

A criteria framework for critical cartography education

Melissa del Carmen Ernstberger ^{a,*}, Juliane Cron ^a

^a Technical University Munich – me.ernstberger@gmail.com, juliane.cron@tum.de

* Corresponding author

Abstract:

The need and potential for implementing critical praxis in holistic, contemporary education curricula has long been argued for by critical education theorists and practitioners. In the field of cartography, our research finds that such discourses are limited, or altogether missing, especially when it comes to the critical dissemination of cartography in formal, higher education settings. Adopting contemporary, critical, feminist, and decolonial pedagogical frames, our research starts with an extensive literature review on existing critical education criteria that provide a basis for how to implement critical praxis in the curriculum. Specifically, we aim to compile criteria for implementation across four central curricular elements: explicitly outlined (1) content, (2) instruction methods, (3) learning outcomes, and (4) assessment techniques. Focusing on the synthesis of these elements, our research builds off the literature in our development of a critical criteria framework specifically for cartography education. Developed with an evaluation of widespread university-level critical cartography courses and interviews with course developers, the framework outlines five criteria for critical cartography content, six criteria for critical cartography instruction methods, and provides an overview of aligning critical cartography learning outcomes and assessment techniques. The final synthesized criteria framework presented in this paper is envisioned for aiding in the evaluation of critical praxis in existing cartography curricula, and for fostering the development of new, critical, cartography education material.

Keywords: critical curriculum, education, critical cartography

1. State of the art: critical cartography higher education

In 1991, J.B. Harley, one of the most prominent critics in cartography, outlined in detail the detriments of uncritical cartographic practice across academic, institutional, and commercial domains. “All this must surely change in the next few years,” (Harley, 1991, p. 198) he went on to say. It is now 2025, more than 30 years since Harley presented his main critiques, arguments, and speculations for the future of cartography. In that timeframe, critical theory across the discipline has morphed, diffused, and grown. Most notably, critique in cartography increasingly incorporates feminist, indigenous, or decolonial worldviews that challenge a discipline still perceived as often operating within Eurocentric, western, or otherwise hegemonic power structures and biases. Contemporary critical cartography uses these views with new mapping practices and methodologies to center tenets of ethics and social justice (kollektiv orangotango, 2018). As Hall and Moore-Cherry (2022) however demonstrate, a ‘technical-critical’ binary is still encountered in contemporary geographic discourses and especially in education domains, despite the progression in critical theory and practice across cartography and education at large. In such a binary, little practical crossover is seen to occur between the two perceived poles: ‘critical’ perspectives remain traditionally sidelined to the social humanities while

‘technical’ studies or skills are developed with minimal reflection on their socio-cultural or political contexts. This binary is not unique in the case of Hall and Moore-Cherry’s study, rather, as Treagust and Won (2023) demonstrate, a reflection of broader trends across much science education at large.

As evidenced in the GIScience and Technology Body of Knowledge (www.ucgis.org/gis-t-body-of-knowledge), there is an ever-increasing number of works that provide teaching material for critical cartography content. Subject topics in this Body of Knowledge include ‘Cartography and Power’ (Thatcher, 2018), ‘Epistemological Critiques’ (Leszczynski, 2017), and ‘Feminist Critiques of GIS’ (Le Noc, 2019). Notably, feminist, decolonial, and otherwise critical strains of thought are at the centers of such content proposals, building upon and diversifying contributions to the critical discipline. Equally, examples of informal critical cartography education that find place within local or grassroots organizations and collectives receive increasing attention (kollektiv orangotango, 2018). This abundance of critical practice, however, falls silent when it comes to how critical cartography rolls out in higher education, or university contexts. Yet further silence is met when one seeks out ways in which cartography content may be delivered, critically, in academic settings. Ultimately, our research remains not aware of any study explicitly examining the link between critical cartography, critical pedagogies, and higher education. Not only have

we found that higher cartography education demonstrates an embedded trend within positivist, techno-scientific paradigms (Ormeling, 2008; Sack, 2023), but the limited literature on cartography higher education at large provides little evidence to suggest significant cross-over with critical theories and pedagogic practices. J.B. Harley's stipulations from 1991 for the future of critical cartography, in which the discipline itself also has a role in challenging the status quo or overturning broader systems of injustice, remains thus ambiguous and unclear. This dilemma has not gone unnoticed by others. Wilson (2017), for example, builds on the dissonance between contemporary critical cartographic praxis and uncritical dimensions of formal education to argue that broader transformation across cartography education is not only lacking, but needed.

This research's examination into critical, 21st century cartography education is a study of how contemporary critical theory and practice, i.e., **praxis**, may be applied for higher education cartography curricula. Though there are many ways critical education praxis may be implemented (see Stein, 2004), the scope of this research lies in the application of curricular frameworks. Attuning to theories of constructive alignment (Biggs, 1999), we believe that critically engaged education does not and cannot separate the content of instructional material from the way material is taught. As such, the criteria framework development is envisioned to expand beyond purely theoretical conceptualizations to practical, pedagogic applications of what 'critical cartography higher education' means, may mean, or should mean in a contemporary landscape.

In this paper, we report our exploration of existing critical education praxis that culminates in a set of general criteria for critical curricula. Here we describe the method applied in detail and document how every single criterion can be used in cartography, leading to our development of a critical criteria framework for cartography education. Our research thus contributes to similar studies conducted in the field of geography (Laing, 2020; Radcliffe, 2022) for demonstrating the potential of critical praxis integration into a cartography curriculum. Our goal with this is to provide a basis for improving evaluation and implementation of critical praxis in cartography education along explicitly outlined examples and recommendations.

2. Critical curricula

Building on the works of Freire (1973) and hooks (1994), critical education theorists and practitioners often apply critical pedagogy as a foundation for addressing how structures of learning may upturn systems of oppression and injustice. Across critical educative praxis, which in contemporary contexts incorporates feminist, decolonial, and epistemological pedagogy and critique, the importance of critical theory embedded into the curriculum is highlighted as a key method for transformative practice. In their study, Tintiangco-Cubales et al. (2020) exemplarily demonstrate on feminist and decolonial pedagogy for how reviewing critique in curricula may contribute towards individual and societal

empowerment, especially in the face of curricula that stand as documents of white, Eurocentric educative structures. Although their study is conducted on middle school curricula in the context of Filipino ethnic studies, their framework for critical evaluation is made to be adapted and applied across educational contexts. McArthur (2010) similarly argues for the use of critical pedagogy as a framework that unites feminist, decolonial, queer, and critical race theory across education and application contexts. Laing (2020) and Radcliffe (2022), in their development of decolonial, higher education geography curricula, build on decolonial pedagogy with special emphasis on epistemological and ontological critique. They demonstrate practical cases in which curricula and syllabi are adapted to fit along recommendations of existing critical praxis. As evident across the literature, these recommendations are *not* lacking. The "elements" (Halagao, 2010, p.508), "strategic intentions" (Serrano et al., 2017, p.3) "dimensions" (Chase, 2019, p.33), "recommendations" (Laing, 2020, p.9), "criteria" (Tintiangco-Cubales et al., 2020, p.23) and general advice on operationalizing critical praxis in contemporary curricula is extensive, with direct application possible across the four curricular elements of critical content, critical instruction methods, learning outcomes, and assessment techniques. These elements together begin to form the frame for a comprehensive, critical education framework. Stipulated now as general criteria of critical education at large, these will later be synthesized along cartography education for a critical cartography-specific (higher) education criteria framework.

2.1 Critical content

The content of a subject forms the main bulk of topics, theories, themes, and ideas taught within a particular module or course. Critical content in the curriculum, as Tintiangco-Cubales et al. (2020) define, is the inclusion of content and resources that challenge hegemony and provide counter-hegemonic narratives. In their study, they present a framework for curricular review that aptly cross-checks for the incorporation of counter-narratives, primary sources, multiple subjectivities, controversial topics, a connection to universal themes or issues, and critical engagement with social justice, community, and humanity. This focus on social political issues and justice is a central tenet of similar studies (Chase, 2019; Laing, 2020), as is the inclusion and prioritization of non-western ontologies and epistemologies (Leenen- Young et al., 2021). Incorporating controversial topics is an idea that Dolphin and Dodick (2014) especially expand upon, in the context of earth science education. Utilizing multiple perspectives and subjectivities, they demonstrate how reinforcing science with philosophy and history contributes to the encouragement of critical student thinking and reflection.

2.2 Critical instruction methods

Critical methods of instruction are those which most closely align to critical pedagogical praxis, aligning what is taught (content) and how. The re-shaping of student-teacher relationships to foster a horizontal classroom

structure, for example, is often at the forefront of subverting traditional classroom power dynamics and, as Chase stipulates, in “disrupting the commonplace” (Chase, 2019, p.9; Laing, 2020; Serrano et al., 2017; Reynolds & Trehan, 2000). Within such horizontal structures, students are placed on an equal footing with an active role in their learning process, from co-developing the curriculum (see Serrano et al., 2017) to co-instructing, for example via student-led workshops (Laing, 2020). Halagao (2010) and Tintiangco et al. (2020) formulate how dialogue-based interactions, discussion, and interchange are a further key pretext for critical student conscientization. Incorporating instruction methods that encourage diverse and especially non-western viewpoints, Laing (2020) emphasizes how instruction may align to principles of decolonization. Of note, diverse representation is to go beyond diverse reading lists to diverse teaching staff, with active inclusion of instructors from the global south. As Leenen-Young et al. (2021) outline, instructions should above all encourage marginalized narratives and diverse ontologies-epistemologies in the classroom. Supported by creative learning tools, Laing (2020) makes a further case for diverse media that brings to attention different, legitimate sources of knowledge production. Serrano et al. (2017) meanwhile argue that creative student freedom brings about independent approaches to student work. The fostering of empathy and emotional exploration, a recurring element of feminist pedagogy, also presents itself here; as Halagao (2010) stipulates, it is the personal and emotional engagement with learned content that may materialize into tangible enactment. In line with decolonial theory, which often confronts students with their own subjectivities and positionalities, the encouragement of emotional exploration may further lead to meaningful implications extending beyond the classroom. Finally, the practical fostering of justice, empowerment, and social change proves at the heart of numerous studies tying together the various components of critical pedagogy praxis. Tintiangco-Cubales et al. (2020) demonstrate the potential of this via practical projects and assignments that confront students with real-world case studies, thus ensuring classroom content is given a broader local or societal context. Halagao (2010) emphasizes this in instruction methods that involve and interact with local communities.

2.3 Learning outcomes

Within constructive alignment, curricular elements of content, instruction, learning outcomes, and assessment may come together in a logical and complementary structure. Establishing learning goals is often discussed as the most important step in curriculum cohesion (Biggs, 1999; McKeachie and Svinicki, 2014). The catapult for conceptualizing adequate content, instruction methods, and student assessment, the learning goals bring curricular elements together towards clearly defined purposes. In contemporary educational practice, these formulated goals are often classified along the standardized Taxonomy of Educational Objectives (Bloom et al., 1956). This taxonomy of goals, originally formulated in the 1950s, has

since been revised to encompass six overarching, hierarchical learning categories (Krathwohl, 2002). These span from ‘Remember’ (also referred to as Learning Outcome 1) to ‘Create’ (also referred to as Learning Outcome 6). The different orders of categorization from outcomes one through six aim to reflect the various degrees of cognitive complexity. Higher-level, more complex objectives are characteristically more difficult to measure, but are outlined as inherent to facilitating engaged student motivation and learning. As McKeachie and Svinicki (2014) and Serrano et al. (2017) elaborate, such higher-level objectives are often at the forefront of learning processes that work towards deconstructing conventional education environments and curricula, simultaneously breaking away from more formal assessment and instruction methods. On this front, Serrano et al. (2017) outline key learning principles deemed crucial to broader learning goals of collective and individual intellectual growth. These are supported by McKeachie and Svinicki (2014), who point out that goals linked to critical praxis involve students’ abilities to explore contradictory ideas, distinguish and search out relevant information for a particular subject, and develop critical learning and reflexive self-regulatory skills.

2.4 Assessment techniques

Student assessment is where uneven, hierarchical power dynamics may most explicitly emerge in learning processes. Student perspectives are marginalized especially when assessment does not involve student input (Serrano et al. 2017). ‘Critical assessment’, as coined by Chase (2019), is a term not explicitly defined across theory or literature, but may be applied as a way for operationalizing evaluation framed by critical pedagogy. Critical assessment primarily emphasizes horizontal evaluation that puts students on a more balanced footing with teachers and instructors of a particular course, project, or assignment. In particular, Reynolds and Trehan (2000) elaborate on forms of participative assessment that incorporate self-, peer-, and collaborative- evaluation methods. In collaborative assessment, students and tutor work together, reflexively, to reach a final evaluation. Peer-assessment, which is evaluation by fellow students, may involve commentary on written work, with the tutor’s role falling back to facilitator rather than final judge (Reynolds & Trehan, 2000; Serrano et al., 2017). Self-assessment is in some ways the method that asks for the most reflexivity and may take many different forms. Chase (2019), for example, proposes evaluation that involves student- defined assessment criteria. In other words, at the beginning of a course or module, students set the grading criteria by which they will later grade themselves against. This may be combined with peer-evaluation, in that evaluation occurs with the collectively student-defined grading criteria. Of note, different assessment types may apply the principles and values of critical assessment. Ultimately, Chase (2019) and Serrano et al. (2017) make the point that a diverse range of assessment techniques is fundamental towards open and inclusive learning styles.

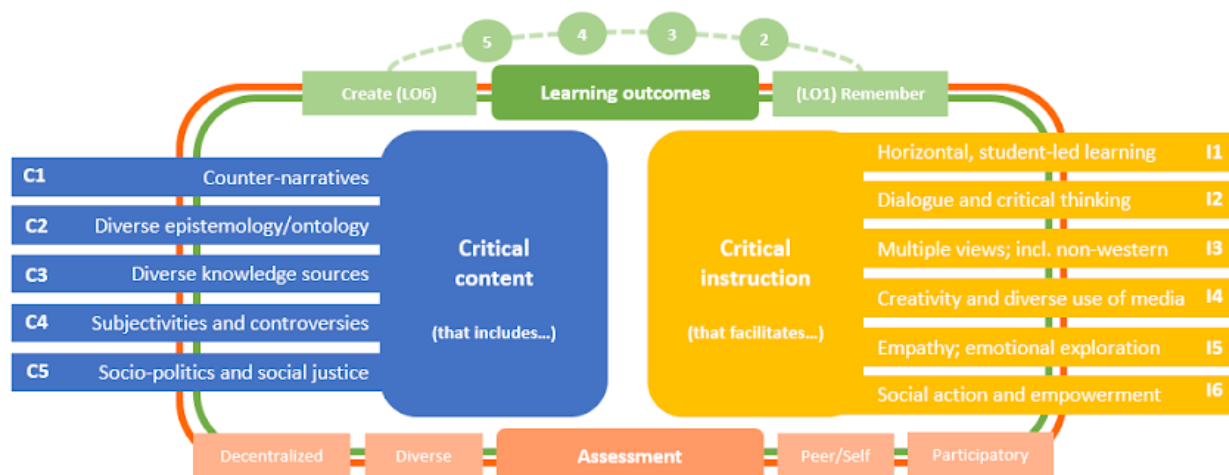


Figure 1. Synthesized critical education criteria.

2.5 Synthesis

The input of the reviewed literature forms the backbone of a criteria framework for critical education at large, and is holistically visualized in Figure 1. This comprises:

- Criteria for critical content, summarized into five overarching categories C1 to C5.
- Instruction methods, intended to supplement how content is disseminated and interacted with between students and in the classroom, categorized into six categories I1 to I6.
- Learning outcomes (LOs), as per Bloom's Revised Taxonomy, ranging from remembering (LO1), explaining (LO2), applying (LO3), analyzing (LO4), evaluation (LO5), to the highest order thinking (LO6), focused on creating.
- Assessment techniques which should be diverse and dispersed across the LOs. Sensitive to nuances, specific assessment chosen should be taken into consideration with learned content and instruction methods used in the classroom.

These general criteria recommendations may be applied to cartography for a cartography-specific critical education criteria framework.

3. Developing the framework

Cartography is a field of study traditionally incorporated within broader programs of geography or related disciplines in the geo-sciences. The state of cartography in higher education is relatively well-documented within positivist, techno-scientific domains (Ormeling, 2008; Peters, 2016). Where, then, exactly, does critical praxis come into play in cartography higher education?

Though literature is limited, a specific search of university-level curricula demonstrates the existence of critical cartography courses within university programs (detailed in section 3.1). The method for this research primarily makes use of those course examples to develop upon best practices that can be applied to the general critical education criteria detailed across the literature. Building on the course examples, the method conducts an in-depth analysis of critical cartography syllabi and interviews with respective course instructors to develop a coherent,

applicable critical criteria framework specifically for cartography education.

3.1 Critical cartography university courses

Examples of critical cartography taught within higher education institutions are limited, but do exist. Appendix A demonstrates a global sample of such university courses, primarily found via the internet and selected based on their listing of 'critical cartography' either in their title, course, or linked/parent program descriptions. Where the same course was found in several year formats, the most recent and up-to-date was selected for the list. In four cases, additional courses were referred to for the research by contacted course instructors. Altogether, the courses demonstrate a variety of interdisciplinary interests, evidenced by organizing Faculties and Departments ranging from Environmental Sciences, Social Sciences, Geospatial Sciences, Geography, Architecture, History, Philosophy, Culture, Literature, and Media Studies. A non-exhaustive list that covers a diverse range of purposes and objectives, the courses serve as template examples of how critical cartography higher education plays out in practice.

3.2 Syllabi analysis

From the found courses, it was decided to conduct an in-depth analysis of selected syllabi documents to explore what and how content, instruction methods, learning outcomes, and assessment techniques operate in practice. In total, six syllabi documents of critical cartography university-level courses were systematically gathered for in-depth examination. These were sampled, as the courses reviewed at large, on their basis of teaching, centering, or otherwise incorporating 'critical cartography' in their descriptions. In cases where multiple courses were found offered by the same instructor, syllabi which repeated a large proportion of information were excluded from the in-depth analysis. All examined syllabi documents may be viewed in Appendix B.

3.3 Interview analysis

As syllabi data was found at times sparse or varying in depth and detail, it was decided to complement this data with personal course instructor insights. Interviews ensured an extension of the syllabi data that prevented missing significant information, such as inexplicit

instruction practices applied ‘on the ground’. In this way, the two datasets build a comprehensive overview of existing critical cartography higher education praxis.

Of the 17 course instructors contacted via email to take part in the research, four interviews were finally conducted in the timeframe June-July 2024. All contacted interviewees were selected based on their participation in founding, leading, or teaching the critical cartography courses listed in Appendix A, with care taken to gather diverse perspectives across gender, nationality, and ethnicity. Interviews were conducted with one from Colombia (University of Nariño), two from the Philippines (UP Diliman), and one from the United States (University of Kentucky). All interviewees are members of their university affiliation’s Department of Geography, represent two female and two male perspectives, and have varying years of university teaching experience. Given the geographically dispersed nature of interviewees, all interviews were conducted online via Zoom. The recorded semi-structured calls, conducted in English or Spanish, lasted between 1-1.5 hours each. With a focus on course content, instruction methods, and personal experiences with critical cartography teaching, interview questions were posed accordingly. Anonymity was granted to the interviewees with the replacement of their names and minimal personal data incorporated in the research. As interviewees’ affiliated university departments and courses are however listed, anonymity could not be fully guaranteed. In light of these ethical concerns, as well as on data recording, consent to the use of data was verbally established at the commencement of interviews as well as in a shared Data Consent form. To further aid in transparency in the data analysis interpretation process, revised co-produced interview summaries were sent to interviewees post-interview. The interview documents are available in Appendix B.

4. A critical cartography education criteria framework

The analysis of the data described in the previous section altogether presents key content topics, instruction methods, assessment techniques, and explicit learning outcomes for application in contemporary, critical cartography higher education. We found that the syllabi overall present explicit information on course content, learning outcomes, assessment, and limited details of instruction methods. Interviews, on the other hand, present in-depth information on overarching content topics and instruction methods. Thus, where syllabi present clear and concise—albeit at times limited—formulations of their respective courses, interviewees provided rich accounts of personal critical cartography teaching experiences. In terms of the analysis on content, data from the syllabi and interviews were first organized into so-called ‘content categories’ found prevalent across the courses overall. These comprised **Social politics and justice**, **Map Practice & Representation**, **Counter- cartography**, **Critical GIS**, **(Technical) GIS**, **Theory**, and **History**. Instruction methods were similarly grouped across so-

called ‘instruction categories’, namely: **Discussion-based**, **Skills training**, **Applied fieldwork**, **Seminars**, and **Guest instruction**. Upon later examination of the data, **Practicing reflexivity** and **Excursions** were added as instruction-categories for additionally found methods. As will be demonstrated in the following sections, specific content topics and instruction methods pertaining to these categories were then assigned to their appropriate critical criterion. These specific topics and methods (*italicized in later text*), are taken directly from syllabi formulations or interviewee recommendations. Learning outcomes were directly categorized into their fitting LO category, whereas assessment, found to be diverse across the examined courses, was analyzed in tune with the respective LO.

4.1 Critical cartography content

Following the first grouping of the syllabi and interview data to content-categories, the data was synthesized and thematically organized according to the overarching content criteria C1 to C5. Across all the content criteria, the most diverse array of sub-topics is found to adhere to content of C5. This criterion is primarily made up of topics from the content categories **Social politics and justice**, **Maps and power**, and **Critical GIS**, where topics from *gender and mapping*, *data ethics*, to *democratization of maps* were found to align. Evidently, there is cross-over between several sub-topics and the criteria. The sub-topic of *(alternative) mapping practices*, for example, is the most widespread of the sub-topics, seen to align to three critical content criteria: C1, C2, and C3. The following Table 1 sorts all cartographic topics encountered per critical content criteria.

4.2 Critical cartography instruction methods

Critical instruction methods across syllabi documents and interview transcripts underwent similar analysis to the analysis for critical content. The most dispersed methods from the data were found to be **Discussion-based**, incorporating *active discussion* and *student-led discussions* in the classroom. The criterion I3 is demonstrated as fitting the most diverse number of instruction methods, encompassing methods which are **Discussion-based**, **Applied fieldwork**, **Practice reflexivity**, **Guest instruction**, and **Seminar-based**. Of note, I3 methods of *tolerating different views*, *supporting colleagues* in discussion rounds, and *being modest* in one’s own discussion demonstrates a sensitive encouragement of sharing diverse perspectives and normalizing alternative or unfamiliar views. All instruction methods found applicable for critical cartography are listed in Table 2.

4.3 Critical cartography learning outcomes

Learning outcomes from the data were most explicitly formulated in the syllabi documents, with interviewee responses supporting overall teaching aims. Categorized according to Bloom’s Revised Taxonomy, it was found that all syllabi outlined at least three course objectives. These objectives prominently stick to higher, upper-end learning outcomes, detected by associated illustrative verbs (including synonyms) listed in Table 3.

Critical content criteria [C] Operationalized via topics of...	
C1	Activist mapping; mapping poetry; mapping stories; militant cartographies; performative cartographies; sensorial mapping; indigenous cartography; emotional cartography; (alternative) mapping practices; subverting hegemonic ideas
C2	Indigenous cartography; semantics and semiology; meaning of maps; mental maps; knowledge; representation; (alternative) mapping practices;
C3	Community mapping; collaborative mapping; (alternative) mapping practice; participatory GIS; knowledge; representation; diverse media; experimentation; open data; map collections/archives
C4	Critique and critical theory; critical Marxist thought; theoretical cartography; cartographic theory; concept of space; Harley; deconstructivism; quantitative cartography; scientific cartography; emotional cartography; (alternative) mapping practice; representation; (post-)representational cartography; queer theory; feminist theory
C5	Creation and appropriation of space; silence of maps; maps, politics, and war; state mapping; democratization of maps; subverting hegemonic ideas; social justice; maps and power; gender and mapping; race and mapping; technology for empowerment; promoting social change; politics of cartographic art; marginalized communities; data ethics; colonial roots; history of cartography; history of GIS; GIS and society; GIS wars; participatory GIS

Table 1. Critical content criteria applied to cartography.

As an interviewee underlined, the clear and explicit formulation of learning goals, in the context of critical cartography courses was itself deemed crucial:

“It’s important to be upfront with students about what the course is and what it is not, and to help them understand the value of a critical, engaged approach.”
(Interviewee D, University of Kentucky)

In turn, clearly formulated learning outcomes may have a larger role to play especially when students are new to or unfamiliar with critical approaches in teaching methods. Ensuring students understand the learning outcomes should then be ensured in such a learning environment.

4.4 Critical cartography assessment techniques

Assessment techniques, also predominantly presented in the syllabi, were found to be diverse, encompassing a myriad of techniques for evaluating student achievement of the learning objectives. From the applications, it became evident that a learning outcome such as ‘Understand’ (LO2) was rather linked with timed examination techniques in which students could demonstrate their ability to explain understood concepts, written or orally.

Critical instruction criteria [I] Operationalized via methods of...	
I1	Horizontal structure; student-led discussion; student-led community research; skill sharing
I2	Seminar; response questions; reflective writing; engaged reading; active discussions; questioning; contradictions in the classroom; small groups; verbal feedback
I3	Diverse literature; pluralities; different cartographies; contradictions in the classroom; modesty; tolerating different views; supporting colleagues; guest artist; community guest speaker; collaboration abroad; excursion
I4	Creative discussion design; (non-conventional) mapping project; creative freedom; hand-drawn maps; materiality; museum visits; workshops; excursion
I5	Tolerating differing views; supporting colleagues; creative discussion design; creative freedom; (non-conventional) mapping project
I6	(Student-led) community research; community guest speaker; community assessment; student-led discussion; (local) case study projects; community mapping project; decolonizing cartography

Table 2. Critical instruction criteria applied to cartography.

Learning outcome [LO] Students should be able to...(illustrative verbs)	
LO6	produce; become; discuss; develop, create, apply, challenge, give voice (to), participate, engage, synthesize, combine, produce
LO5	evaluate; critique; interpret
LO4	analyze; examine; investigate; interrogate,
LO3	apply; gain experience; utilize, analyze gain skills, acquire experience; integrate
LO2	explain; understand
LO1	practice skills; extend skills; engage, familiarize

Table 3. Aligning learning outcomes to critical cartography.

Assessment techniques per learning outcome	
LO6	mapping project; classroom leadership; writing project; reports; reflective paper; active participation
LO5	map critique; peer desk critique
LO4	map analysis; peer critique; site analysis; lab exercise; response to peer reflection
LO3	data observation; data collection; mapping project
LO2	open-book exam; oral exam; written exam; written response; response to peer reflection
LO1	technology demonstration

Table 4. Aligning assessment to critical cartography LOs.

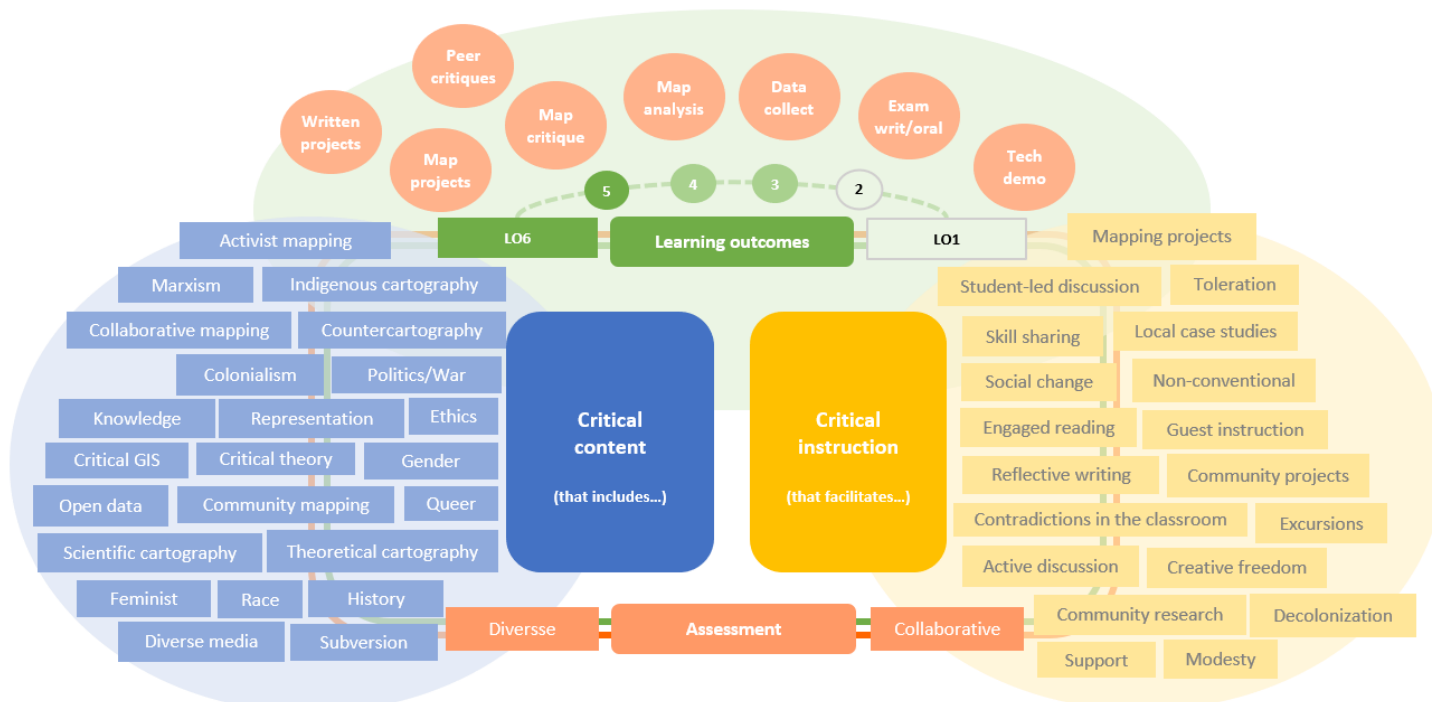


Figure 2. Synthesized critical cartography education criteria framework.

In other cases, there was a cross-over between LO2 assessment techniques and more complex evaluation methods. Student responses to peer reflection, for example, were found to judge students' ability to understand content as well as to evaluate peers' formulations and provide appropriate interpretations. Assessment through mapping projects may similarly target two learning outcomes; the ability to produce or create (LO6) as well as the ability to apply learned content or methods to own work (LO3). Reflective papers, reports, as well as larger writing projects were all seen in the examined data to be predominantly applied for LO6. These long-form interpretative, argumentative, or reflective assignments may be perceived as more suitable for the assessment of complex cognition extending beyond LO1 information recalls.

5. Synthesizing the framework and applicability

In a critical curriculum for cartography education, curricular elements should be synthesized. Presenting five criteria for critical cartography content, six for critical cartography-specific instruction methods, and aligning critical cartography learning outcomes with appropriate assessment techniques, the developed criteria framework outlined in Tables 1 to 4 is visualized in Figure 2.

Beyond the research detailed in this paper, the usability of the criteria framework has been demonstrated in a case study application testing how critical cartography education operates (and may be improved) within a higher education cartography curriculum (Ernstberger et al., 2024). This application demonstrates how the criteria outlined in the developed framework may be used for evaluating existing curricular documentation, and further for developing new educational material that aligns with the recommendations of contemporary critical praxis. The application also indicates additional points that should, however, be taken into due consideration: First and

foremost, it is certain that an analysis of additional syllabi, modules, or curricula incorporating critical cartography would improve the developed framework and provide a more comprehensive overview of the critical cartography education landscape. Additionally, and in light of the research conducted by Stein et al. (2004), it is evident that holistic, critical education may be examined from several additional fronts. Engagement with students, for example, as demonstrated by Laing (2020), may provide additional insights and ideas on the potential for disseminating critique within such curricular frameworks.

6. Conclusion

This research presents best practices in terms of critical cartography content, critical cartography-specific instruction methods, learning outcomes that measurably help student abilities in critical cartographic praxis, and suitable, diverse assessment techniques that help evaluate the achievement of learning goals. Taken together, these four elements comprise the development of a critical cartography education criteria framework. The framework is intended for application in the evaluation of existing cartography curricula and further in the development of critical cartography educational material. As such, we encourage the application of the developed criteria framework on further case study programs to provide insights into its widespread use and applicability. As elaborated, the criteria framework would benefit from a more extensive dataset of critical cartography higher education sources for adequate representation in the framework across institutional settings, cultures, and other differentiating factors. We also call on future research into the broader critical cartography higher education landscape—the comprehensive examination of which is currently found lacking. We believe filling this gap will contribute to strengthening the diverse intersections between cartography and education at large.

7. References

- Biggs, J. (1999). Teaching for Quality Learning at University. Buckingham, UK: SRHE, and Philadelphia, PA: Open University Press.
- Bloom, B.S. (Ed.), Engelhart, M.D., Furst, E.J., Hill, W.H., & Krathwohl, D.R. (1956). Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain. New York: David McKay.
- Chase, M.K. (2019). Critical assessment: a student-centered approach to assessment. Papers on Postsecondary Learning and Teaching: Proceedings of the University of Calgary Conference on Learning and Teaching, 3, p-pp.
- Dolphin, G. & Dodick, J. (2014). Teaching Controversies in Earth Science: The Role of History and Philosophy of Science. In: M.R. Matthews (ed.), International Handbook of Research in History, Philosophy and Science Teaching. Dordrecht: Springer. pp. 553-599.
- Ernstberger, M.D.C., Cron, J. & Ignateva, O. (2024). Critical 21st century cartography education: identifying course content and instruction methods for the curriculum. *Abstracts of the ICA*, 7(28).
- Freire, P. (1973). Education for Critical Consciousness. New York: Seabury Press.
- Halagao, P.E. (2010). Liberating Filipino Americans through decolonizing curriculum. *Race Ethnicity and Education*, 13(4), 495-512.
- Hall, T. & Moore-Cherry, N. (2022) Negotiating applied and critical perspectives within the geography curriculum. *Journal of Geography in Higher Education*, 46(4), 489-494.
- Harley, J. B. (1991). Can there be a cartographic ethics? *Cartographic Perspectives*, (10), 9–16.
- hooks, b. (1994). Teaching To Transgress (1st ed.). Routledge.
- Krathwohl, D.R. (2002). A revision of Bloom's Taxonomy: an overview. *Theory Into Practice*, 41(4), 212-218.
- kollektiv orangotango+ (2018). This is Not an Atlas: A Global Collection of Counter-Cartographies. Bielefeld: transcript Verlag.
- Laing, A. F. (2020). Decolonising pedagogies in undergraduate geography: student perspectives on a Decolonial Movements module. *Journal of Geography in Higher Education*, 45(1), 1–19.
- Le Noc, M. (2019). Feminist Critiques of GIS. In: J.P. Wilson (ed.), The Geographic Information Science & Technology Body of Knowledge (2nd Quarter 2019 Edition).
- Leenen-Young, M., Naepi, S., Thomsen, P. S., Fa'avae, D. T. M., Keil, M., & Matapo, J. (2021). "Pillars of the colonial institution are like a knowledge prison": the significance of decolonizing knowledge and pedagogical practice for Pacific early career academics in higher education. *Teaching in Higher Education*, 26(7–8), 986–1001.
- Leszczynski, A. (2017). Epistemological critiques. In J.P. Wilson (ed.), The Geographic Information Science & Technology Body of Knowledge (4th Quarter 2017 Edition).
- McArthur, J. (2010). Achieving social justice within and through higher education: the challenge for critical pedagogy. *Teaching in Higher Education*, 15(5), 493-504.
- McKeachie, W.J. & Svinicki, M. (2005). McKeachie's Teaching Tips: Strategies, Research And Theory for College And University Teachers. Houghton Mifflin.
- Ormeling, F. (2008). Mapping the Changes in Cartographic Education in the Last 50 Years. *KN - Journal of Cartography and Geographic Information*, 58(4), 178–185.
- Peters, S. (2016). CET university programs. Retrieved on 5 September 2024 from: <https://education.icaci.org/wp-content/uploads/2018/07/CET-university-programs.xlsx>
- Sack, C. (2018). Curriculum Development and Pedagogy for Teaching Web Mapping. University of Wisconsin-Madison.
- Serrano, M.M., O'Brian, M., Roberts, K., Whyte, D. (2017). Critical Pedagogy and assessment in higher education: the 'ideal' of authenticity in learning. *Active Learning in Higher Education*, 00(0), 1-13.
- Stein, S., Isaacs, G., & Andrews, T. (2004). Incorporating authentic learning experiences within a university course. *Studies in Higher Education*, 29(4), 239-258.
- Thatcher, J. (2018). Cartography and Power. In J.P. Wilson (ed.), The Geographic Information Science & Technology Body of Knowledge (1st Quarter 2018 Edition).
- Tintiango-Cubales, A., Halagao, P. E., & Cordova, J. T. (2020). Journey "Back Over the Line": Critical Pedagogies of Curriculum Evaluation. *Journal of MultiDisciplinary Evaluation*, 16(37), 20–37.
- Treagust, D. F., & Won, M. (2023). Paradigms in Science Education Research. In N.G. Lederman, D.L. Zeidler & J.S. Lederman (eds.), Handbook of Research on Science Education: Volume III (Vol. 3, pp. 3–27). Routledge.
- Wilson, M.W. (2017). New lines: Critical GIS and the Trouble of the Map. University of Minnesota Press: Minneapolis, MN.

8. Appendix

- A) Critical cartography course list: [link](#)
- B) Supplementary syllabi documents: [link](#)
- C) Supplementary interview documents: [link](#)