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Introduction

Harald A. Mieg and Susanne Haberstroh

Undergraduate research (UR) has become a global endeavor. In a constantly changing world, universities in the United States of America (US) and Europe, and from Argentina to Nigeria and Japan, are beginning to reconfigure their undergraduate study plans. One core measure is UR. Our handbook is intended to serve this global endeavor, expanding both on the fundamentals of the idea of UR and its implementation around the world.

Applying the most commonly used definition by the US-based Council on Undergraduate Research (CUR), undergraduate research is understood as:

> An inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline.
> (cf. www.cur.org, also for expanded definitions)

There is an ongoing discussion about whether this definition is too closely tied to its origins in the natural sciences, and thereby excludes research in the humanities or interdisciplinarity (Beckman & Hensel, 2009; Brew, 2010). We leave the definition as it is and emphasize two aspects. Firstly, this definition has a clear target group: undergraduate students; secondly, it provides a less clear objective: an original research contribution. The questions of what constitutes research that a student can contribute to, and how we can link it to teaching at universities have accompanied the development of UR ever since its emergence. Our introduction provides a short overview of the history, concept, and challenges of UR in universities as well as studies examining its impacts.

1.1 History

UR is embedded in what we would term modern universities that today embody science and academic education. To begin, we discuss both the

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origins of UR in the birth of European universities during the late medieval period, and the reformulation of the idea of student research starting in the 1960s.

The University of Bologna (Università di Bologna), founded in 1088, is the world's oldest existing university in continuous operation. The Latin name "universitas" derives from "universitas magistrorum et scholarium," a community of teachers and students organized like a guild or corporation. These communities offered mutual aid and were protected by the city and later the emperor. In general, protection derived from one of the major powers of the time: the church, the emperor, or the city – powers that often competed with each other. Protection was necessary, as the students came from all over Europe and would otherwise be considered unprotected foreigners. Therefore, for several centuries, European universities were autonomous legal entities, authorized to both protect and punish their students, which included managing their own prisons. The history of the university contains many accounts of complaints by ordinary citizens concerning drunken or disorderly students, even including later statesmen like Otto von Bismarck. However, it was generally in a city's interests to host a university, as the students brought with them money. In addition, the University of Bologna was and remains a renowned law school. In the late medieval period, lawyers became extremely important for local and transregional trade and administration.

Consequently, the University of Bologna was not only the blueprint for later universities all around Europe, its foundation also contains two core elements that are fruitful for UR: firstly, the community of teachers and students; secondly, student autonomy. The concept of the university was a great medieval institutional and intellectual invention. It combined several existing institutions and resources: the institution of writing and teaching in monasteries and cathedral schools; the corporate structure of guilds; and Latin as the language of study in theology and Roman law. Latin became the academic reference language and the common ground for codifying and communicating the knowledge to be studied, particularly when Aristotle's work was rediscovered, which when retranslated into Latin was subsequently used as an academic standard for the subjects taught at university.

Nevertheless, universities took different paths in different countries, thereby developing and mutually enriching the overall concept of a university. France, in particular the University of Paris, contributed greatly to systematization, defining the main schools of philosophy (rationalism vs. empiricism) and the faculty structure of the university. Even the term "nations" was introduced there, to differentiate and organize the groups of incoming students by nationality. In the sixteenth century, the Dutch universities infused the educational ideal of humanism, inspired by Erasmus (1466–1536) and the idea of academic freedom. In the nineteenth century, the concept of the modern research university was crafted in Germany and exported to the US. With support from United Kingdom

(UK) and US universities, the twentieth century witnessed the globalization of universities as teaching and research institutions, including English as the new academic reference language.

The UR movement in the US started quite soon after World War II, as Karukstis (2019) has shown. A milestone was the Undergraduate Research Opportunities Program (UROP) that Margaret MacVicar, a physicist at the Massachusetts Institute of Technology, developed in 1969, which was offered to all undergraduate students. At the same time, in Germany, the association of young assistant university teachers (Bundesassistentenkonferenz, 1970) demanded "forschendes Lernen" (inquiry-based learning) as a new or renewed standard for university. The idea goes back to Wilhelm von Humboldt's (1809/2010) maxim of "Bildung durch Wissenschaft" (research-based education, where "Wissenschaft," here translated as "research," has the meaning of "academic knowledge creation"). In the German example, "forschendes Lernen" was considered a means of democratic participation in science (cf. Huber & Reinmann, 2019). The final impulse came almost three decades later, when in 1998 the Carnegie Foundation's Boyer Commission recommended implementing UR for US research universities (Boyer Commission, 1998).

1.2 Concept

UR shifts the academic focus "from teaching to learning" (Barr & Tagg, 1995), from revealing or imparting knowledge to a focus on the student's autonomy and self-regulated learning. Historically, universities had four faculties: law, theology, medicine, and philosophy. The shift in question primarily concerns the fourth faculty, philosophy, which evolved over the centuries into the variety of natural and social sciences (or science and humanities). What also changed is the concept of knowledge, which has become a matter for the academic community. Academic education no longer consists of providing access to the shrine of knowledge; and it is doubtful whether this idea of teaching has ever been a dominant feature of universities. Instead, what research-based teaching offers to students is an introduction to knowledge production within knowledge communities (often addressed as "scientific" or "epistemic" communities).

Education at universities has always been multifunctional, encompassing both vocational training (as in law and medicine) and research preparation (as in the sciences); UR may therefore serve both vocational and research purposes. In general, the problems tackled by academic research and teaching are complex and highly ambiguous. This applies to astronomy and theoretical physics as well as more practical and urgent problems in social work and health care. The core difference between vocational training and research preparation comes with the timing of problem solving. Pure research (i.e., the search for new scientific knowledge, wherever that may

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lead) is often, by definition, open-ended in both its trajectory and timeframe; in contrast, applied research (i.e., research-to-an-end) within a commercial or industrial complex must solve much more specific (and often commercially oriented) problems and present conclusions or recommendations within a given timeframe. Whenever a research component is included in professional problem solving it is time-limited. A historian may wait decades until documents from relevant archives are released and accessible, whereas a doctor or social worker might have to take action immediately.

There is a broad literature covering thinking on UR or the research–teaching nexus (Brew, 2006, 2013; Fung, 2017; Healey & Jenkins, 2009; Hensel & Blessinger, 2020; Huber, 1970, 2009). A common denominator is the focus on the student. At the turn of the millennium the refocusing on the student seemed an important step in view of, on the one hand, the many large universities worldwide and, on the other hand, the increasing need for highly qualified knowledge workers (cf., e.g., OECD, 1996). With regard to the history of the university, the focus has always been on the student: The University of Bologna was initially self-organized by its students. One could even argue that as higher education of individuals was always the main objective of universities, their focus has never really changed. With regard to describing UR, Beckman and Hensel (2009) provided some clarification, describing "tensions" inherent to the facets of the definition of UR by the Council on Undergraduate Research (CUR), as mentioned above. Taking into account the subsequent discussion and reformulations by Brew (2013), Walkington (2015), and Fung and colleagues (2017), we can distinguish twelve dimensions based on the mentioned tensions:

1. Focus: Student, process-centered ↔ Outcome, product-centered
2. Motivation: Student initiated ↔ Staff initiated
3. Inclusivity: All students ↔ Honors students
4. Setting: Curriculum-based ↔ Co-curricular fellowships
5. Collaboration: Collaborative ↔ Individual
6. Originality: New knowledge ↔ Original to the student
7. Content: Multi- or interdisciplinary ↔ Discipline-based
8. Audience: Professional audience ↔ Campus/community audience
9. Staff–student relationship: Partnership ↔ Supervision
10. Compensation: Unpaid ↔ Paid
11. Timing: Student's first year ↔ Final year
12. UR University strategy: Whole university ↔ Single departments

University teachers and administrative staff might be familiar with the dimensions, as these define different understandings of teaching success. For instance, a student-focused "process-centered" interpretation (dimension no. 1) places the emphasis on "helping students to move along a developmental trajectory in the practice of research" (Beckman & Hensel, 2009, p. 40). In comparison, an outcome-focused "product-centered" interpretation emphasizes low numbers of study dropouts.

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A very basic distinction perceives UR as curriculum-based versus co-curricular fellowships (dimension no. 4). Since their introduction at MIT in 1969, UROPs (undergraduate research opportunities programs) have become well-established forms of co-curricular study, yet remain unknown to many European universities and are often structurally incompatible with the organization of studies. Timing is also critical (dimension no. 11), as first-year students require completely different support for UR than undergraduates who complete their studies by conducting their own research.

If UR is not part of a university's general strategy (dimension 12), it might be organized in several different ways within a single university, depending on disciplines and subjects. The question of whether an undergraduate can make an "original" research contribution (dimension no. 6) may be viewed differently between diverse disciplines such as history or physics: In that comparison, the emergence of "oral history" as a method of inquiry in history may even enable history undergraduates to produce new research insights, an outcome that would be difficult to achieve in a field such as quantum physics. However, "history" itself is not a homogenous subject, as the kinds of sources employed may be entirely different (e.g., written documents vs. radiocarbon dating of historical artefacts via carbon-14 traces). Traditionally, professional schools such as law and medicine follow their own paths of university education, with specific phases of practical training or integration into professional practice that are less easily integrated into the UR structure of a university. The differences between study subjects may also constrain or enable the organization of community-oriented and interdisciplinary UR (dimension nos. 7 and 8), as is often the case in sustainability science.

Last but not least, we must take into account that despite the common denominator of focus on the student, cultural context nevertheless strongly influences conceptions of what a student is. Being a student means different things in Asia, Africa, Europe, or the US. Small cultural differences might have significant implications. For instance, universities in Germany and the German-speaking part of Switzerland have very similar forms of organization and considerable exchange of both students and faculty. However, owing to the strong basic democratic tradition, a Swiss student is first and foremost a citizen. Consequently, a Swiss university educator might instruct a student in the morning, and in the evening cooperate with the same student on a local political issue (often involving significant public budgets). This defines a student–teacher relationship "at eye level," so students easily get a say at university. This is entirely different from the mostly care-oriented approach in Germany: There, university students are often considered as elder children to be educated. The question of who has to pay respect to whom, and for what reasons, is highly culture-dependent and defines the roles that students adopt within UR.

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1.3 Alternatives?

When introducing a concept, one should be aware of alternatives. What might be the alternatives to UR? If we know the alternatives we can derive arguments for or against the introduction of UR. Often, thinking of alternatives helps clarify an idea and the functions that our idea should serve. We will see that defining alternatives depends on how we consider the role of the university – a subject that could form a discussion of its own. Here, we touch on five alternative approaches: some are very general, such as critical thinking, and some quite specific, such as problem-based learning. The presented alternatives are not mutually exclusive, but rather represent different conceptual approaches.

- *Critical thinking* is a term coined by Glaser (1941), reflecting the old, established idea that universities must educate students' characters so that they become engaged citizens (cf. Tight [2016] concerning the historical view in our context). Based on this, some scholars conceptualize the "scientist" as a societal role model even in educational studies (often with reference to Kuhn, 1999). If the goal is critical thinking, then it is not necessary to conduct research, and so better alternatives to UR might include soft skills training (communication, teamwork, etc.) or simply philosophical debate.
- *Lifelong learning* means self-directed learning throughout the course of one's life, and particularly includes job-related competencies. Lifelong learning was promoted by the European Commission in the 1990s (cf. the "Delors Report": UNESCO, 1996) as a means of adapting to constant social and economic change. Applied to UR, the idea of lifelong learning goes along with an understanding of research as a learning process. Therefore, UR could be considered as a form of experiential learning (cf. Kolb, 1984).
- Does UR, in the long run, mainly serve the production of *human capital in the knowledge-based economy*? The notion of human capital was introduced by Becker (1984), often complemented with other forms of capital, e.g., social or cultural, as defined by Bourdieu (1986). Consequently, UR can also be viewed as producing human capital (e.g., Donald et al., 2019; cf. OECD, 1996). From this point of view, industry-based higher education might be a better alternative to UR – however, only for industry-related fields of study.
- The *case method* was introduced to legal education at Harvard University more than a century ago. In principle, it is about training using example cases that have been processed (see Hammond, 1980). This also corresponds to the Anglo-American legal tradition. Harvard then adopted the case method to provide a scientific basis for management training. This requires students to think themselves into a case and make appropriate decisions. Through Harvard, the case method has

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now become standard approach worldwide in MBA (Master of Business Administration) education.

- A similar approach to the case method is *problem-based learning* (PBL). PBL was developed at the medical school of McMaster University in the 1960s and is still mainly used in medicine (Barrows, 1996). The research and design of PBL is closely related to cognitive expertise research (How do people become experts? cf. de Grave et al., 1996; Schmidt et al., 2011). PBL is usually implemented as follows: In group work, cases are analyzed, discussed, and solutions are worked out. Much emphasis is placed on independent research. In contrast to "free" research, PBL offers a protected learning space with clear learning goals.

The mentioned alternatives – namely critical thinking, lifelong learning, and investment in human capital – provide frameworks to guide and transform students' experiences and learning, and may induce transformations in universities. Today, many universities define their own profile, for instance, with respect to sustainability. However, any attempt to view universities from one specific normative angle – entrepreneurial (Etzkowitz, 2004) or ecological (Barnett, 2013) – misunderstands the multifunctional nature of the university. Since their inception, universities have always been major economic actors in a town or region. The most problematic misunderstanding results from a failure to accept that the concept of university is also driven by the idea of academic freedom of study (i.e., to learn; to conduct research; etc.). UR in particular profits from being, in principle, based on the academic freedom to follow lines of research of one's own choice and judgment.

1.4 Research on Undergraduate Research

Since the 1990s there has been considerable investigation into UR. Evaluation studies have resulted in the consensus that UR requires mentoring and support structures. We have grouped this research literature into five categories.

1. First of all, more than twenty years of studies show that UR is *effective* (cf., e.g., Elken & Wollscheid, 2016; Sadler et al., 2010; Seymour et al., 2004). Parker (2018) summarizes the positive effects with regard to "students' knowledge, skills and personal development over time," including, for instance, intellectual skills as well as ethical conduct (p. 145). We would like to highlight three types of gains. Firstly, the effects concern scientific competence, that is, "students' conceptions and practice of scientific thinking" (Brownell et al., 2015; cf. also Beck & Blumer, 2012) and also their research interests (Deicke et al., 2014). Thus, UR fosters "becoming a scientist" (Hunter et al., 2007; cf. also Willison & O'Regan, 2007). Secondly, we see a clear positive effect of UR

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on academic achievement: grades improve among students with research experience (cf. Fechheimer et al., 2011; Parker, 2018). Last but not least, although the literature sometimes focuses on self-selected samples of highly motivated students engaged in co-curricular projects, there is nevertheless a positive effect from the perspective of the university administration: UR strengthens retention (e.g., Hathaway et al., 2002; Laursen et al., 2010; Lopatto, 2007). Any dropout by a student (especially if occurring late in the course of study) represents a loss of financial investment and personal potential. UR supports undergraduates in clarifying their study interests and may thus be considered a "retention tool" (Freeman, 2000). Therefore, UR has become a characteristic of high-impact educational practices (Kuh, 2008) and of top European research universities (Fung et al., 2017).

2. Another clear lesson is that UR requires *mentoring* and some form of *scaffolding* (Hall et al., 2018; Linn et al., 2015; Shanahan et al., 2015). In a seminal analysis, Kirschner and colleagues (2006) convincingly argued "why minimal guidance during instruction does not work," referring, among others, to experiential and inquiry-based teaching, which they considered as "unguided or minimally guided instructional approaches." In their response, Hmelo-Silver and colleagues (2007) provided evidence for the effect of scaffolding: "Scaffolding not only guides learners through the complexities of the task, it may also problematize important aspects of students' work in order to force them to engage with key disciplinary frameworks and strategies" (p. 100). Scaffolding may: (i) make disciplinary thinking and strategies explicit, (ii) embed expert guidance, (iii) structure complex tasks, or reduce cognitive load (pp. 101–2). As Shanahan and colleagues (2015) showed, scaffolding is only one aspect of effective mentoring in UR, and mentoring itself ranges from "engage in strategic pre-planning" (p. 362) to "encourage and guide students through the dissemination of their findings" (p. 369).
3. The literature has examined and revealed *differences* in the effect of US, such as due to gender. Before going into detail, a methodological remark seems necessary: We have to find evidence of whether there is a difference at all and also whether it still exists in the same form. The implementation of UR is evolving. Therefore, some conditions might be relevant when introducing UR, but conditions might also change once that research is implemented. Thus, first and foremost, differences exist among the national educational systems within which UR must be embedded (cf. Hensel & Blessinger, 2020; Tight, 2016; Turner et al., 2008). Less obvious are gender differences in the effect of UR. One early study in the US reported a disadvantage for female students who participated in UR, when compared with their male counterparts (Kardash, 2000). Later, more comprehensive studies found no such effect (Taraban & Logue, 2012) or else a disadvantage for male

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students (Parker, 2018). Similarly, Taraban and Logue (2012) in their US study reported that higher-performing students benefit most from UR. Conversely, a UK study by Parker (2018) showed that lower-performing students usually benefit more. We find greater consensus with regard to disciplines. In general, students in the natural sciences may benefit more from UR experience than students of the social sciences or humanities (Parker, 2018; Taraban & Logue, 2012). Mieg (2019) argued that such differences vary less between disciplines than between forms of research: simple forms of data collection (interviews, inventories and so on) provide undergraduate students with easier access to research and inquiry than do theory-building or conceptual research (mathematical theorems, judicial concepts and so on).

4. A somewhat puzzling finding concerns *diversity and inclusion*: There is augmented evidence that UR fosters diversity and inclusion, in that participation in UR benefits historically underrepresented students, underserved students, and/or minority students (Bangera & Brownell, 2014; Eagan et al., 2013; Finley & McNair, 2013; Haeger & Fresquez, 2016; Hernandez et al., 2018; Lopatto, 2007; Parker, 2018; Satilmis, 2019). This includes an argument for course-based UR experience (Bangera & Brownell, 2014). However, the diversity effect also holds for co-curricular UR, as long as the student invests sufficient time in research and inquiry. The benefit for diversity might be puzzling from a theoretical point of view: seriously conducting research is a highly selective task, in particular when research is not directly related to the professional practice a student strives for. We can certainly espouse the argument of "soft ties" (Granovetter, 1973), referring to the networks that students enter when engaging in UR. These types of soft ties help to advance the careers of students who are otherwise underserved. The many reasons for the positive impact of UR on historically underserved students may well be inextricably linked to what Theobald and colleagues (2020) understand as "active-learning classrooms experience" and term the "heads-and-hearts hypothesis, which holds that meaningful reductions in achievement gaps only occur when course designs combine deliberate practice with inclusive teaching" (p. 1).
5. Last but not least, studies in recent years show that research for the purpose of UR must *make sense* for students in order to be effective – from a professional, intellectual, or personal perspective. In the context of biology, Brownell and colleagues (2012) reported that students in an authentic research environment clearly profited more than those in a "cookbook laboratory course." As to students in the arts, humanities, and social sciences, Levy and Petrulis (2012) showed that experiences of research as "evidencing and developing students' own ideas" or as "making discoveries" (p. 91) seem most effective. Similar findings come from a national study on research-based learning, involving fifteen German universities. Students benefitted from courses that included

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research-based learning when they perceived the course as being useful for a later profession or when the lecturer had a specific interest in the findings of the student research (Wessels et al., 2021). In this context, cross-disciplinary research in Germany revealed that many trainee teachers were resistant to accepting research as part of their studies, a typical response being "I want to become a teacher, not a researcher" (cf. Thiem et al., 2020).

1.5 Implementation Challenges

The introduction of research-based learning at a university necessitates a series of decisions and changes while taking various obstacles into account. To this end, Brew (2013) introduced a wheel model for decision making on research-based learning, which can be characterized as follows:

1. The focus is on the students; the model hence places students at the center. This decision reflects the shift from teaching to learning (Barr & Tagg, 1995).
2. The eight segments of the wheel represent the tensions as defined by Beckman and Hensel (2009) or dimensions on which decisions have to be made, for instance whether a research topic is chosen by the student or the teacher.
3. The concentric structure of these segments represents the degree of autonomy ceded to students. The inner circles, marked in gray, depict low autonomy, the outer circles high autonomy.
4. Decisions about research-based learning are made in specific contexts. This is symbolized by the first inner circle, in which the focus on students is embedded. Fundamentally, we must distinguish between pedagogical decisions (of a particular teacher) and curricular decisions (of a department). Further contextual constraints are set by the institutional context (within a country's educational system) or the disciplines or type of research involved.
5. Furthermore, we need to decide on the required learning outcomes, depicted by the second inner circle. Which content must be communicated? Which skills should students acquire (e.g., from mastering experimental methods to developing team leadership)? Which attributes do we want to foster through research-based learning (e.g., from critical thinking to tolerance of scientific uncertainty)? (cf. Wessels et al., 2021).

Brew (2013) called her model "wholistic," as it encompasses all facets of decision making for research-based learning (see Figure 1.1). It shows an epistemological touch, since many of the segments are defined by how and what knowledge can be gained: knowledge that is new to a discipline, and/or knowledge that is in principle negotiable, and/or an open-ended inquiry.

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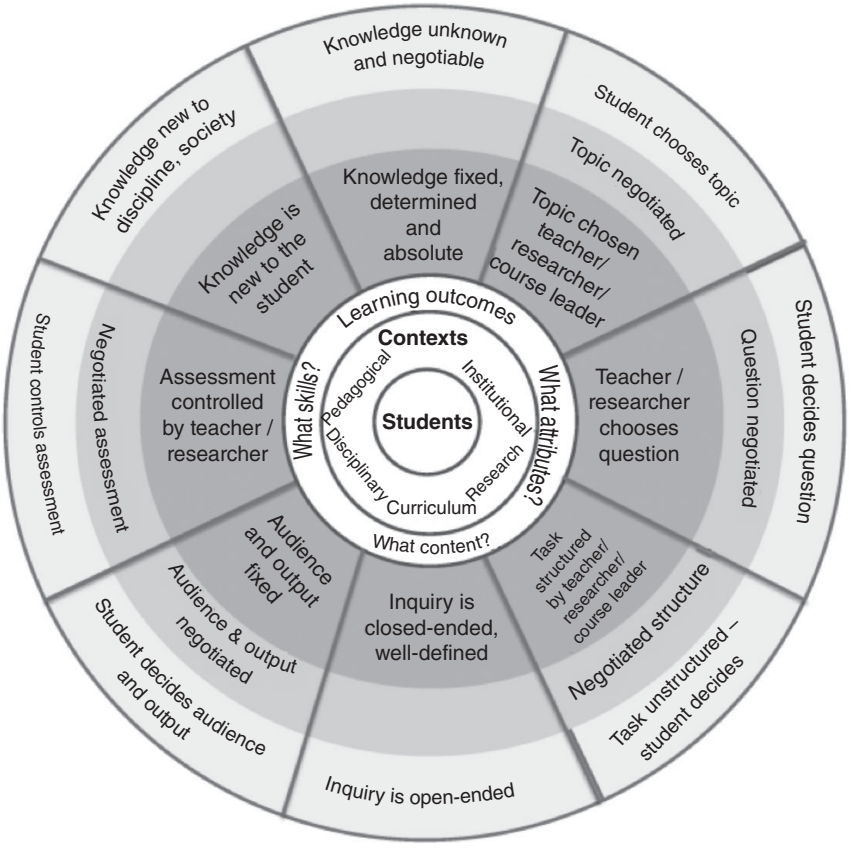

Figure 1.1 A "wholistic" model for research-based learning decision-making
Source: Brew, 2013, p. 613

If pedagogy shifts from teaching to learning, and refocuses from the content to the student, then the *role of the teacher* will also change. Lehmann and Mieg (2018) defined eight challenges for research-based learning from the educator's perspective (in a similar vein, see Rowlett et al., 2012). They called for contributions from university teachers involved in instructing and supporting student research and inquiry. What advice can university teachers provide for their peers? Their findings clustered the many peer guidelines and descriptions of best practices into eight challenges.

1. *Winning students for research*: For most students, it is not self-evident that they should or could conduct research. Teachers may even need to convince some students to participate in UR. To be a role model for research is a good starting point to win students for research. For some students, it is important to see the link between UR and their targeted professional work. In encouraging students to participate in research, an educator might mention that qualified professional work today

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often necessitates using research results such as statistics, scientific reports, and market studies. However, how reliable are such data sources? As students, educators, professionals, or citizens, we are best able to assess this issue if we have performed research ourselves.

2. *Understanding and reflecting on research*: Although there is an overwhelming body of existing research and scientific literature, all students have to familiarize themselves with published research. To this end, educators need to rethink the questions: "What is knowledge; what is research, scholarship, and creative inquiry?" not only within their discipline, but also for themselves and with their students. A useful guide is *Decoding the Disciplines* (Pace & Middendorf, 2004). To learn about knowledge gaps and research methodologies, students should be given the opportunity to draft research plans and/or review research proposals by their peers. Lastly, after completing a research project, students should be expected to provide a written reflection on their experience, including acquired research and transferable skills.
3. *Provide space (physical, social, online)*: Perhaps the most important advice is to provide space and opportunities for student research (see, e.g., Hensel, 2012). This has several dimensions, the first being physical space such as labs or project rooms where students can meet for their research project (e.g., in engineering: Jungmann, 2009). Equally important is the social dimension. Educators should prepare opportunities, such as working in groups, connecting with professionals at conferences, or conducting research within a business or industrial setting or in other cities or institutions. Providing social space includes allowing students to make mistakes and to learn from them. Finally, the use of blended learning can unburden the scarce time that educators have available to effectively engage with student researchers. If some course content is provided online and left to self-learning, then more time remains for face-to-face discussion and doing research.
4. *(Interdisciplinary) collaboration*: Interdisciplinarity has long been an academic ideal in both research and teaching. However, with regard to UR, two caveats should be taken into account. Firstly, successful interdisciplinarity often requires a different and more intense level of active preparation, organization, and collaboration (cf. Mieg et al., 2008). Our experience leads us to recommend: Avoid team-based interdisciplinary teaching with educators who express to students their own prejudices about other disciplines, as this is waste of time for all involved – students and teachers (Prytula et al., 2019). Secondly, interdisciplinarity is not a value within university environments per se. From successful interdisciplinary projects in UR we learn that it can be useful to include a teaching focus on a particular disciplinary method (cf. Boix Mansilla & Duraising, 2007; Pinkelman et al., 2015) that both helps students to make a real contribution to the interdisciplinary project and to deepen their own discipline.

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5. *Getting practical*: Research-based learning is of most benefit to students when such courses are perceived as being useful for a future profession (Wessels et al., 2021). Getting practical provides ways of linking university teaching to professional work. Here, UR can be combined with service-learning (Schaffer & Peterson, 1998) and other forms of cooperation that require students to apply classroom learning to the needs of local communities or companies (see also Chapter 74 of this volume).
6. *Making public (publish)*: The opportunity to disseminate their research results is a factor in motivating students to engage in UR (cf., e.g., Adams, 2019), and is facilitated by a range of UR journals and conference presentation opportunities. Moreover, running such a journal can be organized as a student project in literature or library studies. Furthermore, student research is sometimes of sufficiently high quality to warrant publication in the standard peer-reviewed scientific journals. However, as the publication process can be quite protracted, specific forms of mentoring need to be identified, for example, co-authorship with faculty members. There are various ways in which students may present their research, including inviting guest speakers to attend students' presentations, motivating students to present at conferences (including UR conferences), and organizing one's own conference.
7. *Developing teaching competence*: Excellence is built on continuous improvement, on the will to improve oneself, to train and develop one's skills over a long period of time (cf. Ericsson et al., 2018). This also relates to teaching competence. Most universities run professional development courses for faculty members. Experiences with training university teachers to mentor research-based learning in Germany taught us (e.g., Lehmann & Mieg, 2018): Firstly, to make clear the research cycle or research phases that student research projects will have to follow (see Chapter 14 of this volume). Secondly, to train teachers to use feedback on their own performance, either from students or from colleagues, for example, in peer groups of university teachers. In recent years, in the US, the concept of "near peer" research mentorship – by more senior students to students just beginning their research experiences – has become a common facet of UR (Tenenbaum et al., 2014).
8. *Changing the university*: Last but not least, in some cases it may be advisable to try to change the context, as defined by Brew (2013, see Figure 1.1), in particular the institutional setting for implementing a research–teaching nexus. Also, in universities as in any organization, standard rules of change management apply (e.g., Kotter, 1995). Effective change requires commitment from top management – the university president or board, a coalition within the university – a vision that should be communicated, provision of necessary resources, making initial successes visible, etc.; and, equally importantly: buy-in

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from all faculty, who must be willing to change the way they teach and to serve as mentors. This is why implementing UR is or becomes part of university reform (e.g., Brew, 2006; Fung, 2017; Hensel, 2012; Jenkins & Healey, 2005; Kaufmann & Schelhowe, 2019). In this context, degree accreditation has become a driver for change in European and US universities.

1.6 Rationale for the Handbook

Our handbook is intended to provide a comprehensive, international, and multidisciplinary overview of concepts for and experiences with UR. It introduces theoretical foundations of UR, and describes general implementation approaches as well as insights into specific best practices of UR from different countries. The handbook is organized into five major parts.

Part I is on theories and concepts. There are concepts that are linked either more or less closely to UR, such as student autonomy or the research circle, each of the concepts being viewed from different disciplines and theories. Autonomy has a philosophical basis, but is viewed differently from psychology or educational sciences. Therefore, we examine four coherent conceptual viewpoints from which the functioning of UR can be discussed and explained:

- Educational science, with a focus on the teaching–research nexus
- Psychology, with a focus on the competences involved in UR
- The sociocultural view, with a focus on the conditions under which UR provides a meaningful student activity
- Philosophy, with a focus on the role of students in the knowledge process today

Part II is on implementation, approaches, and methods. The proof of the pudding is in the eating. In contrast to Part I, this part provides practical strategies and tactics for UR practitioners. It introduces different implementation models for the teaching–research nexus, namely US and European models. Part II also highlights central issues in implementing UR, such as mentoring and assessment. As a reflection on theory, one chapter discusses the research circle.

Parts III and IV provide "cross-sectional" overviews and are the longest sections of the handbook. Part III shows disciplinary differences. This section introduces UR in almost thirty disciplines, ranging from architecture to theology. In particular, we wanted to see how the logic of disciplines also imprints on the implementation of UR. Part IV shows international differences. Our starting point was: Even though UR is not established everywhere, every university will nevertheless have educators who link teaching to research in a passionate way. The overview includes countries

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from all continents and has a major focus on the differences between educational systems, that is, the contexts for implementing UR.

Finally, Part V shows avenues for developing UR. Unsurprisingly, these avenues already exist in one form or another. For instance, interdisciplinarity has always been a challenge to both research and teaching, thus it has potential to further develop UR. We identified four such avenues, and were interested in how the specific contexts challenge UR. The four avenues for developing UR are:

- Community-based UR
- Interdisciplinary UR
- Digital UR
- Crosscultural UR.

Our conclusion from the handbook project, conveyed in the introduction to Part V, concerns the democratization of research and knowledge. Is democratization the new driving force for UR? We see a new role for students: that in ever more differentiated modern societies, collaborative, cross-segmental knowledge production becomes a new necessity, the educational means to which might be UR.

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