Issues In Interdisciplinary Studies,
Vol. 40 (1), Spring 2022, pp. 55–73

TEXAS TECH
UNIVERSITY PRESS

Pluralism in Teaching Interdisciplinary Research: The Amsterdam Institute for Interdisciplinary Studies Textbook

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Abstract: Immediately after its appearance, we at the University of Amsterdam's Institute of Interdisciplinary Studies enthusiastically adopted Allen Repko's *Interdisciplinary Research: Process and Theory* (Repko, 2008) as it was the first textbook that offered systematic explanation of and guidance through the complexities of an interdisciplinary research project. However, several characteristics of the projects conducted by our students made it an uneasy match for their needs and ours. For one thing, the Repko text targets students doing individual research projects whereas our students typically perform interdisciplinary research in teams. Our students also typically bring more disciplinary expertise to their interdisciplinary work than those whom the Repko text targets. And they often undertake empirical research as part of their projects—and not just the research in relevant literature that is emphasized in the Repko texts. Feeling the need for a textbook on interdisciplinary research that would better support students like ours, we decided to develop our own textbook, *Introduction to Interdisciplinary Research: Theory and Practice*. In this article, we describe the version of the research process we present in our text, emphasizing the many forms of pluralism involved in the process as reconceived to better suit teams of researchers based in different disciplines, and sometimes pursuing empirical work which may involve extra-academic stakeholders.

Keywords: pluralism, interdisciplinary integration, interdisciplinary research, research model, team research

ISSN: 1081-4760

1. Decades of Teaching Interdisciplinary Studies in Amsterdam: The Quest for a Textbook

The maturation of a discipline or field can be recognized in the availability of relevant textbooks supporting research in it. After several decades of exchanges among colleagues at the Association for Interdisciplinary Studies (then still called the Association for *Integrative* Studies) about a multi-step model of interdisciplinary research, the publication of Allen Repko's *Interdisciplinary Research: Process and Theory* was an important milestone in the field (Repko, 2008). Intended to provide a comprehensive introduction to interdisciplinary studies as well as a guide for doing interdisciplinary research, it targeted students conducting individual research projects—similar to the examples in the book. It was quickly adopted by those teaching in the University of Amsterdam Institute for Interdisciplinary Studies in our interdisciplinary bachelor's and master's programs, yet we observed quite soon that students doing our interdisciplinary research projects were not optimally served by it. Since our students typically perform interdisciplinary research in teams, quickly acquiring increasing levels of disciplinary expertise, and often conduct empirical research as part of their projects, we felt the need for developing a textbook suitable for such projects. Below we explain how our textbook aims to fill that need.

We will set out the main characteristics of Repko's model for interdisciplinary research and then present how our IIS model of interdisciplinary research deviates from it.[1] Insisting on the conceptual, theoretical, and methodological pluralisms that are prevalent even within single disciplines, we describe how our model echoes these pluralisms in several ways. We explain how multiple forms of interdisciplinary integration may be involved in a single research project, involving not just conceptual or theoretical integration but also methodological integration or the development of a more robust intervention, for example. Given our desire to support interdisciplinary research as performed by a team of disciplinary experts, we also attend to the challenge of team collaboration, offering some practical instruments to foster it. In thus presenting our textbook as an alternative textbook for interdisciplinary research, we hope to contribute to the increasing maturation of the field of interdisciplinary studies.

The history of interdisciplinary studies in the Netherlands is relatively short. It was the dissatisfaction with increasing disciplinary specialization and isolation that motivated emeritus biochemistry professor Karel van Dam to

1 In line with other articles in this special issue, we will refer to "Repko's model" here. However, given our references below to the preliminary work done by Julie Klein and William Newell and others after them on this research model and its steps, we would have preferred calling it the "AIS model."

establish the Institute for Interdisciplinary Studies (IIS) at the University of Amsterdam more than 25 years ago, in 1996. Primarily based in the natural and life sciences, with strong connections to the social and behavioral sciences and some relations to the humanities, it became the home for several bachelor's and master's programs and a series of elective and honors courses focusing on a wide range of topics from sustainability, cognitive neuroscience and complexity, to history and philosophy of science, forensics, and area studies.

Students in the programs offered by the IIS were to complete a broad interdisciplinary core curriculum and in addition complete a disciplinary major that was largely comparable to that of a common mono-disciplinary program. Indeed, most students were to complete their program doing two research projects in parallel. Individually, they would perform a substantial capstone research project that was disciplinary in nature and generally involved acquisition of novel data, for example by doing experiments or conducting surveys. In addition, they would conduct an interdisciplinary research project together with a small group of other students with different specializations and hence different research expertise. Given this situation and the existing need for relevant teaching materials and pedagogy, in 2005, one of the authors of this article, Machiel Keestra, newly appointed to the IIS as coordinator of the interdisciplinary research seminars, identified the Association of Interdisciplinary (then still Integrative) Studies as a valuable resource and community of experts. He joined AIS, and soon after became its international liaison, then board member, and eventually AIS president (from 2014–2016). From the start he participated in numerous conversations and conference sessions with colleagues seeking to define an interdisciplinary research method that would provide support comparable to that provided by disciplinary textbooks, while at the same time being sufficiently versatile to serve any combination of disciplinary contributions to an integrated result.

When in 2008 Allen Repko's *Interdisciplinary Research: Process and Theory* appeared, Keestra gladly introduced it at the IIS, welcoming it as a milestone for its interdisciplinary undergraduate and graduate students. However, quite soon we discovered that both our students and our purposes were not served adequately by it. In 2011, we replaced the textbook with several of the case studies in an edited volume that were inspired by Repko's textbook, *Case Studies in Interdisciplinary Studies* (Repko et al., 2011), representing a larger variety of research problems and methods, including a case study on "Understanding Human Action: Integrating Meanings, Mechanisms, Causes and Contexts" by Keestra (2011). Still, we felt the need for a textbook on interdisciplinary research that would support teams of researchers representing experts based in different disciplines. As a result, we decided to develop our own textbook, *Introduction to Interdisciplinary Research: Theory and Practice*, which was published in 2016 (Menken & Keestra, 2016) with an extensively revised version

appearing in 2022 (in press), composed by the authors of this article, Keestra, Anne Uilhoorn, and Jelle Zandveld.[2]

2. From a Multi-Step Model for Interdisciplinary Research to a First Textbook: Progress and Limitations

Unsurprisingly, the first proposals made by colleagues in interdisciplinary studies—all members and often past presidents of AIS wishing to provide guidance for interdisciplinary research—described a process consisting of several steps or decisions. In their early article on "Defining and Teaching Interdisciplinary Studies," Newell and Green (1982) defend interdisciplinary studies against the "skepticism, if not hostility" of those who think it lacks in disciplinary substance, or indeed merely borrows from the disciplines. Their defense partly relies on reference to a specific process in which "narrowly disciplinary insights" are assembled in response to a comprehensive question on a complex topic. In a final step, these insights have to be integrated (Newell & Green, 1982). In her seminal 1990 book, *Interdisciplinarity: History, Theory, and Practice*, Julie Klein refers to several similar descriptions of the process from the literature and offers a few versions of the process herself. Her description of a brief version of "ideal interdisciplinarity" contains five separate phases. Starting from a "methodical epoché by having all disciplines abstain from approaching the topic along lines of their own monodisciplinary methods," the process entails formulating an interdisciplinary question that then needs to be translated separately for each discipline. This process ends in researchers "agreeing upon a global answer that must not be produced by any one particular discipline but rather integrating all particular answers" (Klein, 1990, p. 192). This suggests that after agreeing upon a joint research question, every disciplinary expert participating on an interdisciplinary team separately develops an answer to a specific component question that eventually must be integrated with other answers.

Continuing this conversation in the literature a decade later, Newell argued that interdisciplinarity is mainly concerned with phenomena related to complex systems. Elaborating the interdisciplinary research process, he describes it starting from a certain division of disciplinary tasks: "each discipline focuses on the behavior of a particular sub-system modeling one facet of reality; its very definition of the problem (indeed, its understanding of whether there even is a problem) is shaped by the context and scale of its sub-system" (Newell, 2001, p. 16). The process accordingly is divided into a first phase,

2 The third edition of Repko's textbook does contain a brief Note on Team Research in which it is acknowledged that interdisciplinary research is often a team effort, yet it overall guides individual more than team research (Repko & Szostak, 2017, pp. 83–84).

"Drawing on disciplinary insights," followed by the phase of "Integrating disciplinary insights." As in Klein's version(s), integration is being relegated to the end of the process, involving separate contributions that have their own focus. Newell emphasizes the value of developing common ground among these separate contributions, a task that involves "the modification or reinterpretation of components or relationships from different disciplines to bring out their commonalities so that linkages can be identified between sub-systems" (p. 20). This phrasing implies that developing common ground entails a form of translation enabling the recognition of these relations. In a well-known and influential co-authored piece that we finally mention here, Klein and Newell (1997) agreed to define interdisciplinary studies as "a process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession" (p. 393). And they also agreed that an important part of that process is the integration of insights from the different disciplines involved.

Published in 2008, the first comprehensive textbook on interdisciplinary research, Allen Repko's *Interdisciplinary Research: Process and Theory*, largely follows these earlier views of the research process, including the two phases of "drawing on disciplines" and "integrating insights."[3] It develops those views—and discusses those phases—in much more detail over almost 350 pages—expanded with another 50 pages for the 2017 version. It dedicates many sections to some basic information on disciplines often involved in interdisciplinary research, informing readers, who are presumed to be mostly undergraduate students in interdisciplinary programs undertaking individual research projects, of these disciplines' main contents, theories, methods, assumptions and insights. According to the book, for example, the overall perspective offered by the discipline of psychology "sees human behavior as reflecting the cognitive constructs individuals develop to organize their mental activity. Psychologists also study inherent mental mechanisms, both genetic predisposition and individual differences" (Repko, 2008, p. 60). Furthermore, students are told that psychology's illustrative phenomena are "The nature of human behavior as well as the internal (psychological) and external (environmental) factors that affect this behavior" (p. 85). Additional information on its research methods and its strengths and weaknesses is provided, more or less in line with the earlier descriptions.

Obviously, such characterizations cannot do justice to the breadth and depth of any discipline and its wide range of sub-disciplines. However, these descriptions of disciplinary contents, methods, and primary insights can be helpful for those for whom a discipline like psychology is completely or relatively new. Their role in this textbook is to support an individual student with

3 The third edition (Repko & Szostak, 2017) returns to Newell's formulation "drawing on disciplinary insights."

a different specialization than psychology or a student in interdisciplinary studies without a specialization in any discipline at all. Having used this valuable textbook for several years, we realized it worked best for interdisciplinary research conducted by individual undergraduate students with limited, if any, actual research experience in a single discipline and very limited knowledge of other disciplines. In addition, the research it discusses often relies only on a review of literature, focusing predominantly on theories, concepts, and assumptions as interdisciplinary integration has to be discovered or created mainly via these elements. Consequently, this amounts in many cases to a relatively linear interdisciplinary research process, with integration as its final result.

3. Aligning our *Introduction to Interdisciplinary Research* to the Science Cycle

These characteristics of the Repko textbook convinced us at the Amsterdam Institute for Interdisciplinary Studies of the need for an alternative textbook for interdisciplinary research, a textbook that facilitates interdisciplinary projects carried out by teams of disciplinary researchers who might even conduct empirical research. Given the different disciplinary backgrounds of researchers in such teams, our textbook includes a brief primer in the philosophy of science—with the term "science" taken in the broadest possible sense, including humanities—written specifically for this context. This primer focuses in part on the Science Cycle (see Figure 1), highlighting the elements that might be involved in one or more forms of integration later in the interdisciplinary research process. (It should be noted here that although the Science Cycle is generally associated with empirical research in the natural and life sciences, its structure and elements are largely comparable to those of the hermeneutic circle that is more commonly applied in the social sciences and humanities.)

Tailored to interdisciplinary research, our exposition of the philosophy of science emphasizes the theoretical, conceptual, and methodological pluralisms that are nowadays common even in monodisciplinary research and hence relevant when we are integrating disciplinary insights. Moreover, pluralism is even more relevant when extra-academic stakeholders are involved in the research project, as we explain in one of several sections dedicated to such trans-disciplinary research. If such extra-academic perspectives are to influence the research process, that process has to allow for pluralism all along its phases from the beginning until the end. Associated with this emphasis on pluralism, our discussion of interdisciplinarity points out several dimensions according to which interdisciplinary research projects may vary. We distinguish between narrow and broad interdisciplinarity, for example, referring to the similarity or divergence of disciplines involved. Other distinctions refer

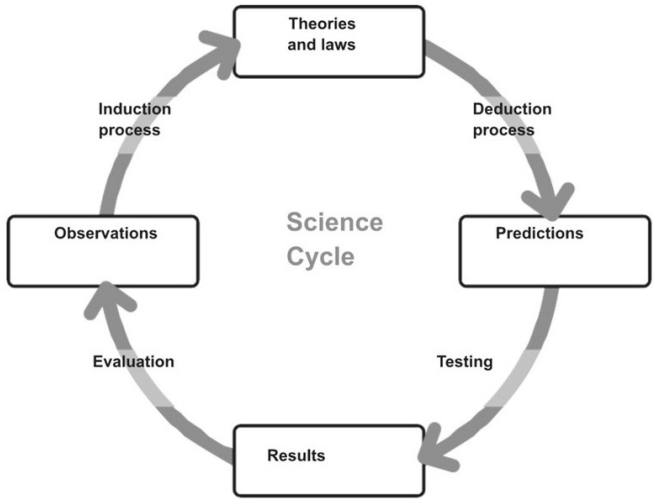

Figure 1. The Science Cycle consists of four processes, connecting four components, together providing a (somewhat simplified) representation of science as an ongoing process. (Reproduced with permission from Keestra et al., 2022, in press.)

to the number and relevance of disciplines involved, and to case-based and theory-driven interdisciplinarity. The fourth distinction we discuss refers to the levels of integration involved in interdisciplinary projects that focus on complex systems or explanatory mechanisms. Understanding these distinctions makes a research team aware of several options available to adjust its interdisciplinary research project to its needs and capabilities.

Finally, our emphasis on pluralism has also affected our presentation of the key ingredient of interdisciplinary integration. As we will set out more in detail below, for our second edition we offer an approach to interdisciplinary integration that is very different from that of the first edition of our textbook. Previously, we approached integration more along the lines of Repko's model, which presents five integrative techniques for creating common ground among disciplinary insights. These integrative techniques involve the expansion of relevant theories, the redefinition of concepts and assumptions, the extension of concepts and assumptions or their application, the organization of related elements, and the transformation of assumptions and variables to bring out their commonality (Repko, 2008, pp. 280–292). Motivated by our experience with supervising numerous interdisciplinary research teams we are now presenting an expanded interdisciplinary integration toolbox that includes tools that do not focus only on theories, concepts, and assumptions. Accordingly, we include new integration tools related to multiple components of the Science Cycle, as in the case of methodological integration or the integration of results in an adjusted policy or therapy. In this context we are again emphasizing that

many projects require integrative pluralism, which might involve the use of multiple forms of integration in parallel or sequential order.

4. The IIS Interdisciplinary Research Model

Although we have positioned our approach to research critically against that of its predecessors, we should acknowledge these being a main source of inspiration for our model. Our model for interdisciplinary research presents a series of steps not dissimilar from those of the model described by Repko and Rick Szostak (who had joined Repko as co-author for the edition of 2017), as is visible in Figure 2. However, some significant elements from our model that are distinctive ought to be mentioned.

Aligning our model closer to the steps of the Science Cycle, we are no longer speaking in terms of the two phases established by Repko and Szostak (2017), "Drawing on disciplinary insights" followed by "Integrating disciplinary insights." We insist instead on the four phases that now characterize our understanding of the interdisciplinary research process. Steps 1–5 out of 9 have more focus on the development of the interdisciplinary theoretical framework from which research (sub)questions are deduced. Assuming that an interdisciplinary group of researchers or students each bring their own disciplinary perspectives to bear on a shared research problem, we also assume each is tasked with identifying relevant (mono)disciplinary theories connected to this problem. This necessitates that integration takes place throughout the whole phase of the theoretical analysis. Indeed, the next to last step in Repko's model (Repko & Szostak, 2017, p.78)—step 9: Construct a more comprehensive understanding—is comparable to what in our model is the result of only the first half of the project.

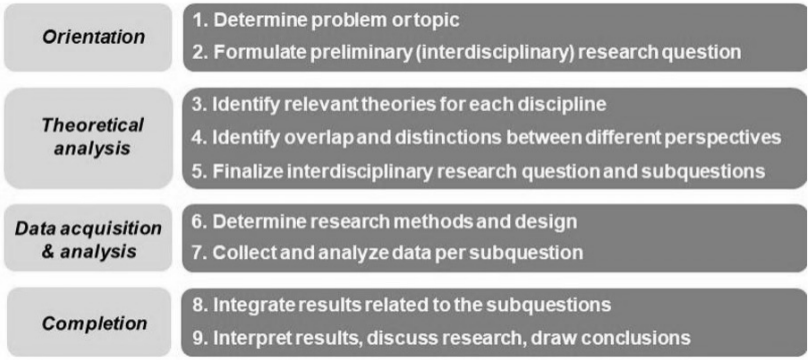

Figure 2. The IIS interdisciplinary research model consists of four main research phases. (Reproduced with permission from Keestra et al., 2022, in press.)

A sample research problem that we return to repeatedly in our textbook is the relation between alcohol and aggression, interacting in many different ways with each other. Multiple yet very different factors affect this interaction; for example, genetics has an impact upon the biochemistry involved, while culture may influence how individuals expect alcohol consumption to influence their behavior. If a project is to determine how we can mitigate alcohol-induced aggression, there are many interventions possible, depending on the integration of different insights drawn from many different disciplines. Discussion of this example serves to show how necessary it is to first develop a comprehensive interdisciplinary theoretical framework before specific research questions can be formulated and investigated more in detail.

What in Repko's model is almost like an epilogue to the research project, final step 10, "Reflect on, test, and communicate the understanding," comprises the final four steps in our model (steps 6–9). After dedicating the first five steps and two phases of our model to developing a comprehensive understanding of the interdisciplinary theoretical framework of the research project, our model continues with phase 3, "Data acquisition and analysis." This phase is described such that it may include empirical research by practitioners of one or more of the contributing disciplines, research that might present an answer to one or more of the subquestions determined before in step 5 ("Finalize interdisciplinary research question and subquestions"). Importantly, it is not unlikely that empirical work might be informed by the previously developed interdisciplinary theoretical framework and as a result might involve two or more participating disciplines. Consequently, the integration of disciplines that characterizes the research process we are describing might occur on the methodological level as well as the theoretical level. For example, investigating the relation between alcohol and aggression from an integrated environment-brain-behavior perspective, researchers could develop an experimental paradigm that employs a specific environmental stimulus that might trigger aggression in some subjects more than in others.

While we agree that finding common ground and subsequent integration may and often does focus on theories, concepts, and assumptions, we insist on the fact that integration of insights can also involve other elements key to the research process and occur at other research steps or phases before the final one. Our textbook shows that, when one is performing successful research in a multidisciplinary team, integration might occur throughout the whole research process. The integrative decision-making process that has been recognized as a key ingredient of interdisciplinary research in most of the literature cited earlier has thus affected our interdisciplinary research model perhaps even more than other models, given that we see it as an iterative part of the process and not just a culminating one.

5. Teamwork and Collaboration in Inter- and Transdisciplinary Research

Interdisciplinary and transdisciplinary research generally solves complex problems by bringing together academics and extra-academic stakeholders with various backgrounds, with views involving not just concepts and assumptions, but also other ingredients like norms and values. Consequently, in such research teams collaboration can be a challenge. Thus, at multiple occasions in our textbook where we emphasize the importance of collaboration, we also acknowledge its challenging nature given the differences among researchers' perspectives. Highlighted in this section of our article are the most important elements of team collaboration we address in the most recent version of our textbook. And we also note that we are preparing some online resources that are meant to further facilitate team collaboration.

As a starter, we are using the *Toolbox Dialogue Initiative* developed by O'Rourke and colleagues (cf. Hubbs, 2020) to discuss (historical) disciplinary differences and to encourage teams to focus on the concepts, assumptions, values, and research goals of individual members within the research team (Looney et al., 2014). Specifically, in the textbook as in our interdisciplinary research seminar we ask students to individually respond to multiple questions or prompts regarding the nature of the Science Cycle, interdisciplinarity, implementation of results, and related topics. At a later stage, we ask team members to discuss the questionnaire results, focusing on both overlaps and differences in their aims. Especially for questions with a high variety of answers, this step in the process may help teams to overcome obstacles to collaboration (Keestra, 2017). An example of such a Toolbox question is shown in Figure 3, where the outcome shows a strongly variable view in the value people attach to certain research methods and assumptions about the "correct" way of executing the Science Cycle.

In addition to considering differences elicited by responses to the Toolbox questions, team members preparing for interdisciplinary research should attend to other factors. Team members may not only differ regarding their disciplinary perspectives, but also regarding more personal matters such as their confidence, motivation, sense of security, (communication) style, and more. To make sure that everyone keeps a sound level of project involvement and is prepared to collaborate optimally, addressing such personal differences is important. Students participating in our interdisciplinary research seminars have to individually fill out a form in which they're asked to make explicit their weaknesses and strengths, their ambitions, and what they need from their team members in order to function optimally. To that end we're recommending in our textbook the use of a matrix like the one in Figure 4.

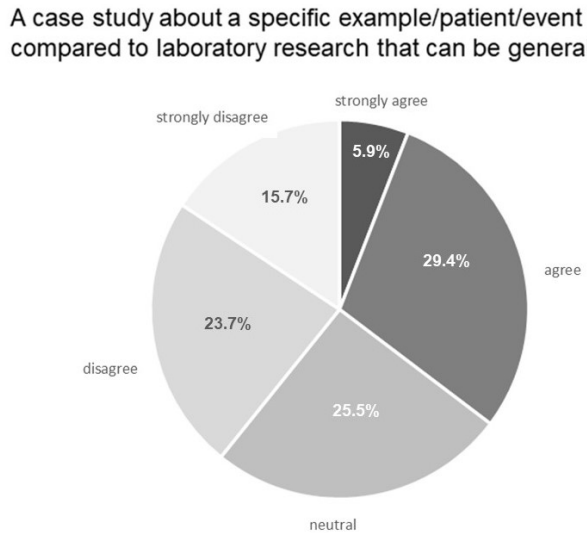

Figure 3. An example of results of a question used for joint reflection and discussion during preparation of interdisciplinary team research at the Amsterdam Institute for Interdisciplinary Studies.

In a two-step process comparable to that of the Toolbox Dialogue Initiative method, each team collates the individual responses to the questions in this matrix, effectively preparing to create a "team charter," an exercise also recommended in our textbook, intended to help develop a high performing team by giving team members the opportunity to define direction while simultaneously setting boundaries. Analyzing and reflecting upon the combined responses, the team can prepare to deal with potential pitfalls and obstacles during their collaboration while making optimal use of the strengths and ambitions represented among its members.

What can I contribute? Which strengths do you have?	**What should the team know about me?** What are your challenges or weaknesses?
What do I need from my team? What would help you to smoothly contribute to the project?	**What are my success criteria?** When is the project successful for you? Content-wise Process-wise Relation-wise

Figure 4. A table that individual team members have to fill in as a preparation for the creation of an interdisciplinary research team charter to facilitate interdisciplinary team research at the Amsterdam Institute for Interdisciplinary Studies.

We finally explain in our textbook how an interdisciplinary team has to coordinate and plan together several of its tasks, including subprojects that individuals may perform separately. Given individual and disciplinary differences, this largely amounts to knowing what others are to do while making sure that team communication is adequate for each to provide the others with the necessary information about separate subprojects. In a teaching situation this also involves communication with supervisors such that their input optimally fosters the team's performance. Supporting these different collaboration tasks, we ask each student to take responsibility for a specific component of the team research project, for which we have prepared separate manuals. These tasks include the management of the project, internal communication, and communication with (extra-academic) actors. Even when teaching at the bachelor's level we aim to prepare our students for how interdisciplinary research at a senior level is typically performed: as a collaborative team effort.

6. The Iterative Nature of the Interdisciplinary Research Project

As mentioned above, our textbook emphasizes the iterative nature of the interdisciplinary research process. It is important to realize that these iterations in the decision-making process of any research gradually bring the project closer to some optimal condition or goal (Newell, 2007). As this condition or goal in interdisciplinary research is usually of a complex nature, as are the wicked problems such research addresses, iterative work is especially important. Full integration of multiple insights is commonly not reached after cycling through the Science Cycle once only. Therefore, the interdisciplinary research team should reconsider any previously made decisions in light of decisions made later on in the research process, cycling back through the research model, represented in Figure 5, perhaps multiple times.

The iterative character of interdisciplinary research is particularly reflected in the earlier phases of the research process as we describe it in our textbook, those involving the development of the theoretical framework, as was mentioned earlier. As the team is integrating multiple disciplinary frameworks into a comprehensive interdisciplinary framework, decisions have to be made on how to integrate the most relevant parts. In line with the iteration that serves this process well, the team may need to reformulate their research question, leading to a more comprehensive and specified version of it. Obviously, when a team is decomposing such a comprehensive research question into various subquestions, specific empirical subquestions may arise, requiring subprojects to answer them. It is not uncommon that the results of such subprojects require subsequent adjustment of the original theoretical framework. A subproject may have demonstrated the influence of an additional factor—education mitigating aggressive behavior after alcohol consumption in some

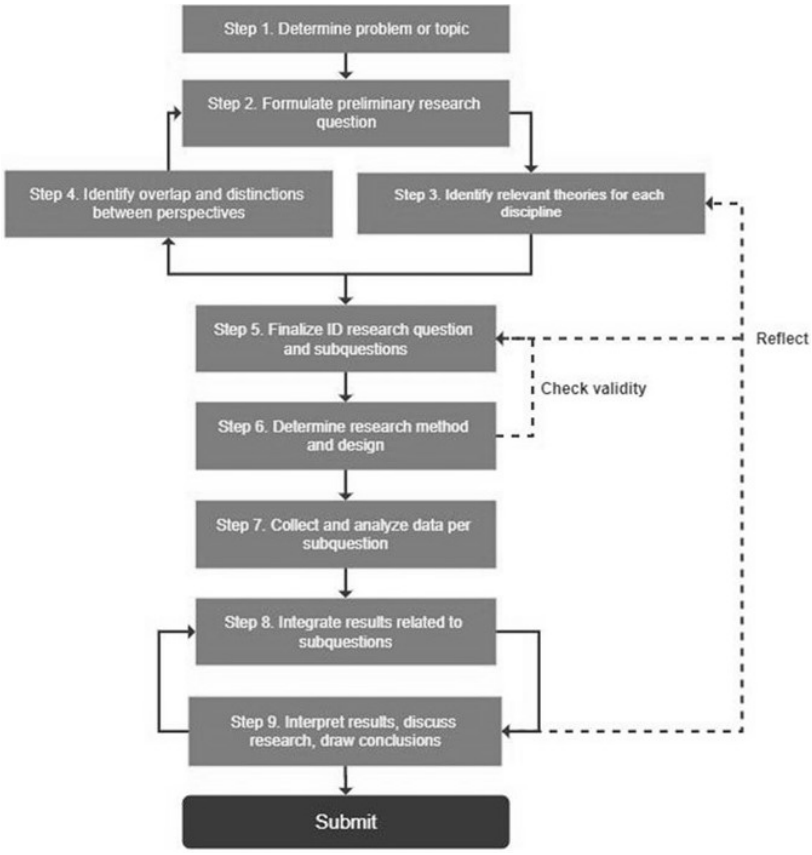

Figure 5. Interdisciplinary research as an iterative process according to the IIS interdisciplinary research model.

subjects, for example—which must then retroactively be incorporated in a comprehensive framework. Taking a step back in the research model in such a case supports the overall progress towards more robust research outcomes.

A similar iterative cycle with regard to research methods may be similarly productive. Concurring with the interdisciplinary research model provided in the 2017 edition of the Repko textbook, authored by both Repko and Szostak, our textbook also requires students to employ a data management table as a means to gather insights from the multiple perspectives to be integrated in the interdisciplinary theoretical framework. This table is a useful instrument for a team's discussion of disciplinary insights and their potential integration as it contains information about each of those insights on its underlying theory, relevant concepts, and general assumptions. We require

students to additionally include information on the methods used in each paper assessed in the data management table, since their interdisciplinary project may entail empirical subprojects in which several methods are to be integrated as well. The operationalization and specification of an empirical subproject invite the team to return to their data management table, this time focusing on the integration of research methods. Such methodological integration typically creates more robust research methods, as the weaknesses of one—say, qualitative—method may be compensated by integrating it with another—say, quantitative—method.

Supporting the reflection upon and communication of integrated disciplinary perspectives, we encourage interdisciplinary research teams to use any form of visualization when possible, especially when communicating the results to a wider transdisciplinary audience. Examples of such visualization are the familiar concept maps, the "boxologies" that are used to represent cognitive processes like visual perception, or the maps employed by the IPCC Working Group II containing numerous causal factors in physical, biological, and human systems that together lead to climate change (Cramer et al., 2014). Such visualizations also facilitate iterative decision making by helping team members reflect on the impact of adding or subtracting a factor from a model. Furthermore, a visualization in the form of a system diagram may also facilitate uncovering the possible leverage points where a small intervention can have great impact (Meadows, 2008), by clearly pointing out the relationship between the factors and actors. Therefore, in our textbook we advise interdisciplinarians, whether students or researchers, to visualize their research throughout their project, from beginning to end.

7. Integration Pluralism

We have mentioned pluralism many times in the explanation of our understanding of interdisciplinary research. It will come as no surprise, then, that this concept also applies in our discussion of the core ingredient of this mode of research: interdisciplinary integration. Here again, we deviate from Repko's model of such research in several ways. We will mention here the most apparent differences, though more still could be discerned.

First, we no longer follow the distinction that divides the research process into two phases ("Drawing on disciplinary insights" and "Integrating disciplinary insights"), a distinction that suggests that integration only occurs after disciplinary insights have been collected. Instead, as described earlier, we show that in many cases the development of disciplinary insights itself depends upon the preceding development of an integrated interdisciplinary theoretical framework from which research questions can be deduced.

Second, we do not describe integration as being a process applied to disciplinary insights only. Instead, according to our approach integration might be involved in all research phases and components. Indeed, once an interdisciplinary theoretical framework has informed a project by defining the relations between previously unrelated factors, it is to be expected that a method for its further investigation will in some way integrate those factors—for instance as variables in an experimental paradigm or in survey questions.

Third, we emphasize that integration pluralism implies that for a single project we may need to apply different integration techniques in parallel and/or sequentially. As we have noted, the development of an interdisciplinary theoretical framework alone may already depend upon multiple forms of pluralism. Furthermore, if we've been able to divide a research project neatly into different subprojects, each of these might involve some form of integration.

We acknowledge that the more recent 2017 version of Repko's model of interdisciplinary research, that is, the version authored by both Repko and Szostak, presents a broader set of integration techniques than the 2008 version. And indeed, for some years now, a pluralist approach to integration has not been uncommon.[4] But we have developed for our textbook a more comprehensive "interdisciplinary integration toolbox," which deviates in several ways from Repko's model. Our toolbox contains materials in the following categories: 1) theoretical and conceptual integration; 2) integration of research methods and instruments; 3) integrative models and objects; 4) integration of data and results; 5) integration via explanation; 6) integration in a practical intervention or instrument; 7) integration of the research team and its members. This list of materials relative to integration is by no means exhaustive but contains much that appears to be commonly used. Clearly, forms of integration that involve theories, research methods, or interventions are different in nature, reflecting the pluralism we've embraced. Not focusing especially on the conceptual and theoretical dimensions of research, we invite research teams to consider for interdisciplinary integration all research phases up to the implementation of interdisciplinary insights in a practical intervention or instrument—like an intervention to avoid alcohol-induced aggression or the invention of a robotic surgical instrument. Since developing a socially robust intervention generally requires a transdisciplinary approach, we have even included team integration as a separate category of toolbox material, emphasizing that special attention and techniques are needed for integrating academic and extra-academic perspectives.[5]

4 A very rich systematic and pluralist approach to integration is offered in Bergmann et al. (2012). In addition, a useful inventory of integration toolboxes is presented by the global Inter- and Transdisciplinary Alliance at https://itd-alliance.org/inventory-overview/.

5 Focusing even more explicitly on socially robust problem solving, the ecological research paradigm entails not only research that is transdisciplinary and team-based but also research that is in addition translational and transcultural (Stokols, 2018).

Finally, although insisting on the importance of integration of insights in the process of inter- and transdisciplinary research, we explicitly acknowledge the possibility that different insights on a given complex problem may not lend themselves to seamless integration or synthesis. Having introduced the subject of so-called wicked problems, we make the point about this all-too-likely challenge by using the example of the future of healthcare in affluent societies as demanding sometimes painful societal and political choices about finances, robotization of care, availability of plastic surgery, and so on. There may be no comprehensive optimal solution available that does integrate all separate insights into such a wicked problem. Still, having a sufficient grasp of integration pluralism is required for people to be able to understand why integration can yield only a limited result in some complex cases of interdisciplinary research.

8. Concluding Remarks

The availability of more than just a single textbook demonstrates the maturation of a discipline, field, or mode of research. Such maturation is also visible in the widening spectrum of associated undergraduate and graduate programs. Interdisciplinary studies now range from liberal arts and sciences programs teaching individual students to act as interdisciplinarians to curricula preparing students for team-based research into complex real-world problems like sustainability. Aiming to serve a potentially large audience interested in the latter, and especially teachers of the latter, the textbook we developed at the Amsterdam Institute for Interdisciplinary Studies emphasizes how much research nowadays is characterized by multiple forms of pluralism including conceptual, theoretical, and methodological pluralism. Similarly, pluralism is at stake with regard to forms of integration required in most interdisciplinary projects. And we also address the challenges that pluralism as a consequence of teamwork brings along. Inspired by colleagues from within AIS and beyond—and by earlier textbooks like that published by Repko in 2008, with its model for interdisciplinary research performed by individual researchers—we developed our own IIS model and textbook for interdisciplinary research performed by teams, being fully aware that its characteristics may not be equally useful for all readers. We do encourage teachers and students of interdisciplinarity to compare different textbooks to see which might suit their purposes best, as the process will force them to reflect on their assumptions, aims, and constraints when performing a research project. Indeed, such reflection in itself is a key ingredient of and good start at doing interdisciplinary research.

Biographical Notes

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