Spatial Analysis 101

Spatial data for social
and environmental impact.

Course design: Isabel Ceron

Introduction

Context

This course was originally designed for first-year university students in Geography, Urban Planning and Environmental Management (here on the 'subject disciplines' or 'professions'). Cohorts are expected to include diverse groups in terms of age, gender and cultural background. It is assumed to be delivered internally, with approximate 2 hours lecture time and 2 tutorial hours per week.

Guiding philosophy

This section presents the philosophy behind the design. Subsequent sections will describe the components in detail, and how they are consistent with this philosophy.

The purpose of the course is to focus on key capabilities that would be required from a foundational course in quantitative analysis in the subject disciplines, namely:

i. The ability to think spatially, which requires students to become aware and sensitive to the impacts of locational distributions and patterns on human and natural environments.
ii. The ability to use spatial analysis to formulate and solve research questions to guide decision-making in policy or management settings.
iii. The ability to use maps to communicate the outcomes of such analyses with purpose and affect, based on an appreciation of the power of spatial information to transform people and places.

These capabilities reflect the type of skills that are required of graduates in these disciplines Kaufman and Simons 1995; Arrowsmith et al 2011). Designing courses around capabilities is advocated as a means to facilitate meaningful and relevant learning experiences, and to increase students' motivation and engagement (Crosling, Heagney and Thomas 2009; Cowan 2013).

These capabilities are also threshold concepts, in the sense that they require students to see the world in a new way, and have been demonstrably difficult to grasp in assessment and tutorials. Course design around threshold concepts is recommended in Mathieson (2015).

Additionally, these capabilities work together as an integrated set, with each new skill building upon the previous one, and all being necessary to fully enable/operationalise their use. Bednarz and Bednarz (2008) argue that the ability to think spatially is inseparable from the abilities to formulate and respond spatial problems, and to communicate with spatial literacy. Designing courses to integrate skills, rather than leave integration to occur later, is recommended in Dall'Alba (2009). By achieving these foundational skills early on in the program, students and teachers are awarded opportunities to revisite and refine them in subsequent courses.

The above capabilities will require students to use higher-order abilities, such as analyse (i, ii, iii), evaluate (i, ii), and create (ii, iii), consistently with the educational shift towards curriculum design for higher and deeper learning (Whetten 2007; Cowan 2013). The ability to reflect critically on the use of spatial information and technologies has been recognised as fundamental to enable their sensible application in social science disciplines (Goodchild an Janelle 2010).

Ultimately, the measure of success will be a student that emerges on the other side as a spatial, critical being. One who begins to detect spatial patterns in his/her daily commuting trips, who wishes that newspaper article also came with a map, who holds a smartphone and sees a world of possibilities for crowd-sourced problem solving. Some education scholars argue this kind of learning, that goes beyond understanding, towards actually transforming the self, is what higher education should be about (Dall'Alba 2005). This course hopes for such a transformation.

Aims and objectives (A&Os)

Course Aims

The aim of this course is to equip students with the foundations for quantitative analysis in geography, urban planning, and environmental management. In these disciplines, quantitative analysis revolves around the capacity to think spatially, this is, to reveal and understand the

connections between the location and distribution of activity, and the outcomes observed in urban and natural environments. Students will become spatially aware, and use this advantage to approach critically and creatively the solution of urban and environmental problems. Students will also explore the power of spatial information and technologies to transform people and places, and its changing role in the management of urban and natural environments.

Learning Objectives

After successfully completing this course students should be able to:

LO1 Identify potential linkages between real-world urban and environmental problems, and the location and distribution of activity, based on a critical and creative assessment of available evidence.

LO2 Formulate and respond empirical research questions, which take into consideration the spatial dimension of urban and environmental problems, and are geared to support decision-making in policy and/or management settings.

LO3 Demonstrate an appreciation for how spatial information and technologies can be used to communicate urban and environmental issues with purpose (i.e. awareness, coordination, advocacy), in professional and community settings.

The aim statement differs from existing approaches to teaching spatial analysis in that it lays clear, and high, the expectations from the course to the students (promoted in Ramsden 2003 and Whetten 2007). Verbs used reflect the desired higher-order abilities (‘critically and creatively’, ‘formulate and respond’) whereas existing first-year course aims usually signal lower expectations (‘basic understanding’) or offer no clue as to the level of performance expected (‘skills’). A definition of ‘spatial thinking’ in plain language is also included. Language used in the statement reflects excitement for the topic and the experiences ahead (i.e. ‘reveal’, ‘become’, ‘advantage’, ‘power’, ‘transform’, ‘changing’).

The learning objectives (LOs) reflect the capabilities/threshold concepts and higher-level abilities identified earlier. What stands from the existing approaches to this subject is the exclusion of generic skills from the list of LOs (i.e. data collection, survey design, sampling, statistical analysis). The existing sets the stage for a declarative-knowledge approach, which has been associated with narrow or surface learning outcomes (Ramsden 2003).

A table showing the LOs and graduate attributes is included in the Appendix.

Learning activities

Course contents

Course contents are organised in three consecutive clusters, in alignment with the LOs:

- **Cluster 1 (weeks 1-4):** Waking up to location. How spatial thinking differs from traditional (i.e. high-school) problem-solving approaches in the social and natural sciences. Basic conceptual building blocks (location, distribution, patterns). Applications of spatial thinking to explain current issues in the disciplines, using international case studies (i.e. population spreads, spatial disadvantage, habitat fragmentation, etc.).
- **Cluster 2 (weeks 5-8):** Using spatial analysis in policy and management. How to formulate and answer spatial research questions in different policy and management settings. Key numerical skills (i.e. statistical analysis) and how they are harnessed to support decision-making. Ethical dimensions of spatial analysis (i.e. data availability and access; spatial literacy and equity; exclusions, misrepresentation). Theories explored in Cluster 1 are revisited with a focus on formulating and testing hypotheses.
- **Cluster 3 (weeks 9-10):** Using location to change people and places. Exploring the transformative potential of spatial information and technologies in society; from using maps to effectively communicate the spatial dimension of problems, to the possibilities arising from the internet of things, to crowd-sourcing information and campaigning for urban and environmental change. The emphasis is on the future and its possibilities.
- Group project presentations (weeks 11-12).

Structure of lectures and tutorials

Nowadays, good teaching practice includes active or student-centered learning strategies (Whetten 2007) as well as those where learning is collectively construed in interactions with peers (Cowan 2013; Mathieson 2015). The traditional lecture format was abandoned in favour of a flexible structure that accommodates various forms of active and collectively-construed learning, namely:

- Lectures are preceeded by required readings and guided reflection.
- Sessions start with a 30-minute presentation by the lecturer (or a guest), where s/he introduces the purpose of the session, key concepts, and relevant case studies or other provocative material.
- In Clusters 1 and 3, students use the next hour to work in small groups, in guided discussions, and using materials brought to class by them. In Cluster 2, students use this time to develop

their group project (main piece of assessment) in class, with assistance from the lecturer and tutors.

- In the last 30 minutes, students turn to discuss with the rest of the class, around open questions posed by themselves and the lecturer.
- In the last 2 weeks, groups project presentations include Q&A time.

The role of tutorials will change from a space to work individually on textbook-style exercises, to a space to develop the main piece of assessment (group project) with the guidance and formative feedback from tutors (sessions running from week 3 to 10).

Learning by doing

In-class learning activities require students to perform the capabilities outlined in the LO1, LO2 and LO3, respectively:

- During Cluster 1, as part of their preparation for the weekly lectures, students are asked to search newspapers and magazines for real-life examples of urban and environmental problems of interest to them, which could be better explained if approached with a spatial perspective (here on 'the news activity'). They should bring them to class to use as inputs in organised group discussions.
- During Cluster 2, students will work, in and outside the classroom, in a project that asks them to assume the role of a policy-maker or manager in the discipline of choice, identify a real-world problem amenable to spatial analysis, and undertake all the steps from problem formulation and data collection, to analysis and recommendations ('the group project').
- During Cluster 3, students will be asked in class to try out for themselves a series of web-based or downloadable geoapps (i.e. crowd-sourced campaigns), using modern electronic devices (i.e. smartphones, tablets), then critically evaluate their potential to achieve the urban and environmental goals of various community/interest groups ('the geoapp activity').

These approaches differ significantly from current approaches, where 'doing' is limited to tutorial sessions, in the form of textbook-style exercises (a series of short exercises to remember and practice concepts in the context of contrived situations).

I expect the proposed activities, which make students repeatedly display the target capabilities in situations that resemble professional practice, will get them as closely as possible to becoming spatially critical beings.

Relevant to students' experiences

According to Crosling, Heagney and Thomas (2009), the use of real-life material that is relevant to the personal experiences of students is a way to promote their engagement.

In the 'news activity' described earlier, students are prompted to find and share materials from current media, guided by their personal interests, and developing spatial intuition. Engagement continues as these cases can later evolve into assessments 1, 2 and 3.

Where possible during Cluster 2, practicing geographers/planners/environmental managers who use spatial inputs into their jobs will be invited to present to the class and respond questions by students (including questions about the students' own projects).

In Cluster 3, the 'geoapp activity' asks students to critically analyse geoapps using their phones, tablets or laptops, in class. Looking at ordinary objects in new ways is likely to increase the relevance and excitement of the learning experience.

Assessment

Item	%	Description
Poster (individual)	30	Develop a poster explaining how spatial analysis can reveal new, exciting, and/or useful perspectives on seemingly ordinary urban and environmental problems, using a real-world example from a newspaper or magazine.
Project (group)	40%	Assuming the role of a policy-maker or manager in a professional setting, provide advice about a real-life urban or natural problem, using spatial analysis.
Design (individual)	30%	Formulate a proposal describing how an existing geoapp you frequently use (mobile, desktop or web-based) could be used to solve an identified urban or environmental problem.

Assessment items and structure seek close alignment with the LOs by requiring students to display identical capabilities. This implies a shift away from assessing understanding and remembering (current schemas include quizzes, tutorial-style assignments, and exams), and a reduced number of assessment items (3). Work- and Project-Based Learning strategies, such as those exemplified in Assessments 2 and 3, are recommended to support capability-oriented learning and skill integration (Dall'Alba 2009).

All items are weighed similarly to communicate the fact that all thresholds are regarded as equally important. The weight of assessment 2 is slightly higher to reflect the additional effort required to complete it.

Curriculum integration

Cowan (2013) advocates for curriculum integration, defined as learning design that "focuses on achieving the outcomes and satisfying the assessment while the learning activity is in progress" (p. 75). The proposed assessment structure pursues integration in that:

- Assessment 1 is a replica of the 'news activity' developed in weeks 2 to 4 (albeit presented in a different format –poster) and can be based on a case used in class, so they are being assessed in what they learn.
- Assessment 2 is developed in class and tutorial times, so it is at the same time a learning activity, and a piece of assessment. Students are encouraged to use one of the cases from Cluster 1 as the basis for their project.
- Assessment 3 replicates the in-class 'geoapp activity', where they critically analyse the potential of geoapps to solve real-world natural and environmental problems, taken a step further by the requirement to imagine an application to solve a real-world problem.

References

Arrowsmith, C., Bagoly-Simó, P., Finchum, A., Oda, K., & Pawson, E. (2011). Student employability and its implications for geography curricula and learning practices. Journal of Geography in Higher Education, 35(3), 365-377. doi:10.1080/03098265.2011.563379

Bednarz, R. S. and Bednarz, S. W. (2008). The Importance of spatial thinking in an uncertain world. In Sui, D. Z. (Ed.), Geospatial Technologies and Homeland Security (pp. 315-330), Springer, retrieved from: www.researchgate.net/publication/226304415.

Cowan, J. (2013). Education for higher level capabilities: beyond alignment to integration. In Gil, V. M. S., Alarcao, I, and Hooghoff, H. (Eds), Challenges in Teaching & Learning in Higher Education (pp. 53-76), Universidade.

Crosling, G., Heagney, M., & Thomas, L. (2009). Improving student retention in higher education: Improving teaching and learning. Australian Universities' Review, 51(2), 9-18.

Dall'Alba, G. (2005). Improving teaching: Enhancing ways of being university teachers. Higher Education Research & Development, 24(4), 361-372, doi:10.1080/07294360500284771.

Dall'Alba, G. (2009). Learning to be professionals. Dordrecht: Springer.

Goodchild, M. F., & Janelle, D. G. (2010). Toward critical spatial thinking in the social sciences and humanities. Geojournal, 75(1), 3-13. doi:10.1007/s10708-010-9340-3.

Kaufman, S., & Simons, R. (1995). Quantitative and research methods in planning: Are schools teaching what practitioners practice? Journal of Planning Education and Research, 15(1), 17-33. doi:10.1177/0739456X9501500102.

Mathieson, S. (2015). Student learning. In Fry, H., Ketteridge, S. and Marshall, S. (Eds), A Handbook for Teaching and Learning in Higher Education: Enhancing Academic Practice (pp. 63-79), 4th edition, retrieved from

Ramsden, P. (2003). Learning to Teach in Higher Education. Retrieved from http://www.eblib.com

Whetten, D. A. (2007). Principles of effective course design: What I wish I had known about learning-centered teaching 30 years ago. Journal of Management Education, 31(3), 339-357. doi:10.1177/1052562906298445.

Appendix – Graduate attributes

Graduate attribute	Learning Objectives
A. In-depth knowledge & skills in the field of study	
A1. A comprehensive and well-founded knowledge in the field of study.	1, 2
A2. An understanding of how other disciplines relate to the field of study.	1, 2, 3
A3. An international perspective on the field of study.	1, 3
B. Effective Communication	
B1. The ability to collect, analyse and organise information and ideas and to convey those ideas clearly and fluently, in both written and spoken forms.	1, 2, 3
B2. The ability to interact effectively with others in order to work towards a common outcome.	2, 3
B3. The ability to select and use the appropriate level, style and means of communication.	1, 2, 3
B4. The ability to engage effectively and appropriately with information and communication technologies.	1, 2, 3
C. Independence and Creativity	
C1. The ability to work and learn independently.	1, 3
C2. The ability to generate ideas and adapt innovatively to changing environments.	1, 2, 3
C3. The ability to identify problems, create solutions, innovate and improve current practices.	1, 2, 3
D. Critical Judgement	
D1. The ability to define and analyse problems.	1, 2, 3
D2. The ability to apply critical reasoning to issues through independent thought and informed judgement.	1, 2, 3
D3. The ability to evaluate opinions, make decisions and to reflect critically on the justifications for decisions.	2, 3
E. Ethical and Social Understanding	
E1. An understanding of social and civic responsibility.	1, 2, 3
E2. An appreciation of the philosophical and social contexts of a discipline.	1, 3
E3. A knowledge and respect of ethics and ethical standards in relation to a major area of study.	2, 3
E4. A knowledge of other cultures and times and an appreciation of cultural diversity.	1, 3