JOURNAL OF SPATIAL INFORMATION SCIENCE
Number 26 (2023), pp. 129–136
doi:10.5311/JOSIS.2023.26.299

LETTER TO THE EDITOR

Teaching GIScience in the multidisciplinary nexus

René Westerholt

Department of Spatial Planning, TU Dortmund University, Germany

Abstract: Many GIScientists are affiliated with institutions beyond what we would call core GIScience. This implies that we teach in degree programs that follow their own curricular logic, and presents us with challenges in terms of what to teach, how to possibly attract students to GIScience careers, and in terms of our own self-images and identities. After briefly taking stock of some of the bigger curricular initiatives from the past 30 years, and informed by a brief discussion of key arguments and findings regarding teaching GIScience 'elsewhere', this commentary aims to stimulate discussion on the multifaceted and multidisciplinary nexus in which many of us are embedded. The commentary includes short reflections on the implications of the multidisciplinary contexts mentioned for the creation of a GIScience identity among students enrolled in other degrees, recruitment of PhD students and faculty, and what all this possibly means for how we see ourselves as GIScientists.

Keywords: GIScience, geoinformatics, geomatics, teaching, education, multidisciplinary

1 Introduction

Many GIScientists teach in disciplines other than GIScience itself. It is contested, of course, what exactly falls within the realm of GIScience and what clearly lies outside of it. Accordingly, there has been much debate in recent years about whether GIScience, including its namesakes and varieties such as geoinformatics, geomatics, and, more recently, spatial/geographical data science, has the status of a discipline (see [3, 9, 16, 19]). It is not my intention in this commentary to delineate precisely where GIScience begins and where it ends. Even institutions that can be clearly named as GIScience institutions, such as the departments in Salzburg and Münster, do differ in the details and are by no means uniform. What they have in common, though, is that they offer GIScience/geoinformatics degree programs taught by instructors, many of whom share a GIScience identity. Alongside these types of institutions, there are departments that offer GIScience courses but are embedded in a different umbrella discipline. Examples of the latter are the departments

at UC Santa Barbara and at TU Vienna. In these cases, a mixture of identities within and outside GIScience is to be expected. However, it is undisputed and can be safely asserted that many of us work in contexts where the majority of colleagues and students do not identify with GIScience, but follow their own theoretical and curricular cores. Examples of the diverse institutional anchors of GIScientists include degree programs in geography, planning, computer science, sociology, economics, surveying, engineering, to name but a few. Although some of these subjects are undoubtedly closer to GIScience than others (e.g., geography and computer science, depending on how one views the field), it is evident that graduates of undergraduate and postgraduate programs taught in these other domains do not inherently possess a GIScience identity. Instead, most students (and researchers) will have been exposed to the field through a minor, an elective class, or through learning tools such as GIS. What does this mean for curricula in such multidisciplinary contexts, graduate student recruitment, and the identity and cohesion of the GIScience community?

2 Curricular developments

There have been a few proposals for recommendations on core curricula for GIScience in recent decades. One of the earliest such attempts was the Core Curriculum in Geographic Information Systems (not Science) [11] developed in 1990 by the then newly established National Center for Geographic Information and Analysis (NCGIA)[1] in the USA. This curriculum was updated in 1997 and renamed Core Curriculum for Geographic Information Science (no longer Systems) [12]. In parallel with this development, which was mostly aimed at full-fledged GIScience degree programs, NCGIA also developed a GIS Core Curriculum for Technical Programs in 1997 [13], a curriculum for instructors in other fields that include elements from the domain of GIScience. In the 2000s, a related development took place in Germany, in line with NCGIA's earlier efforts but with a slightly more technical focus. The latter was favored by the strong roots of GIScience in surveying, geodesy, and applied computer science in Germany (and some other European countries, see [15]), which is why the discussion there revolved around the term geoinformatics. The GfGI (Gesellschaft für Geoinformatik), a non-profit society of academics, non-academic stakeholders, and universities, which later merged into today's Society for Geoinformatics, GeoIT, and Navigation[2], has driven curriculum development and in 2009 presented a collection of core basic and applied topics and proposed skills [17,18]. All of the efforts outlined now appear to be aging (especially the more applied aspects) and have not been updated for some time. Another, third, coordinated project in cooperation with major American and European umbrella organisations (AAG and AGILE) is the GIS&T Body of Knowledge (BoK) of the University Consortium for Geograpic Information Science (UCGIS)[3] [22,24]. This curriculum of topics is continuously being updated and has had its last revision (at the time of writing) in February 2023. The BoK serves several purposes (e.g., designing vocational certificate programs, drafting job specifications), but it can also be understood as a foundation for educational programs. This paragraph is not exhaustive and reflects only some of the bigger and concerted, explicitly curricular initiatives that have taken place over the years. Other efforts include the Dutch GIMA curriculum [7], which was developed for a nationwide joint study

[1] http://www.ncgia.ucsb.edu, last visited: 16 May 2023
[2] https://geoit.org, last visited: 16 May 2023
[3] https://www.ucgis.org, last visited: 16 May 2023

program and can also be understood as a blueprint for teaching GIS/GIScience, and the early initiative that led to the 'Big Book' of GIS [8], which provides a compendium of key topics that can be used as a basis for teaching purposes. There are also many more works on GIScience education that address more specialized aspects and deserve to be acknowledged. Among others, these address topics such as e-learning [5,20], lifelong learning [21], GIS education in the school context [1,6,23], and curricular developments at the fringes of the field, for example, in the interface with surveying [10]. However, these topics would take us too far away from the intended context of this commentary.

3 Teaching GIScience 'elsewhere'

The outlined efforts have provided valuable momentum that has helped consolidate and establish GIScience as a professional scientific and practical field over the past 30 years. The frameworks presented focus on important topics (NGIA, UCGIS) or competencies (GfGI) both in stand-alone GIScience courses and (to a lesser extent) as part of curricula in other disciplines. The latter circumstance, however, seems to me to be a not insignificant one. A large number of GIScientists teach in the context of curricula other than GIS, GIScience, geoinformatics, or the like. The developed core curricula may not adequately address the broader implications of this situation – since they were designed against a different purpose. However, this fact of teaching in other disciplinary contexts has implications for the identity and development of GIScience as an independent domain. Wolfgang Reinhardt has discussed general challenges in teaching GIScience in dialogue with other disciplines, in his case in tandem with computer science and geodesy courses [14]. He concludes that a key challenge is to align the curricula as formulated by the initiatives presented in the previous paragraph with the competency profiles of the respective other disciplines. Some of the competencies and topics defined from a GIScience perspective may already be covered in a similar way by the respective other curricula, but taught in a different way than would be the case if they were conveyed from a GIScience perspective. Certainly, an important aspect of this is that other disciplines deal with objects of inquiry other than geographic information. Furthermore, it is concluded that the 'major' of each student must always be considered when GIScience content is 'interspersed'. The way I summarize Wolfgang Reinhard's assessment here makes it clear that a key factor seems to be that many of the students we educate do not develop a GIScience identity and mindset but become computer scientists, geodesists, geographers, etc. This is reflected in the use of the term 'major' (implying that GIScience is at best a minor) and in the fact that we often have to cater to requirements from outside our intellectual field. I do not intend this rationale to criticize the teaching of GIScience embedded in other disciplines (I myself teach in spatial planning). Instead, I would like to point out the resulting challenges (and opportunities) and thus stimulate a discussion about them.

The described ambivalence between the acknowledgment of GIScience as a scientific field with its own objects of investigation and the appreciation of an application-oriented mindset (which typically reaches into other disciplines in terms of research interest) is reflected in a survey by Kai Behncke et al. [2]. This survey was conducted in the context of the development of the GfGI Core Curriculum and operationalizes some of the competencies defined therein. A total of 133 GIScience and geoinformatics experts from German-speaking academia, industry, and public administration participated. Among many other

questions, the respondents were explicitly asked about the importance they placed on developing a distinct intellectual identity in the geoinformation field among geoinformatics students. They were further asked how important it is for them that students are able to relate and apply their geoinformatics knowledge to questions from external application domains. Both questions were answered positively by a large majority (73% and 83% rated these aspects as 'very important' or 'important' on a five-point Likert scale). To some extent, these results may be colored by the professional backgrounds of the respondents, though no significant differences between the different types of respondents are reported in the paper. The ambivalence of expecting both strong identification with GIScience and skills for transfer may not be problematic in monolithic degree programs with a strong geographic information emphasis. These degree programs provide ample opportunity to foster GIScience identity formation. However, when it comes to teaching GIScience in other disciplines, it may be more difficult to achieve both. In these cases, the expectations reflected in the survey results may be hard to reach: the development of an interest in research questions from other disciplines will be strongest among students who identify with those other disciplines; yet, the survey indicates that we want students to develop a GIScience identity. A related and more recent example is the increasing influence of machine learning, at least in the context of those programs that are more technical/technological in nature. Here, it is not so much other disciplines but rather a strong paradigm that has a significant influence on the way of thinking and the self-image of students, especially at more advanced levels. For the given context that is the focus of this commentary, the outlined ambivalence ties back to the discussion in the previous paragraph and shows that, in particular, the multidisciplinary teaching context that many of us are embedded in, and in which identity formation can indeed emerge from different angles, deserves more explicit and systematic attention in GIScience.

4 Open questions on GIScience education across domains

This commentary is not intended to provide conclusive answers, but to encourage reflection on how we might approach the teaching of GIScience 'elsewhere' in more strategic and beneficial ways for our field. Drawing on the discussion above, I pose two teaching-related questions that go beyond curricular aspects, and the answers to which I believe could have a major impact on how we as a field can further sharpen our profile and strengthen our core in the multidisciplinary context that is so common for many of us.

How can we create a stronger GIScience identity among students embedded in other intellectual contexts?

The main question I want to raise is a fundamental one: how to get students from disciplines other than GIScience excited about considering geospatial information as a research subject in its own right, and not just as a tool for another discipline. Trying to answer this question in practice is a challenge. As discussed above, teaching in a non-GIScience program means adapting to the needs of another discipline. It is not an option to simply ignore this fact and pretend that we teach our lectures and seminars in a standalone manner that bears no relation to the broader institutional embedding. Students would (rightly) complain because they did not enroll in a GIScience course. In addition, this approach could be detrimental to the promotion prospects of early career researchers and create political

tension at the institution. We should therefore find better ways to motivate students to engage with geoinformation concepts and methods at a fundamental level without violating institutional and disciplinary customs. For inspiration, I suggest looking to fields that are themselves multiparadigmatic. One such context is spatial planning, which comprises in itself a great deal of heterogeneity ranging from jurisdictional issues to design-oriented drafting to statistical empirical research methods. Academic planners of various flavors (who themselves often have backgrounds outside of planning) working at such institutions seem to be reasonably successful at moving interested students into their own intellectual domains without challenging the students' underlying identities as planners. One reason for this, no doubt, is that this drawing into what may be non-core (from a planning perspective) topics still occurs under a particular discursive regime that consistently assures the concerned students that they are still somehow within the confines of planning. In practice, however, many of these students (at least in my experience) in the end contribute to geography, urban studies, political science, and other fields in addition to the core areas of planning. Perhaps we as GIScientists ought to engage more with planning-like fields for inspiration on how to communicate our contents beyond the tool aspect in other contexts and, most importantly, to give appropriately interested students an identity as GIScientists already at reasonably early stages. This brings certain challenges, such as students from other disciplines initially missing some fundamentals that they would have learned from the outset if they had studied GIScience or geoinformatics undergraduates. But this is also true for someone moving from core planning to contributions in sociological topics and can certainly be compensated for. So, as a community, we may look more in a systematic way at the deeper processes of the context of positive examples that I have outlined. Certainly there are also many positive examples in existing hybrid GIScience constellations. Another promising avenue could be to demonstrate much better that GIS and GIScience are sometimes truly integral parts of subjects from other domains, rather than just optional tools. For example, we have argued in a crossover article that survey research and GIScience need to work together to address certain challenges [4]. In doing so, we worked out that the relevant objects of inquiry are at least partially anchored in both domains. We addressed this to researchers, but perhaps similar approaches could also work on a student level. What I want to aim at with these remarks is a more systematic addressing of the challenge raised in order to gain knowledge on how this kind of mentality change can take place in a systematic manner.

What are the potential long-term implications of the multidisciplinary fragmentation of GIScience education across different intellectual domains?

We observe at least two types of identity-related fragmentation in GIScience that are closely related: (i) as scholars, we ourselves may originate from other domains than GIScience and may now work in very different institutional contexts, and (ii) our education of the next generations takes place in different types of degrees (in addition to the relatively few core programs in GIScience). The former is partly an effect of the latter (since we may have undergone the outlined dynamics ourselves), though not entirely, since, pragmatically speaking, GIScience positions often emerge in all sorts of contexts, including beyond those in which we were trained. Two different dynamics are at play: those trained 'elsewhere' begin their GIScience careers with a different identity and are often prone to be attracted to *applications* of GIScience in these other fields; and those who move into novel contexts often undergo a shift in mindset to some extent, and in some cases adopt a new,

hybrid form of identity. These dynamics undoubtedly have positive effects in the form of broadened perspectives, interdisciplinary exchange, and an expansion of the influence of GIScience research into other fields. However, there are also challenges in this highly dynamic, fluid, and dispersed setting. The most tangible of such challenges is the difficulty in finding conceptually oriented PhD students focusing on core GIScience concepts. The fact that so many students were originally trained in a different mindset makes it less likely to fill positions with individuals who *genuinely* want to contribute to core issues in GIScience, rather than explore the latter *in the context of* an application domain. A natural follow-up consequence of this is the difficulty in filling tenured positions with respective scholars, which could have a long-term impact on the cohesion of GIScience as a field and on higher education policy in terms of funding, staffing, and proper institutional recognition. Another challenge is that our core (not applied) conceptual progress is probably slower than it could be. Our formalisms, our understandings of geographic information and representations, and our methods are far from perfectly understood. It is, of course, important to see all of these aspects in application, but we are probably lagging behind our own theoretical potential. This is reflected also outside academia, where geoinformation has become an important topic, but seems to be dominated at its core (not in its mere application) by graduates of computer science and other technical disciplines. What this brief outline indicates is that the fragmentation due to identity, caused in part by the formative influence of other disciplines and the subsequent often peripheral engagement with core conceptual issues of GIScience, may have long term implications for us as a field. I do not doubt that many of the challenges we face do indeed require a combination of competencies and can therefore only be successfully addressed by multifaceted teams. However, I equally believe that we should not overlook the development of our own core topics and concepts beyond applied perspectives. For the latter, our identity plays a significant role as a prerequisite for our research interest arising from it. For this reason, I would like to use this commentary to invite reflection on our self-images and identities, especially as conveyed in our teaching.

5 Summary

Teaching GIScience in variegated contexts is challenging. This commentary is an opinion piece that, supported by a brief discussion of the curricular context in the introduction and middle section of this essay, reflects a partially speculative perspective. However, I believe that we should seek to better understand how we teach in contexts other than GIScience in order to create an awareness of what this entails and how we might address some of the challenges outlined. A more concerted effort to understand the teaching-related aspects of the GIScience education context embedded in other disciplines beyond curricular considerations might lead to a strengthening of the position of our field: in terms of theory building, reaching a greater critical mass by attracting in more genuine manners additional students from other fields, and also in terms of our long-term relevance in the wider institutional and political academic context.

Acknowledgments

I thank the editorial team for additional thoughts and inspiration that helped expand some parts of my commentary.

References

[1] BARTOSCHEK, T., GUNDELSWEILER, G., AND BROX, C. GI@School: GI education and marketing at high schools. In *Proceedings of the 10th AGILE International Conference on Geographic Information Science* (Aalborg, Denmark, 2007), M. Wachowicz and L. Bodum, Eds.

[2] BEHNCKE, K., SCHIEWE, J., AND WEHRENPFENNIG, A. Ergebnisse einer Online-Befragung zur GfGI-Initiative „Kerncurriculum Geoinformatik". *gis.Science 2011*, 1 (2011), 1–21.

[3] BLASCHKE, T., AND MERSCHDORF, H. Geographic information science as a multidisciplinary and multiparadigmatic field. *Cartography and Geographic Information Science 41*, 3 (2014), 196–213. doi:10.1080/15230406.2014.905755.

[4] BLUEMKE, M., RESCH, B., LECHNER, C., WESTERHOLT, R., AND KOLB, J.-P. Integrating geographic information into survey research: current applications, challenges and future avenues. *Survey Research Methods 11*, 3 (2017), 307–327. doi:10.18148/srm/2017.v11i3.6733.

[5] BROX, C., PAINHO, M., BAÇÃO, F., AND KUHN, W. International exchange of e-learning courses. In *Proceedings of EUGISES 2004 – Fourth European GIS Education Seminar* (Villach, Austria, 2004).

[6] DEMIRCI, A. The effectiveness of geospatial practices in education. In *Geospatial technologies and geography education in a changing world: geospatial practices and lessons learned*, O. Muñiz Solari, A. Demirci, and J. Schee, Eds. Springer, Tokyo, Japan, 2015, pp. 141–153. doi:10.1007/978-4-431-55519-3_12.

[7] GIMA PROGRAM. GIMA course catalogue 2022–2023. https://www.msc-gima.nl/wp-content/uploads/2022/08/GIMA-Course-Catalogue-2022-2023.pdf, 2022. Last accessed: 26 May 2023.

[8] GOODCHILD, M. F., MAGUIRE, D. J., AND RHIND, D. *Geographical information systems: principles and applications*, first ed. Wiley, Harlow, UK, 1991.

[9] HAKLAY, M. Geographic information science: tribe, badge and sub-discipline. *Transactions of the Institute of British Geographers 37*, 4 (2012), 477–481. doi:10.1111/j.1475-5661.2012.00541.x.

[10] MASUM, F., MANSBERGER, R., MARTIN, A., NAVRATIL, G., AND MUSHINGE, A. Adapting the surveying curriculum to new dimensions of the profession. *Journal of Professional Issues in Engineering Education and Practice 145*, 2 (2019), 04019003. doi:10.1061/(ASCE)EI.1943-5541.0000408.

[11] NCGIA. Core Curriculum – Geographic Information Systems (1990). https://escholarship.org/uc/spatial_ucsb_ncgia_cc, 1990. Last accessed: 16 May 2023.

[12] NCGIA. Core Curriculum – Geographic Information Science (1997–2000). https://escholarship.org/uc/spatial_ucsb_ncgia_ccgis, 1997. Last accessed: 16 May 2023.

[13] NCGIA. GIS Core Curriculum for Technical Programs (1997–2000). https://escholarship.org/uc/spatial_ucsb_ncgia_cctp, 1997. Last accessed: 16 May 2023.

[14] REINHARDT, W. Geoinformatics education in different disciplines – challenges, approaches, and experiences. In *LeGIO Workshop* (Leuven, Belgium, 2011), pp. 21–28.

[15] REINHARDT, W., AND TOPPEN, F. The UCGIS geographic information science and technology body of knowledge – some thoughts from a European perspective. In *Proceedings of the Fifth International Conference on Geographic Information Science (GIScience)* (Park City, UT, USA, 2008).

[16] SCHEIDER, S., NYAMSUREN, E., KRUIGER, H., AND XU, H. Why geographic data science is not a science. *Geography Compass 14*, 11 (2020), e12537. doi:10.1111/gec3.12537.

[17] SCHIEWE, J. Kerncurriculum Geoinformatik – notwendige Grundlage für Studierende, Lehrende und Arbeitgeber. *gis.Science 2009*, 4 (2009), 137–141.

[18] SCHIEWE, J. Orientierung bitte! *gis.Business 2009*, 5 (2009), 40–41.

[19] SINGLETON, A., AND ARRIBAS-BEL, D. Geographic data science. *Geographical Analysis 53*, 1 (2021), 61–75. doi:10.1111/gean.12194.

[20] STROBL, J. UNIGIS – networked learning over a distance. In *Teaching geographic information science and technology in higher education*, D. J. Unwin, K. E. Foote, N. J. Tate, and D. DiBiase, Eds. Wiley, Chichester, UK, 2012, pp. 383–394. doi:10.1002/9781119950592.ch24.

[21] STROBL, J. The geospatial capacity building ecosystem – developing the brainware for SDI. In *Sustainable development goals connectivity dilemma*, A. Rajabifard, Ed. CRC Press, Boca Raton, FL, USA, 2019, pp. 213–219.

[22] UCGIS. GIS&T Body of Knowledge. http://gistbok.ucgis.org, 2023. Last accessed: 16 May 2023.

[23] WEST, B. A. *Conceptions of geographic information systems (GIS) held by senior geography students in Queensland*. PhD thesis, Queensland University of Technology, Brisbane, QLD, Australia, 2008.

[24] WILSON, J. P. Geographic Information Science & Technology: Body of Knowledge 2.0 project. Final report. https://ucgis.memberclicks.net/assets/docs/ucgis_bok2_wilson_report_dec2014.pdf, 2014. Last accessed: 26 May 2023.