, 2010, p. 9). Graduate Schools can be differentiated by their thematic focus as well as their size, as four types schools exist: (1) GS with a narrowly defined research program, (2) GS with a more broadly defined research program, (3) GS with a focus on one field of expertise and (4) university-wide GS (GWK, 2015). Whereas type (1) schools consist of a maximum of 30 doctoral students and are comparable to RTGs, the number of doctoral students of type (2) and (3) schools range between 50 and 500. Graduate Schools of type (4) are generic and may host up to several thousands of doctoral students.

The categories (2) and (3) are more common than (1) and (4). Examples of type (4) are the GS at the Ruhr University Bochum (Ruhr-University Research School) and the GS of the Technical University Munich (TUM). While Humanities and Social Sciences as well as Life Sciences are most strongly represented among promoted GS, 30 out of the 51 funded Graduate Schools cover more than one scientific field, illustrating the multidisciplinary of these schools (see GWK, 2015). Thus, the transition from RTGs to GS was driven by the idea that universities should be given more flexibility with regard to the size of the school and the inclusion of different disciplines. Whereas RTGs were designed to support the qualification of doctoral researchers within the framework of a focused research program, GS are supposed to promote young scientists more generally including training in general (career-related) skills.

The left chart in Fig. 12.2 shows that the number of active RTGs increased substantially during the 1990s and has declined slightly since then. The additional implementation of GS has, however, made up for the decline so that the overall numbers remained at levels of 250–300 active schools since 2002. Figure 12.2 thus
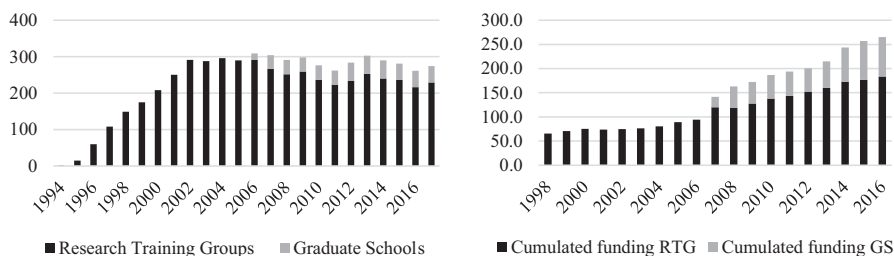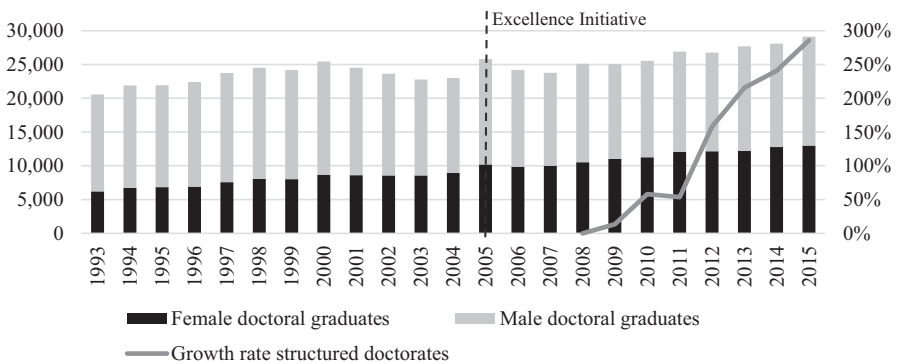

Source: DFG, own representation.

Fig. 12.2 Research training groups and graduate schools (# Ongoing) and funding for structured doctoral education (in Mio. Euro). (Source: DFG, own representation)

shows that the newly introduced Graduate Schools partly replaced the established model of RTGs. The right hand side of Fig. 12.2 depicts the development of funding for RTGs and GS over time. Funding typically covers the wages of the doctoral candidates, travel and training expenses. The two charts thus show the substantial increase in funding for both RTGs and GS by the German Research Foundation and in particular the increasing share of GS in the overall funding.

Following the example of the USA, Graduate Schools should not only offer a more structured and systematic doctoral training, but also increase the transparency of the overall process. In order to monitor respective achievements, the Excellence Initiative as a whole (including the Graduate Schools as one of the funding pillars) was subject to evaluations through the WR. In 2008 and 2015, the WR submitted joint reports with the DFG to the Joint Science Conference (GWK, *Gemeinsame Wissenschaftskonferenz*) (GWK, 2015). In 2016, the International Expert Commission to Evaluate the Excellence Initiative (IEKE, *Internationale Expertenkommission Exzellenzinitiative*) published its first evaluation report (IEKE, 2016). At the level of the individual institution, the evaluations revealed that the candidate selection as well as the determination of the standards have been professionalized. Compared to alternative doctoral training, the dropout rate of young scientists and researchers at Graduate Schools is low (1–6% percent compared to 16–66%) and a considerable share of the doctoral students remain within academia after their graduation (40–90% depending on the discipline, see Groenvynck, Vandevelde, & van Rossem, 2013; GWK, 2015, p. 46).

Despite the steep increase in the number of doctorates awarded to graduates from structured programs (see Fig. 12.3), in the academic year 2014/2015, only 23% of all doctoral students were enrolled in structured doctoral training (BuWiN, 2017).

Source: German Federal Statistical Office, own representation. Growth rate relative to 2008. Information for earlier years is not available.

Fig. 12.3 Annual number of graduated doctoral students and share of female graduates (all disciplines); growth rate of the number of graduates from structured programs. (Source: German Federal Statistical Office, own representation. Growth rate relative to 2008. Information for earlier years is not available)

Whether structured doctoral education will become the norm in Germany will depend on how future decision makers perceive the cost-benefit trade-off associated with it.
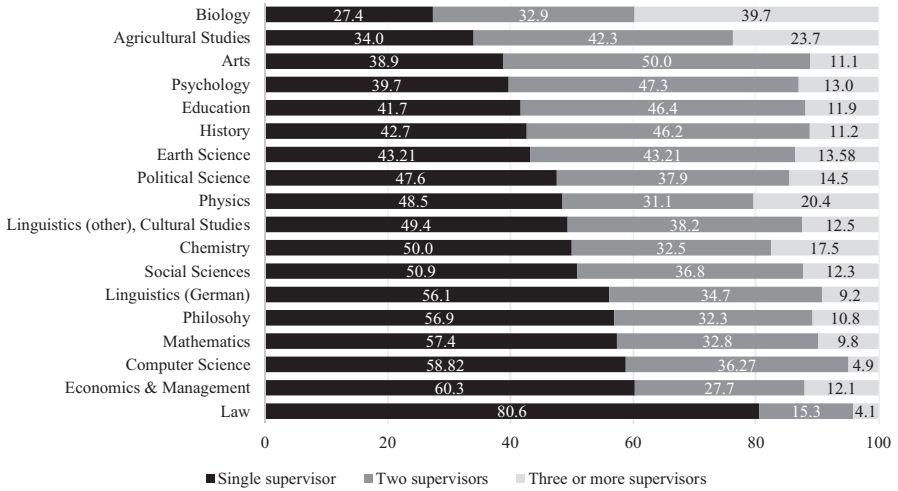
In the discussion regarding the success of structured doctoral education, however, little attention has so far been paid to differences in the socialization processes between the traditional style and structured doctoral education. The framework by Weidman et al. (2001) provides a valuable guide for analyzing socialization of doctoral students. The authors state that "changes in higher education institutions, often necessitated through increasing pressures from external constituents, challenge long-standing academic goals" (Weidman et al., 2001, p. 9). Although a review of the literature on professional and doctoral programs from the 1950s to the 1990s in the USA by Weidman et al. (2001) suggests that patterns of socialization still follow many of the long-standing norms associated with collegial culture, they identify increasingly less homogeneous socialization processes in more diverse student populations. The shift in the nature of the organization of doctoral education in Germany since the 1990s, in addition to such developments, may therefore provide a substantial force with potentially important consequences not only for doctoral students, but also for the institutions in which they are active.

Structured Doctoral Education and the Socialization of Graduate Students

Before discussing differences between socialization processes in a structured doctoral education versus the traditional approach and possible consequences from a stronger focus on the former, we need to define how we differentiate between organizational forms of graduate education in Germany. Ambrasat and Tesch (2017) distinguish five different groups of doctoral students based on their type of working contract and their enrollment in structured programs. Other previous studies contrast the emerging structural doctoral programs with either the master-apprentice model (Hornbostel, 2009; Janson, Schomburg, & Teichler, 2007; Kehm, 2006b) or the so-called individually-pursued doctorate (Mittelstraß, 2010).

In the following, much of the discussion will focus on the distinction between those enrolled in structured programs and those pursuing a more traditional "non-structured" doctorate. The latter represents the traditionally dominating organizational form of doctoral training in Germany organized within chairs and small research groups, led by a professor who is solely responsible for the doctoral candidates under his or her supervision. Explicit examination requirements, preparatory and accompanying courses are rather rare and – if existing – rather informal. The content and the design of the training is determined by the supervising professor according to his or her own standards, rules and values. We label this form of doctoral education as chair-centered or one-on-one training.

In contrast to this, we label doctoral education organized in GS or RTGs as structured doctoral training (see Korff and Roman (2013) for a detailed discussion of the organizational variety of structured programs). Although chair-based doctoral train-

Fig. 12.4 Number of supervisors by discipline (in % of respondents). (Source: Survey data as presented in Hauss et al. (2012), own representation)

ing obviously also follows a certain structure, it is more supervisor-specific and dependent on the relationship between the chair-holder and the individual graduate student. In GS-based training the structure is similar for a larger cohort of students who have different supervisors, but still pursue their training under the same set of courses offered, same rules and standards and face fixed or at least pre-defined steps and milestones to be completed.

According to data collected by the 2017 National Report on Junior Scholars, in recent years 53–76% of doctoral candidates are supervised by multiple supervisors and students in structured programs are more likely to be supported by more than one supervisor (Ambrasat & Tesch, 2017; BuWiN, 2017). The differences between subject groups are substantial. Figure 12.4 shows the occurrence of single versus multiple supervisors by field of study based on a survey of doctoral students (see Hauss et al. (2012) for details). Having three or more supervisors is most common in Biology, Physics and Chemistry and least frequent in Law where one-on-one supervision is the norm. In Biology, 73% of students have multiple supervisors and about 40% of candidates are supported by three or more supervisors. In Law, multiple supervisors are rarer with just 19%.

We refer to individuals enrolled in either form of doctoral education as students although their self-perception may differ. Particularly doctoral students employed as researchers under a chair may perceive themselves as employees rather than students, even though they are the doctoral students of their supervisor. On the other hand, for individuals enrolled in Graduate Schools, it is usually self-evident that they carry the status of a student. In what follows, we base our discussion on the

model by Weidman et al. (2001) who define socialization as a non-linear process that shapes identity and role commitment through experiences with formal and informal aspects of university culture as well as through personal and professional interactions with reference groups outside the university.

The insight that events occurring early in the graduate program can be more decisive than at later stages goes back to Bragg (1976) and Staton (1990). Thus, early experiences can have more impact than those at later stages, when students have already been imprinted with certain traits. Moreover, junior researchers represent an important group simply by their relative size. Table 12.1 shows the increase in the number of early career researchers in Germany from 2000 to 2014. The increase of 91% (compared to 21 in the group of professors) was particularly high in the group of individuals younger than 34 years of age underlining the importance of this group in the higher education sector. The relatively high number of PhD graduates compared to available senior positions makes it further crucial to understand the mechanisms that filter out the most able for remaining in academia and hence for training future cohorts of researchers. At the same time the question emerges of how doctoral education can prepare graduates best for jobs outside academia and whether structured doctoral education is sufficiently flexible to transfer adequate skills for both 'inspired' and 'industrial' students (Louvel, 2012).

Graduate socialization necessitates shared conscious experiences with fellow students, faculty mentors and other role models. Thus, socialization occurs through experiences as students pass through formal and informal processes. The design of graduate education therefore affects these experiences or the set of possible experiences. Lee (2008) suggests that such experiences have long-lasting effects because own experiences determine the type of supervisor a junior researcher will become later in his or her career. The same applies to funding conditions, the nature of employment and the roles that students take on. Students "internalize behavioral norms and standards and form a sense of identity and commitment to a professional field" (Weidman et al., 2001, p. 6). In other words, socialization contains cognitive as well as affective dimensions. Knowledge and skills as curricular aspects and normative or dispositional aspects will affect professional commitment and identification with the profession. As Weidman et al. (2001, p. 5) put it "[…] graduate students must also experience their own particular kind of metamorphosis to move into their postgraduate careers". Since there are good reasons to believe that there

Table 12.1 Arts and science staff (excluding professors) up to 44 years old with fixed-term contracts at higher education institutions in Germany (2000–2014)

	2000	2005	2010	2014	Increase (2000–2014) in %
Arts and science staff (excluding professors)	82,403	87,344	128,547	144,927	76
… of whom up to 34 years old	57,613	60,524	98,052	109,880	91
… of whom 35 to 44 years old	24,790	26,820	30,495	35,047	41
In comparison: Professors	37,794	37,865	41,462	45,749	21

Source: 2017 National Report on Junior Scholars (BuWiN, 2017)

are substantial differences in the experience between structured doctoral training and individual training, the following section discusses possible implications for doctoral student socialization. The discussion follows the stages and core elements of socialization as laid out in the framework of Weidman et al. (2001).

Dimensions of Socialization and the Differences Between Structured and Traditional Doctoral Training in Germany

Early literature on student socialization distinguishes six polar dimensions, which go back to Van Maanen and Schein (1979) and have been discussed by Tierney and Rhoads (1994) and Weidman et al. (2001). The most obvious of these polar dimensions affected through the shift from a one-on-one doctoral education to Graduate Schools is the first, collective vs. individual. Students pursuing their doctoral education in a Graduate School experience collective socialization in the sense that they are all subject to the same set of rules that govern the school, a similar set of faculty and courses. Collective identity will possibly be stronger in students that are part of a cohort in such a structured PhD program. As Weidman et al. (2001, p. 7) note, compared to students in medical schools who "are herded through rounds with experienced physicians […] students in the arts and sciences generally have a more individualistic experience with their major professor". The same applies to the differences in the Graduate School experience versus a one-on-one thesis supervision.

The second is formal vs. informal socialization. Formal socialization describes experiences such as clear rules of conduct, a pre-defined curriculum and specific signifying progress toward degree completion. Informal socialization refers to the interactions between students in the school and emerging peer cultures. In Graduate Schools, formal and informal socialization may in fact complement each other as being more closely engaged with fellow students and relating to a certain culture may increase the likelihood that students also pass the more formal hurdles and achieve the expected goals.

The third polar dimension, random vs. sequential, is a particularly interesting one. Through a more formally structured process in doctoral schools sequential socialization defined as "discrete and identifiable steps for achieving an organizational role" (Tierney & Rhoads, 1994, p. 28) plays an important role. Students who must accomplish specific steps in their PhD program such as examinations and "December papers" might be more exposed to sequential socialization than individually-organized doctoral candidates who may experience random socialization to a larger extent.

A similar logic applies to the fourth polar dimension, fixed vs. variable pace in which experiences occur. A Graduate School environment usually prescribes a

fixed time line along which certain "points" must be collected or certain goals must be achieved. Thus, progression occurs rather uniformly compared to unstructured doctoral education where a variable pace will be more often observed with unclear time frames for the different milestones (if there are any defined at all). In the latter case, progress depend in a much stronger way on student and supervisor pace. As reported in the 2017 National Report on Junior Scholars, the median duration from start of the doctoral studies to graduation is indeed shorter in structured programs with estimates ranging from 3.25 to 3.6 years compared to 3.8 years in other forms of doctoral education (BuWiN, 2017). This is in line with the international experience that identified the doctoral training system, the doctoral program and the general research environment as import factors influencing completion rates and the time it takes for completion (Kyvik & Olsen, 2014; Spronken-Smith, Cameron, & Quigg, 2018). Most factors contributing to high submission rates are more likely to be provided within structured programs, e.g., close monitoring during candidature, provision of research training, a vibrant research culture, high-quality supervision and appropriate research funding incentives (Spronken-Smith et al., 2018).

The fifth polar dimension is serial vs. disjunctive progress. Serial socialization describes planned organizational structures and educational experiences through which PhD students are trained by faculty. Importantly, previous cohorts experienced the same structures and can therefore provide formal and informal guidance for future cohorts. In disjunctive socialization such learning from earlier generations is not possible or not valuable because of incomparable circumstances, rules and/or norms, i.e. when newcomers have no role models available from whom to learn. Disjunctive socialization may not only occur in times of a shift from unstructured to structured PhD education, but also when graduate programs are significantly altered from one generation to the next.

According to Tierney and Rhoads (1994, p. 29), progress to degree completion may be interdependent with the sixth polar dimension, investiture vs. divestiture. They define investiture and divestiture as follows: "Investiture (more affirming) concerns the welcoming of the new recruit's anticipatory socialization experiences and individual characteristics, whereas divestiture (more transforming) involves stripping away those personal characteristics seen as incompatible with the organizational ethos.". Weidman et al. (2001) therefore conclude that the socialization process requires investiture for a student's transformation during graduate education to be complemented with the internalization of values, attitudes, and beliefs. Investiture then means to confirm these values in the professional setting. The problem with disjunctive socialization is that differences between generations of graduate students increase pressures toward divestiture of orientations which are perceived to be undesirable. The current design of fixed-term funding of RTGs and GS in Germany and the potential of their discontinuation after the funding period ends may therefore result in disjunctive socialization despite the intrinsic potential of structured programs to facilitate sequential socialization.

The Stages of Socialization in the Weidman Model Applied to the German Context

The four stages of socialization in the Weidman et al. (2001) model provide a framework for understanding role acquisition through the dimensions of socialization of German graduate students (Fig. 12.5). Two basic assumptions underlay this framework. The first is that socialization is a developmental process and the second is that certain core elements such as knowledge acquisition, investment and involvement are linked to the development of role identity and commitment. The four stages in this framework reflect different states of identity and commitment that can be overlapping (Weidman et al., 2001). Differences between individual and structured doctoral education in Germany can thereby be identified at each stage.

- *The anticipatory stage:* In this stage of role acquisition, a prospective doctoral student "becomes aware of the behavioral, attitudinal, and cognitive expectations held for a role incumbent" (Weidman et al., 2001, p. 12). A student typically enters the recruitment phase with (field-specific) stereotypes and preconceived expectations regarding what a doctoral student is like. These views are shaped by the (mass) media or through interaction with role incumbents in the family or circle of friends. Individuals usually modify these views when they gain a clearer understanding of the reality as a junior researcher while they also make a com-
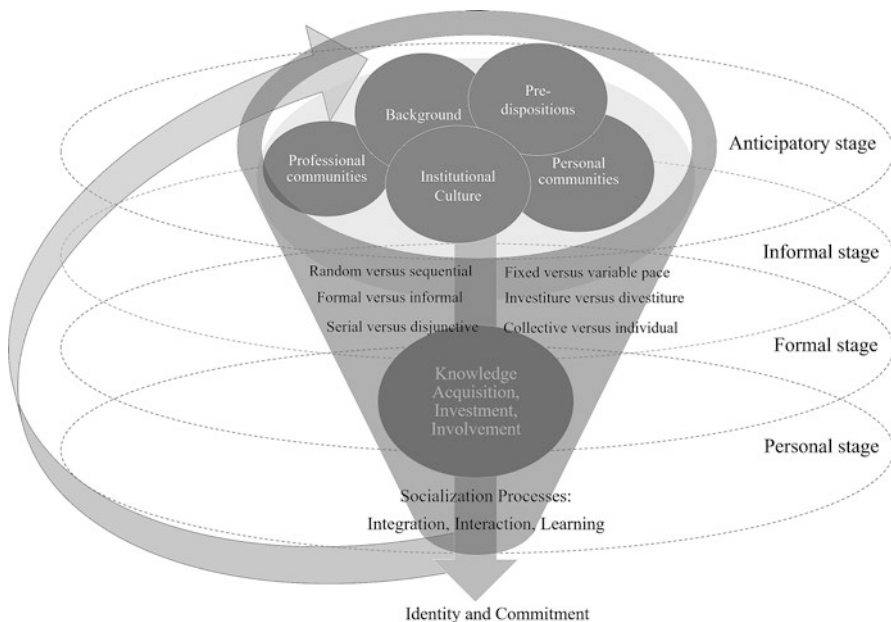

Fig. 12.5 Stages, dimensions and core elements of German doctoral student socialization. (Source: Own representation following Weidman et al. (2001))

mitment to the new role. They also adopt professional jargon, vocabulary, normative behaviors, and acceptable emotions in that process as communication tends to move in the direction from more senior faculty to junior researchers (Staton, 1990). This process might differ substantially depending on the organization of the graduate education a new student becomes involved in. The choice or assignment of a faculty advisor or supervisor can be critical to the socialization process and eventually to the success of the individual student. While the student-faculty relationship and interaction with the supervisor seems less important in structured programs, it may likely be even more important if the student is exposed to a broader set of potential role models. Interdisciplinary contacts may also be more frequent in structured programs (Ambrasat & Tesch, 2017). More remarkably, they also find that transferable skill courses were much more often taken by scholars in structured programs with more than 31% compared to only 13% of external candidates.

- *The informal stage:* During this stage, role expectations are formed not only through interaction with faculty and role incumbents, but also through involvement in and the development of peer culture. Social and emotional support among classmates becomes important as well. Differences between a chair-based traditional doctoral training and doctoral education in Graduate Schools may become particularly visible at this stage. As students pass through stages together they bond and develop their own social culture (Twale & Kochan, 2000). Structure may also help students in the first phases to navigate through their new environment and to understand the requirements and steps they need to take. Close-knit cohort groupings may further facilitate communication and mutual support making it easier for the individuals to see their fit to the program and academic work more generally. In situations that lack group-specific role models, for instance in case of female professors in STEM (Science, Technology, Engineering and Mathematics) programs, female doctoral students may find it easier to find confirmation and support among their peers. In Germany, as in most other developed countries, women are well represented as undergraduate students, but underrepresented in the professoriate. Female graduates are less likely to pursue doctoral studies and are not appointed to professorships at a rate that one would expect given the share of women among PhD students (BuWiN, 2017). Data from Germany suggests that Graduate Schools may have helped to increase the number of females (see Fig. 12.3) which might eventually also lead to more female professors.

While the cohort influences the learning process, professors and administrators have decisive influence on who enters the program as well as on the composition of each cohort. They not only set a minimum level of certain skills or grades, but they may also determine minimum levels of ethnic or gender diversity and a certain skill mix. Another objective of the expansion of structured doctoral programs in Germany is to reduce social selectivity in access to doctoral studies. A recent study by De Vogel (2017) finds that the effects of educational background on entering a structured doctoral program or grant program are lower compared to those found on transition to individual doctorates, but evidence for gender is less clear.

- *The formal stage:* According to the model of Weidman et al. (2001), also in this stage role expectations held by the new student remain idealized. During this stage, the new students learn about their fit to the program and build an expectation about their personal probability of successful completion. Formal instructions received during that stage help to derive these expectations. Young researchers also observe the activities of more senior researchers and learn about normative role expectations that are not visible to the general public. In this phase, newcomers also establish goals and seek feedback which helps them to develop their skills and competences. In structured doctoral education, this stage is often more professionally organized and standardized. The personal fit may be more accurately determined if milestones and specific learning objectives are clearly articulated. Faculty-student interaction, which is typically more formally prescribed and planned in structured programs, may lead to more integrative communication. As university systems such as the Germany system move towards a more structured design, the role of the supervisor also becomes more formal and professionalized. Finally, formal examinations provide a reliable indicator of a candidate's academic capacity providing an early indication of whether successful completion of the program is likely or not. Ambrasat and Tesch (2017) report in a study among doctoral students in Germany that the level of formalization as indicated by written agreements and attendance in colloquia and courses is indeed higher for candidates in structured programs compared to others.

For RTGs and GS in Germany, the German Research Foundation (DFG) provides clear ethical guidelines. The DFG's recommendations for safeguarding good scientific practice were first published in 1998 to "provide guidance and […] form the basis for a self-regulation system that has been initiated in every registered research institution and which since then has enjoyed a broad consensus. They are also an ever-present element in DFG research funding; every researcher submitting a proposal to the DFG must comply with the rules of good scientific practice" (DFG, 2013b). Every institution funded by the DFG including structured doctoral training programs has to comply with these standards. Moreover, graduate programs are typically required to formulate clear rules and criteria for evaluation in addition to the more general examination regulations that apply to every doctoral candidate. At the more micro relationship level, the DFG strongly recommends the use of formal "agreements of supervision" to be signed by the doctoral candidate and all supervisors and mentors involved to ensure awareness of responsibilities on both sides.

- *The personal stage:* In this stage, students form a professional identity and assume their role as researchers. They accept value orientation, resolve conflicts impeding a total role transformation and seek their own identity while at the same time realize that the "program is only preparatory to their professional goal and not the real thing" (Weidman et al., 2001, p. 15). The latter aspect may be particularly true in Graduate School environments when the training becomes the center of attention compared to the pursuit of advancing research projects and learning on the job. Chair-based doctoral students may to a larger extent be

involved in day-to-day research activities from the very beginning of their training. Rather than focusing on certain milestones, exams and compliance with general rules they may be paying more attention to the progress of the actual research conducted at the chair or research group. Table 12.2 shows the average time (in hours per day) doctoral researchers in Germany spend on thesis-related work, research, teaching and administration. Those enrolled in structured programs spend on average more time on their thesis project than students pursuing other forms of doctoral education. However, they are also less intensively involved in other research projects, teaching and administration.

Chair-based training may have a stronger influence of the supervisor on the identity formation of a student. Ambrasat and Tesch (2017) find that there are indeed differences between the perceived exchange intensity with the main supervisor between students pursuing different doctorate pathways and that on average, within structured programs the chance of candidates to exchange with their supervisor at least once a week is 3.8% points higher than in a non-structured context. The role and responsibilities of the supervisor may also differ depending on the nature of the doctoral education system. Pinheiro, Melkers, and Youtie (2014) show that co-publication with advisors is an important driving factor of future publication activity and therefore later career success. At the same time, stricter accountability and quality assurance requirements may be easier to comply with when monitored centrally at the Graduate School level and not solely by the individual supervisor.

However, at larger chairs fellow doctoral students, post-doctoral researchers and technical staff may also be important for the value orientation (Kiley & Mullins, 2005). Unlike in the USA, doctoral students in Germany are, to a large share, also employed at the universities – at least part-time. Formal recognition seeking through securing assistantships plays only a minor role, but the nature of the tasks may change according to specialty areas they are particularly interested in. Flexibility with regard to research orientation may be larger in a Graduate School environment compared to graduate students working at a single chair. At this stage, students also assess their competitiveness compared to students in the same cohort in their field or recognize misfits to the program, discipline or aca-

Table 12.2 Doctoral students' average number of hours spent per day on different activities by type of doctoral education (2011)

	Type of activity			
	Thesis writing	Other research	Teaching	Administration
Structured program	5.9 (2.6)	1.0 (1.4)	0.7 (1.3)	0.6 (0.8)
Junior researcher financed by a research grant	4.4 (2.8)	1.8 (1.9)	0.8 (0.9)	0.9 (0.9)
Junior researcher financed by a chair's core budget	3.3 (2.5)	1.3 (1.5)	1.7 (1.5)	1.2 (1.1)
Independent (without work contract)	4.7 (2.4)	0.9 (1.3)	0.8 (1.5)	0.7 (1.1)

Source: 2017 National Report on Junior Scholars (BuWiN, 2017), Standard deviations in parentheses

demic work more generally. Peer solidarity and peer affirmation that emerge in a Graduate School setting are moreover important factors that might influence the likelihood to succeed. Indeed, lower drop-out rates in structured programs seem to confirm this notion (Groenvynck et al., 2013).

The Core Elements of Socialization in the Model of Weidman et al. (2001)

The stages described above all comprise characteristics that Weidman et al. (2001) label as core elements. A central theme in Weidman's model of socialization of doctoral students is ***knowledge acquisition***. Sufficient cognitive skills are crucial for role performance. However, also affective knowledge including the awareness of normative expectations of the professional role and a realistic assessment of personal ability to pursue the desired career are important. According to Weidman et al. (2001), during socialization, knowledge shifts from being general to being specialized and complex. In all stages of socialization, outcomes will be affected by an individuals' accuracy of knowledge and personal assessment of the own capacity to perform the professional role successfully. Further, to invest in a role involves commitment of time and effort and giving up alternative careers. During the formal stage of socialization much of this ***investment*** is done in learning of specialized skills.

   The supervisor or the team of supervisors plays another important role for investment and commitment. In Germany, a high share of doctoral students receive a *Vertrauensvorschuss* (trust in advance) in the form of an employment contract. Of those doctoral researchers working in higher education institutions, 93% have fixed-term contracts (in non-university research the share is 84%). Despite being limited in duration, salary levels are usually in line with collective labor agreements and doctoral students are generally not at risk of poverty with an average monthly net income of more than 1200 Euros, which is above the poverty threshold defined by the Microcensus 2010 (BuWiN, 2017). Overall, the design of RTGs and GS in the German context provides research funding, in particular funding for the wages of the doctoral candidates, which alleviates pressures on doctoral candidates to raise funding from alternative sources or to seek additional employment "on the side". It also reduces the burden on supervisors to raise funding for doctoral researchers through project-specific grants or consulting work.

   The third core element is ***involvement***, which is defined as the "participation in some aspects of the professional role or in preparation for it" (Weidman et al., 2001, p. 19). Intensity of involvement varies not only over the course of the doctoral education cycle, but also between individuals. Involvement with senior scientists or older students provides the student with insights into professional ideology, norms and attitudes. While involvement is a crucial element, it is also one that can easily be influenced by those designing graduate programs and doctoral education. A key difference between chair-based education and structured programs is that in case of

the former, the supervisor has much control over the intensity of involvement that is offered to the student. The extent to which a student makes use of such offers will then determine the final degree of involvement. In structured programs, the intensity of involvement may be directly pre-defined by the scientific board that designs the program by fixing the number of hours of practice training or by indirectly limiting the time available to the student by determining the extent of certain program-related tasks. As can be seen from Table 12.2, doctoral students in structured programs devote more time to thesis-related work and less to administrative tasks compared to doctoral researchers working at a chair or on a grant-financed research project. The latter group, however, spends more time on research not directly related to their thesis, which may broaden their skill set and expertise. A priori, it is therefore unclear which model is more conducive to successful publishing during the doctoral education phase. Over the past decade, the dissertation style has evolved from monographs to paper-based, cumulative dissertations in most fields. A larger set of research projects may help to produce publishable research papers through the division of labor and support from multiple senior scholars (Horta & Lacy, 2011). Based on the study by Pinheiro et al. (2014), we would expect that any collaborative research supports future research performance through learning to "play the game". Being more intensively involved in teaching (as are doctoral students working at a chair), however, may better prepare doctoral students for teaching roles.

In a more normative tone, Weidman et al. (2001) conclude that socialization of graduate students should happen through mutual exchange rather than be a one-directional training by faculty done to students. Collaborative learning environments and being exposed to several teachers may also facilitate the recognition of talents and interests in students. These factors are more likely to be provided in a structured doctoral education setting compared to the system traditionally in place in Germany.

An important feature of the model of Weidman et al. (2001) is not only its non-linearity (see Stein & Weidman, 1989; Weidman & Stein, 1990), but also that it considers knowledge acquisition as an important element of socialization and not as an outcome. While the preparation for future jobs is obviously the central objective in the training of young researchers, the framework stresses the importance of how knowledge and skills are acquired and that there are interdependencies with other elements of socialization which will eventually affect a graduate's identity, commitment and work ethics that are all based on values, not knowledge alone. Learning is an important process of socialization and the learning environment matters. Moreover, the organization of graduate education in schools and at smaller units matters a lot more than one would derive when only focusing on knowledge acquisition as such. Together with financial and moral support, these factors define individual satisfaction of a doctoral student with his or her situation.

Table 12.3 shows results from a survey on doctoral students' levels of satisfaction with the quality of the supervision provided by type of doctoral program that they pursue. The data shows that doctoral students in structured programs tend to be more satisfied with the quality of their supervision than those pursuing their studies independently (without being enrolled in a program nor being employed at a chair or research group, see also Ambrasat and Tesch (2017)). The numbers for doctoral

Table 12.3 Doctoral students' satisfaction levels by type of doctoral education (2011)

		Satisfaction level with the overall quality of supervision		
		High	Neutral	Low
Structured program (RTG, GS)	N	415	88	46
	%	**75.6**	**16.0**	**8.4**
Chair-based	N	373	83	39
	%	**75.4**	**16.8**	**7.9**
Semi-structured (curricular program)	N	458	216	145
	%	**55.9**	**26.4**	**17.7**
Independent (without work contract)	N	243	111	87
	%	**55.1**	**25.2**	**19.7**
Total	N	1489	498	317
	%	**64.6**	**21.6**	**13.8**

Source: Survey data as presented in Hauss et al. (2012), own representation
N number of respondents

students in structured programs are, however, very similar to those reported by doctoral researchers pursuing their studies in a traditional chair-based way with a large majority of students being highly satisfied (about 75% in both groups) and only a small share reporting a low level of satisfaction (8.4% and 7.9% respectively). Remarkably, of those enrolled in semi-structured programs (neither RTGs nor GS, but with some curricular activities, e.g. selected courses to be completed) only 56% report to be highly satisfied and 18% report low satisfaction levels.

The eventual socialization outcome will therefore be a result of the experiences that a doctoral student makes at every stage and in every dimension while engaging in the core elements of the socialization process as illustrated in Fig. 12.5. There is not one ultimate desired outcome, but satisfaction with the professional activity may be a good indicator of the quality of a certain type of doctoral education.

Conclusions

Doctoral education is an important factor for the development of scientific research and thereby for the advancement of knowledge, technology and living standards in the long-run. Socialization processes may therefore not only differ between individuals, but may also depend on institutional factors and the design of the doctoral training. The transition of doctoral education from the master-apprentice model to structured programs through the establishment of discipline-focused Research Training Groups and eventually larger and more centrally organized, interdisciplinary Graduate Schools in Germany therefore comes with effects on the socialization of doctoral students.

Weidman et al. (2001, p. 50) stress the role that professionalism can play: "Professionalism is accomplished through a carefully structured professionalization process that revolves around students' immersion into an environment that exacts or is prototypical of the one to which the students aspires". They argue that typical ways to achieve certain levels of professionalism is to use certification and licenses or to use controls through professional boards to sanction malpractice. In academia, however, such measures are less effective as in other professions. It is therefore even more important that socialization processes transmit work ethics, norms, values and standards so that future scientists see it as natural to behave according to them and do not need to be forced into compliance.

These goals may be easier to achieve in structured programs, but there must also be an agreement on what these values are and how to transmit them. In Germany, the DFG took an important role in defining standards and setting objectives in terms of research ethics, diversity, and internationalization. Because of its role in distributing research funding not only for Graduate Schools, but also for later-stage research positions, the DFG was also in the position to reinforce these standards. A central novelty related to the establishment of Graduate Schools, was the delegation of doctoral education to these schools rather than leaving doctoral training solely to the individual supervisor. Chair involvement of doctoral students might still not be inferior to structured programs as on-the-job training is crucial and the involvement of doctoral students in day-to-day work may be important in this process. Skills are augmented with standards, acceptable values and behaviors. Formal rules can be taught in structured programs because they apply to every scientist and researcher. But there are also more implicit ethics. The best of both systems can probably be achieved by a combination of both worlds.

Overall, structured programs can increase the efficiency and quality of doctoral education. Standardized skills and general values, norms and ethics can be effectively transmitted and peer-effects in the socialization process and group learning can be valuable. Increased efficiency means that not every chair needs to provide the full, general set of training content, but can focus on the more topic-specific part of the skill set. This cannot only reduce the burden on senior researchers and professors, but can also allow for more interdisciplinary elements in the general part of the doctoral education (Boden, Borrego, & Newswander, 2011). It may also allow a larger group of students to be trained by stars and researchers at the frontier of science, a luxury that would not have been accessible if every chair provides exclusive training for the doctoral students employed at that chair.

However, structured programs should not be used as a tool to simply churn out high(er) numbers of PhDs. The substantial increase in the number of doctoral candidates in Germany may work against the quality objective. Being involved in collaborative research with the supervisor or senior researchers is crucial for career development. Such intensive learning relationships may require that a critical part of the training occurs within a chair, laboratory or department rather than in a separate organization. In addition, program administration needs to be taken into account

which can be intensive in case of the need for continuous adjustment of the curriculum to keep it state-of-the-art as doing so can be more effortful than adjusting it only in smaller organizational units. An additional challenge in structured programs arises from the assignment of responsibilities and alienation as well as impersonal relations may be a problem if schools grow too large. The initial design of research training schools with smaller groups of doctoral researchers may therefore be superior in this regard to the very large and even university-wide schools. These two models, however, do not necessarily exclude each other. Smaller training groups may be part of a larger network of schools that comprise a university's training strategy for young researchers.

In the case of Germany, there is not a "one size fits all" solution in the design of doctoral programs across disciplines and universities of different sizes, technical universities and polytechnics. Funding of graduate programs should therefore leave considerable flexibility to the individual institution also with regard to the extent to which students will be involved in research conducted at the chairs or research groups of their supervisors. Funding of Graduate Schools through the Excellence Initiative appears to be a valuable tool of standard setting and for incentivizing universities to invest in the training of future scientists. However, larger schools are not necessarily better for implementing the institutional factors identified above and the approach to offering support for differently sized schools should not be abandoned. Moreover, RTGs and GS should not be seen as substitutes, but as distinct instruments for achieving higher quality doctoral training.

It should also be stressed that in science systems with a strong public research sector outside universities' structural programs also offer opportunities for training researchers at public research institutes by involving them in trainings jointly with young university researchers. Supervising professors through their function as role models, their work experience, contacts and networks will still be important gate-keepers for those who stay in academia and who move to other career paths. Graduate Schools, however, can expand the set of opportunities for young researchers and improve experience of graduate students as well as of the senior researchers and faculty who train them. As an increase in the quality of conducted research should constitute the ultimate objective, policymakers and university officials need to implement long-term strategies and consider the respective institutional context, enabling structures that avoid additional bureaucratic procedures and inflexible performance targets (see Martin, 2016).

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