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Article

Does When and How Design Students Learn Causal Layered Analysis Matter?

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Abstract

Causal Layered Analysis can help design students to engage with complex societal challenges. Undergraduate design majors differed from non-design majors in learning CLA in a Design Futures course. According to text analysis of student reflections, non-design majors wrote more reflections coded as "design insights" and "thinking structures." Graduate students with real-world work experience shifted discussions towards practical applications. Undergraduate design majors focused more on "individual reflections," "CLA details," and "other" topics. I suggest ways to scaffold student learning to use CLA with design methods and processes and, more broadly, use CLA to think more systematically about complex societal challenges.

Keywords

Causal Layered Analysis, Design Thinking, Futures Thinking, Design Education, Empirical Study

Introduction

We live in exciting yet perplexing times. For example, consider challenges such as the: Climate Emergency and Extinction Rebellion (Farrell, Green, Knights, & Skeaping, 2019), disinformation campaigns from fossil fuel industry groups (e.g., Mulvey & Shulman, 2015), and proposals to reach zero-carbon by the year 2050 (e.g., Gates, 2021; Doerr & Panchadsaram, 2021; Hawken, 2021), and plans to electrify just about everything as quickly as possible (Griffith, 2021), and so forth. Traditional design methods are insufficient for such challenges.

Design Thinking methods rooted in the Anthropocene, focus on short-term issues often associated with consumerism, resource depletion, income inequality, and environmental devastation. However, societal challenges such as zero-carbon transitions require design methods and processes aligned with long-term worldviews, values, and stories. The challenge is to link short-term design action to long-term thinking through futures. In other words, a combination of design and futures methods are needed to meaningfully address societal challenges such as zero-carbon transitions. Next, I describe some initiatives to teach Futures in K-12 education.

Teaching Futures in K-12 and Beyond

The rapid pace of change requires that younger generations learn to shape and inhabit futures in their lifetimes (Toffler, 1970). Teaching futures prepares students to participate in the world that awaits them as adults (e.g., Bishop & Strong, 2010). In addition, there is a long tradition linked to teaching futures to broader populations. For example, Jerome Glenn advocated *futurizing* teaching practice rather than adding separate futures courses to school curriculums (Glenn, 1972). Next, I describe four notable examples to embed futures into secondary education initiatives.

First, in Australia, Richard Slaughter describes the Queensland initiative "Futures Personal, Social, Global" as a two-year subject for years 11 and 12. Even though the pilot program was highly successful, it was nonetheless abandoned (Slaughter, 2008). Second, "Futurizing the K-12 Teaching Practice" was an ongoing workshop co-

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sponsored by the Texas Association for the Gifted and Talented (TAGT) and the Houston Independent School District (Strong & Bishop, 2011). Third, the Department of Education and Design Futures in the College of Education at Tamkang University developed a Futures Studies program for the Senior High School curriculum (Abdullah, 2022). Fourth, Futures Literacy is a capability that helps to imagine societal transitions; UNESCO is teaching Futures Literacy through labs worldwide (Riel, 2018). Finally, Häggström & Schmidt (2021) propose a Futures Literacy pedagogical framework that envisions a transformative critical thinking approach to teaching youth. Next, I describe some initiatives to teach Design Futures in universities.

Teaching Futures to Designers within Universities

Teaching Design Futures to university students varies by tradition: Design Futures and Critical Design (Dunne, 1999; Raby, 2001), Design Fiction (Sterling, 2005), Speculative Design (Dunne & Raby, 2013), Discursive Design (Tharp & Tharp, 2019), and Experiential Futures (Candy, 2010). The growing number of futures-related design courses denotes global enthusiasm.

This article describes a Design Futures course that I call *Dexign Futures.*[1] *Dexign* indicates an experimental form of design that combines Futures Thinking and Design Thinking methods.[2] *Dexign Futures* was developed at the School of Design at Carnegie Mellon University to provide students with new design methods to address societal challenges in the 21st century (e.g., climate emergency, zero-carbon transitions). The *Dexign Futures* methods emerge by embedding Futures Thinking into new design processes and methods. In the next section, I describe CLA and why teach CLA to Design students.

What is CLA, and Why Teach CLA to Design Students?

Causal Layered Analysis (CLA) is a Futures Thinking method developed by Sohail Inayatullah. CLA provides intellectual scaffolding allowing one to notice how behavior links to social systems and infrastructure, worldviews, and myths/metaphors (Inayatullah, 1998; 2004; 2009; Inayatullah & Milojevic, 2015). CLA draws from different epistemologies from poststructuralism, macrohistory, and postcolonial multicultural theory (Inayatullah, 2004; 2009). The power of CLA lies in making explicit such diverse perspectives. In addition, the CLA method allows analysis of current situations and exploration of future scenarios.

CLA helps designers understand the structure of reality where they operate and provides scaffolding to find strategic design opportunities at multiple levels. It is beneficial with societal design challenges such as behavior change for a rapid transition towards zero-carbon by the year 2050 and global pandemics. Such societal challenges require aligning short-term design action with long-term sustainability vision goals. CLA analysis of the current state and the desired long-term future state can help designers identify and frame design opportunities at the behavior, infrastructure, worldview, and myths/metaphor levels.

Dexign Futures: Context and Pedagogy

Terry Irwin led the School of Design faculty at Carnegie Mellon University to overhaul the curriculum to include Design Studies courses to address pervasive societal challenges (Irwin, 2016). The Dexign Futures course is a required Design Studies course for third-year undergraduate design students[3] and an elective course for non-design

[1] The Dexign Futures course goes by different names when taught as a required course in the School of Design (Futures, or Futures 1). When taught as an elective course it goes by the name Dexign Futures.

[2] The term "Dexign" was coined by Arnold Wasserman in 2013 while co-teaching the "Dexign the Future" course with Peter Scupelli.

[3] The Dexign Futures course launched in 2016 was a required 15-week course for all third-year design students (see Scupelli & Brooks, 2018). In 2018, a different version of Futures was taught (see Scupelli, Candy, & Brooks, 2019). From 2019 onwards the Dexign Futures course was redesigned to be a 7-week course called Futures 1 when taught as a required course or an elective called Dexign Futures. I have written about Dexign Futures course content evolution and pedagogy elsewhere (Scupelli, Wasserman, & Brooks 2016; Scupelli & Brooks 2018; Scupelli, Candy, & Brooks, 2019) and teaching Dexign Futures in different settings such as K-12 settings

majors. Other Design Studies courses include Systems, Placing, Research Methods, Cultures, and Persuasion. The Dexign Futures courses use a three-part design-centric flipped classroom pedagogy: pre-class online work with immediate feedback, in-class applied exercises, and reflections (Scupelli & Brooks, 2018).

How was CLA Taught?

Students learned CLA through five learning activities: (a) watching pre-class online videos, reading texts, and answering interactive questions with immediate correctness feedback, (b) in-class mini-lectures followed by class discussion, (c) in-class, small group, scaffolded step-by-step exercises, (d) writing individual online reflections and commenting on two classmates' reflections, and (e) followed by in-class small-group and whole-class discussions.

Two in-class workshops taught alternative futures and CLA. In the alternative futures workshop, students explored their career decisions with a guided step-by-step exercise. First, they created a 2x2 matrix with two axes of uncertainty. For example, one axis could have two careers a student considered, such as "medicine" and "design," at each end. The other axis might have "research" and "professional practice" at each end. The resulting four quadrants define four possible career paths: clinical physician, medical researcher, design researcher, and professional designer.

Next, they explored four possible alternative careers. Finally, students picked one possible alternative job and examined it more in-depth through a CLA-type layered analysis (i.e., litany, systems/infrastructure, worldviews, myths/metaphors). The four CLA layers allowed students to explore their future careers.

An example of a student career CLA follows. First, a graduate student picked five images to describe the "litany level" of an Interaction Designer living and working in San Francisco. Next, she wrote text-based descriptions for the other three levels of CLA analysis. Finally, the in-class discussions focused on applying CLA to design problems.

At the end of the week, students answered the following reflection question:

> You have explored alternative futures based on two critical uncertainties this week focused on career choice and related uncertainty (e.g., research/practice, corporate/freelance, government/NGO, and so forth). Then, you conducted a Causal Layered Analysis to describe the four layers (i.e., litany, social system & structure, worldview, and myths & metaphors) for one such scenario. CLA is a structured analysis tool. What did you learn from conducting such an exercise? On what kind of projects might you use CLA-type analysis as a designer?
>
> Please post one comment (150-word max) by midnight Sunday. Comment on at least two classmates' posts before class on Tuesday.

Research questions

In this article, I compare two student populations that took the *Dexign Futures* courses in 2019 and 2020: (a) two required course sections for undergraduate design students and (b) two elective course sections for non-design majors, both undergraduate and graduate. The course materials and course instructor were the same for all courses. I explore two questions:

1- What aspects of CLA are the focus of design majors and non-design majors?
2- Do undergraduate design majors and graduate non-design majors focus on different aspects of CLA?

Data

Each semester, I teach two versions of the *Dexign Futures* course: first, a required course for only undergraduate

(Scupelli, Wells-Papanek, Brooks, & Wasserman, 2017), other universities (Barbara & Scupelli, 2021), and on Massive Online Open Platforms in China (Scupelli, Fu, Zheng, & Brooks, 2019). In addition, I have described how design students understood CLA concerning design opportunities (Scupelli, 2020; Scupelli, 2022).

design majors, and second, an elective course for non-design majors open to undergraduate and graduate students. In 2019, I taught the *Dexign Futures* courses in person; in 2020, due to the COVID-19 global pandemic, online via ZOOM.

The number of students differed by course section Required design majors (N=81) and Elective non-design majors (N=39). The students in the Required design course sections were primarily third-year (81%) with a few fourth-year undergraduate design majors (19%). The elective non-design major course students were undergraduates (54%) and graduate students (46%). Of the 115 weekly reflections submitted from students, approximately 70% were from female students.

The data and the coding scheme were described previously (Scupelli, 2022). I focus on the differences between design and non-design majors in this article. Next, I provide a summary of the methods.

Methods

I coded the students' written reflections with grounded theory methods in three steps: (a) initial coding, (b) intermediate coding, and (c) advanced coding (Strauss & Corbin, 1998). First, during the initial coding step, I synthesized the essence of the written text. Next, I assigned a code to fit the entry and continued to code text entries. Finally, when existing codes were inappropriate, I formulated new codes focused on similarities and differences and developed sixteen codes.

Second, I sought to reduce the number of codes in the intermediate coding step. Infrequently used codes were merged with codes covering related or adjacent ideas—reducing sixteen codes to five consolidated themes. Third, in the advanced coding phase, a storyline emerged based on the distribution of the main codes in the dataset.

The five codes used were: *personal insights, design insights, thinking structures, CLA details,* and *others* (Table 1). The *personal insights* code describes students' reflections focused on how CLA explained their career or personal choices. The *design insights* code told how CLA could inform design methods and processes. The *thinking structures* code refers to how the different CLA layers can help structure one's thinking. The *CLA details* code describes CLA layers and linkages to other future methods. Finally, I assigned the *other* code when the previous four codes were inappropriate.

Table 1. The five codes used to code the student reflections on CLA

Code	Definition
Personal Reflections	Focused on personal insights from CLA or futures methods.
Design Insights	Reflections on how CLA might be used in design methods or processes.
Thinking Structures	The text describes how different layers of CLA structure thinking or provide contextual insights (e.g., relationships between CLA layers, question assumptions about the status quo, cultural context)—thinking through multiple perspectives (e.g., individuals, groups, organizations).
CLA details	The text explores details of the CLA layers (i.e., litany, systems, worldview, myth/metaphor) or mentions links from CLA to other futures thinking methods.
Other	The text does not fit into the previously described codes.

Results

Next, I present the results for the student reflections coded. First, I describe all data for the four classes studied and provide the data by course section type (i.e., Required courses vs. Elective courses). The data used in this study was published previously (Scupelli, 2022). However, the data analysis reported is novel; it compares two-course sections (e.g., Required vs. Elective).

Overall data

115 of the 120 enrolled students submitted their online posts on CLA. On average, each post was 133.95 words (SD 46.51). The median was 133 words; minimum of 35 words; maximum of 392 words).

Figure 1 illustrates the percentages of codes in the student reflections for the Required and Elective course sections with a bar graph. Table 2 lists the number of codes used, separated according to the course sections. Next, I provide examples of student comments and compare them across the Required and Elective courses.

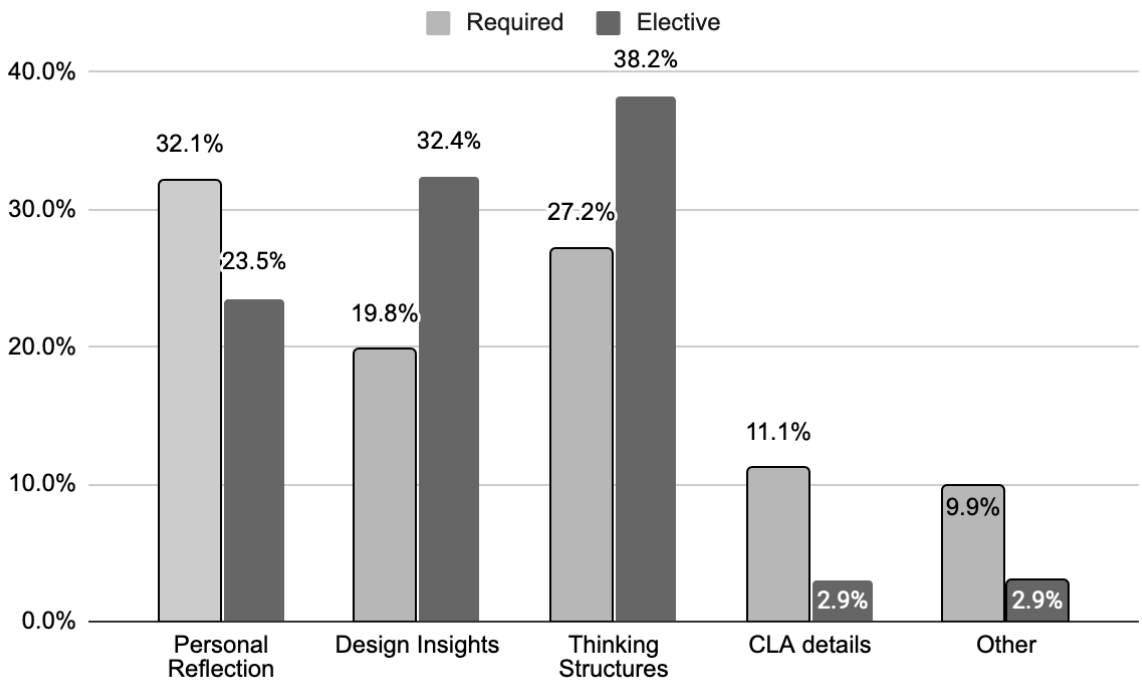

Fig 1: Bar graph with percent of codes for Required and Elective courses taught in 2019 and 2020

Table 2. Codes for CLA reflection texts by elective and required course offerings for 2019-2020

Course	Personal Reflections	Design Insights	Thinking Structures	CLA Details	Other	Total
Required	26 (32.1%)	16 (19.8%)	22 (27.2%)	9 (11.1%)	8 (9.9%)	81
Elective	8 (23.5%)	11 (32.4%)	13 (38.2%)	1 (2.9%)	1 (2.9%)	34
Total	34 (29.5%)	27 (23.5%)	35 (30.4%)	10 (8.7%)	9 (7.8%)	115

Required course students wrote more personal insights (32%) than elective course students (24%). Predictably, asking students to think about alternative possible career choices led students to personal insights. An undergraduate student in the Required course noticed that the CLA exercise bared myths and metaphors that explained past choices and decisions.

> "After conducting the CLA exercise, it became clearer how many of my choices are driven by these myths and metaphors that have been around me my entire life. With each layer of the CLA analysis, the layer before started to make more sense. I think this can be used in any sort of design practice. I can see how this could be used in even my own practice making physical products, as products oftentimes are created to change people's behaviors. I think that products are often created to touch on the litany level, but I believe that there should be CLA analysis during the design process to find insights that will lead to more meaningful items and change." - Participant 97

In the Elective section, an undergraduate student observes that CLA afforded to learn how different career alternatives might impact different layers of their reality.

> "I enjoyed exploring alternative futures and different career choices. From conducting the CLA on these choices, I definitely learned a lot about the impact that different careers could have and how each layer of reality could affect the future. As a designer, it would definitely be helpful to use CLA analyses on projects that are meant to be long-lasting in areas of constant change. This technique helps designers visualize preferable futures and see how their design can influence society, politics, the environment, and other factors in the future." - Participant 113

In the discussion section, I speculate why more students in the Required courses linked CLA to personal career choices than students in the Elective course. Interestingly, undergraduate students primarily wrote *personal insights* in the elective course sections.

Design insights describe students' ideas for how CLA could expand design processes and methods. Surprisingly, the undergraduate design majors in the Required class wrote fewer *design insights* codes (20%) than the Elective course sections for non-design majors (32%). The four layers of CLA allowed students to consider a broader area for possible design actions. An undergraduate student in the Required section proposes a new approach to problems from the inside out, expanding from behavior observed, the infrastructure needed, and more profound causes.

> "Learning about CLA taught me about how I could approach design problems from the inside out. I think that a lot of the time, we will be presented with a problem and look for solutions to that problem without really looking at the deeper causes. For example, let's say the problem is there's a lot of trash on the street. A "solution" might be to get more trash cans or punish people who litter; however, that is just looking at the litany. What is the deeper cause? What causes this excess of trash? Why do we create trash at all? Looking at these other layers helps you approach a problem from a different touchpoint creating better, or at least different, solutions. This would be very helpful when looking at wicked problems." - Participant 34

A graduate student in the Elective course section focused on how CLA allows designers to reflect on how a product might impact behavior, social systems/infrastructure, worldviews, and myths/metaphors.

> "CLA may be a good method to use when creating a new product. As a UX designer, I tend to focus more on the details of the interactions and often forget to view the impact of my designs from a higher level. By using CLA, I can take a step back and learn how the design of a new product impacts society at different levels (litany, social system & structure, world view, and myths & metaphors). This is especially relevant in today's world because technology is more intertwined in our daily lives, and a new product can have a major impact on users. I believe it is our responsibility, as designers, to create products that positively impact users. Furthermore, we should be designing products for a future we want to be a part of." - Participant 8

In the discussion section, I speculate on possible explanations for why undergraduate design students in the Required course wrote fewer *design insights* than in the Elective sections with undergraduate and graduate students (20% vs. 32%).

The *thinking structures* texts described how CLA's layers provided a structure to explore designed products, social issues, etc. Surprisingly, in the undergraduate Required course section, fewer *thinking structures* codes were written (27%) than in the Elective sections with both undergraduate and graduate students (38%). For example, an undergraduate student in the Required design majors section described how CLA's layered structure pragmatically allows one to envision paradigm shifts linked to product opportunities.

> "Litany and social system & structure are perhaps touched upon in every design project; less so worldview and myths/metaphors. It was interesting to think about the relationships between those last two CLA categories and one of the futures scenarios I had identified for myself; for example, they all centered

> around the American capitalist worldview of an individual's career being the road to financial and general well-being. CLA would potentially be useful in defining paradigm shifts, including those that surround a product or service. For example, identifying the myths and metaphors surrounding an automobile could reframe it from being a motor vehicle driven by an internal combustion engine with four wheels to a method of transportation. Through this, an opportunity for a change in how people think about transportation is possible: ridesharing services like Uber and Lyft have done exactly this by lowering the barrier of entry to point-to-point transportation by cars, and Volvo and startups like Canoo are redefining one's relationship to a car from a model of ownership to one of a subscription service." - Participant 40

A graduate student in the Elective section described how CLA provides a structured way to communicate with people about things that otherwise likely go unmentioned.

> "The most exciting thing I have learned from personal futures and CLA exercises is how to use visual and verbal language to depict visions of possible futures in a way that designers can continuously put in detail. Usually, when people talk about prospects, we are led by our emotions or ambitions. These futures in our mind shows our anxiety, desire, wish, a value we want to achieve, or even our subconscious. Information without structure cannot be understood or communicated. It is the primary reason why most of us have a hard time putting our different futures together and work with each other to realize them. The CLA tool solved this problem in a significant way. The structure it provides allows people to see pictures in each other's minds. These visions, arranged in layers, led us to discuss futures from a logical perspective. As a designer, I would consider using this tool in startups, experimental projects, problem-solving for next generations, and company strategy meetings when facing challenges in expanding the market." - Participant 19

In the discussion section, I speculate why fewer *thinking structures* codes were in the Required design-major sections compared to the Elective sections (27% vs. 38%).

The reflections coded as *CLA details* focused on differences in layers. For example, more *CLA details* codes were counted in the Required course section (11%) compared to the Elective sections with undergraduate and graduate students (3%). An example text from the required design majors section illustrates a student's understanding of the myths and metaphors in CLA.

> "CLA is a very useful tool for system Design Thinking , especially when it is a world-scale system problem such as global warming since it is going to involve different cultural groups and social backgrounds that makes coming to a consensus much harder. I find it interesting that CLA includes myth & metaphors as one of the scales since I think that metaphors and myths do represent the ideology and beliefs of a culture that is very hard to give terminology to. Similarly, myth and metaphors can also illustrate the subconsciousness of a certain demographic really well. I think talking about myth and metaphors collectively to understand a large-scale design problem will help us empathize with each other in a deeper way since stories can always connect people better than cold categories and terms." - Participant 54

In the Elective course, a graduate student focused on the myth/metaphor layer as more "subjective" than more "rational" aspects such as economic effects.

> "One thing special I think about CLA is the myth layer. Unlike other layers that are more about a rational fact, this layer is very subjective to person/culture groups, plus indicating to have the greatest contribution lies at the bottom of (the) pyramid. In previous methodologies for future analysis, the most important factor I considered was the economic effect. However, after this conscious motivation is mentioned, the analysis has become more human-centered. Also, the influence from bottom to top is more reasonable." - Participant 17

In the discussion section, I speculate why approximately three times more *CLA details* codes were found in the Required design-major section.

The *other* codes comprised approximately 10% of codes for the Required course sections and almost 3% for the Elective course sections. The *other* codes tended to be misconceptions of CLA or thematic tangents. For example, an undergraduate student's text in the Required design-major section questioned the usefulness of CLA, writing it off as an academic exercise with little practical utility in design.

> "CLA seems useful in very specific contexts to me, and I think it is easy to look at CLA as a very restrictive piece. Each higher-level contains the ones below it, which is indicative of the way societies are run. Myths and metaphors affect everything, including litany and social systems. And worldviews cannot develop without social structures at a higher level. Categorizing these isn't useless, but their utility is more for teaching purposes than for practical purpose; as designers, we should be engaging with all of these levels, if any, as they all go hand in hand." - Participant 89

The student's comment illustrates a gap in understanding how to use CLA insights to drive a design project. More practice opportunities are needed for students to learn to articulate design opportunities from CLA insights.

In an Elective section, a graduate student questioned whether the lower layers, such as myth/metaphor, could drive decisions and ultimately cause the layers above. The student claimed that other factors are at play in decisions, such as where to locate a factory, and questioned the role of myths/metaphors in economic decisions.

> "Causal layered analysis provides a framework for thinking about various influences on the future. The actual organization of the layers is hard to get a grasp on—the implication is that lower layers "cause" the layers above them, but this doesn't seem so true; claiming that things like myths and civilization-level culture are the drivers of say, what factories get placed in some particular place doesn't make much sense. There are also plenty of factors, including those that are probably most important for big-picture thinking about the future, that doesn't fit neatly into one of the categories and may cut across several. I don't think people who aren't trained in history, geography, ethnography, etc., should be making some of these judgments." - Participant 14

Scholars such as Steger describe globalization as linked to five dimensions (i.e., economic, political, cultural, ecological, ideological) and point out that the ideological dimension includes norms, claims, beliefs, and narratives (Steger, 2009). Such an argument proves that the deeper CLA layers are involved in economic decisions. Next, I speculate why approximately three times more *other* codes were in the Required design-major sections.

Discussion

I discuss observed differences in three sections: (a) differences in student samples, (b) Elective non-design major sections: more design insights and thinking structures, and (c) Required design-major sections: more *personal reflections*, *CLA details*, and *other* codes.

Differences in student samples

There likely are four differences in the Required and Elective course student samples: *initiative, life experiences, classroom discussion,* and *practice linkages*. First, *initiative*, non-design majors had to go out of their way to learn about the *Dexign Futures* course and sign up for it. Instead, the undergraduate design majors were enrolled by default in the third year unless they were on a study abroad semester. Thus, there could be a self-selection bias in the Elective course sections. Elective course students chose to take a class outside their department and major. Perhaps, the Elective course students were "risk takers" and more willing to explore new ideas? While there were initiative-prone students in the Required course sections, there also were students that questioned the utility of Futures Thinking methods.

Second, *life experiences*, the Elective course sections were more heterogeneous by major, age, and prior work

experiences. Instead, the Required course sections were all undergraduate students, more similar in age, and all received similar design training.

Third, *classroom dynamics*, a heterogeneous cohort with different life experiences, likely discussed a broader range of topics. For example, graduate students with prior professional experiences brought real-world dilemmas to in-class discussions. I remember the Elective course sections tended to be more engaged and have more lively discussions. The differences in class size likely affected classroom discussion dynamics as well. The Elective course sections had almost half as many students, making debate easier.

Fourth, *practice connections*, students in the Required course sections likely expected direct application of Futures Thinking methods taught in Dexign Futures course in their required studio course projects. However, two-thirds of the design majors took required studio courses with projects that lacked direct connections to the Futures Thinking methods taught. Instead, in the Elective course sections students forged links to their professional practices and interests. To summarize, I posit that it is easier to find connections when one knows to look for them and is in a group where the norm is to pursue such links collectively.

Elective non-design major courses: more design insights and thinking structures codes

The *design insights* code links CLA methods to design methods and process insights. I expected that design majors would describe more connections between CLA and design methods and processes. Instead, the Elective courses had more design insights than the Required course sections. Why might non-design majors make more connections between a future thinking method, design methods, and processes? First, there are two issues to untangle: (a) what kind of design are the design majors learning? And (b) what design problems benefit from future thinking methods? Then, I explore likely explanations for observed differences.

First, let us consider the *kind* of design that undergraduate design majors learn? In this article, *design majors* are students in the School of Design at Carnegie Mellon University studying communication design, product design, or environments design. Core design studio courses for third-year undergraduate design majors focus on traditional design (e.g., form-giving, Design Thinking). In short, conventional design methods focus on short-term opportunities and often ignore long-term sustainable development vision goals.

The integration of futures methods in studio courses is critical, though. For example, a fourth-year design student working on a studio project grounded in future trends wrote that CLA's layered structure was helpful to thinking through what to make instead of making stuff and then figuring out how products might fit into possible futures.

> "I'm currently in the Design Research Studio for seniors and a lot of the principles from this class have seemed applicable. Our entire project is about designing for emerging issues and the CLA would be a great tool to guide from the exploration phase to a more dissected phase. We're slowly transitioning into that phase and trying to understand how our projects can fit into the larger world, the different touchpoint we hit and imagining four different levels of a future reality. This would be a great step to use with my studio topic to look at it in more depth from a more analytic way instead of the process of making. …" - Participant 25

The student comment illustrates that Futures Thinking methods can help with design problems when exploring longer time horizons. Furthermore, I interpret the comment to mean that more care is needed to ensure that Futures Methods taught in *Dexign Futures* are received by studio course instructors and incorporated into their courses. *Futurizing* the design curriculum as a whole (Glenn 1972) is needed to allow students to integrate what they are learning in the *Dexign Futures* course into their design practices. The ultimate goal is to embed Futures Literacy as a core competency for designers.

I use "*design-major*" to refer to three specific design practices taught in the School of Design. More broadly, there are many other kinds of design practices. Examples include fashion design, interior design, interaction design, service design, social design, architecture, engineering, and so forth.

Unfortunately, the terms *design majors* and *non-design majors* may bias many toward unhelpful ideas around "designers" and "non-designers." Two examples include (a) territorial ideas about what "design" is and (b) who practices "design." Such false dichotomies are unhelpful with societal challenges where all kinds of disciplines are

needed to reinvent and design the transition to zero-carbon futures. Next, I describe a broader notion of design that reframes the boundaries of what is design and who is a designer.

Who is a designer? Nobel prize winner, Herbert Simon (1969), said, "Everyone designs who devises courses of action aimed at changing existing situations into preferred ones." If everyone designs, then more exciting distinctions are about the kinds of design they are engaged in and if pressing societal challenges are made better or worse by such efforts. What kind of "design" do design majors and non-design majors practice? What materials are they shaping? What design methods and design processes are used? What problems/opportunities are they finding, framing, and solving? Are new methods needed? How does Futures Literacy play a role in their design practices?

How might broader conceptions of design link to Futures Thinking and CLA? It depends on the design problem/opportunity pursued. Most design major students expected their studio course instructors to forge connections between Futures Thinking and more traditional versions of design focused on short-term concerns. Instead, students in the Elective section likely sought to connect Futures Thinking methods to their majors (e.g., Art, Architecture, Human-Computer Interaction, Sustainability Studies, Social and Decision Sciences, Entertainment Technologies). Next, I describe design problems that benefit from Futures Thinking methods such as CLA.

Even traditional design problems that operate at the litany level, like creating a desirable service/product, can significantly benefit from CLA in two ways: (a) when services/products target different cultures and contexts, and (b) to help create behavior change transitions. CLA significantly helps with societal-level transition problems, such as Climate Emergency, Sustainable Development Goals, Global Pandemics, etc. Such challenges require alignment between short-term design action with long-term behavior change goals. Furthermore, the current situation might differ from the desired situation on multiple levels (i.e., behavior, infrastructure, worldview, myths/metaphor). The layered perspectives of CLA help designers identify design opportunities on various levels.

Why did non-design major Elective courses produce more comments coded as "*design insights*"? Two possible explanations include (a) the graduate students in the elective non-design majors section likely had prior work experience. They discussed the practical applications of CLA to projects they might encounter in the workplace. Students with valuable work experience probably sensed strategic opportunities to frame practical design actions. For example, we discussed: How might CLA be used to shift behavior in the sharing economy? How might rideshare companies (e.g., Uber, Lyft) and home-sharing companies (e.g., Airbnb, VRBO) get people to trust strangers with their cars and homes? (b) The combined effect of such in-class discussions likely explains why more significant percentages of students wrote reflections about practical design insights (e.g., design methods and processes). Even undergraduate students lacking real-world work experience likely benefitted from participating in such in-class discussions.

The *thinking structures* code refers to how the layered structure of CLA provides scaffolding to structure complex problems. CLA's structured layering allowed students to think more clearly in a step-by-step fashion about complex societal issues. Much like the *design insights*, the more significant discussion of real-world challenges in the Elective classes was associated with more reflections coded as *thinking structures.*

Suggestions for Improvement for Design Majors

How might CLA be taught to inform design methods and processes? I suggest three ways: (a) add design-based CLA case studies, (b) provide CLA-inspired applied design exercises, and (c) differentiate CLA applications in design.

Add Design-Based CLA Case Studies

First, add detailed case studies with real-world examples illustrating how Futures Thinking and CLA link directly to design methods and processes and discuss them in class. A series of case studies on real-world challenges analyzed through the lenses of CLA could help students to learn to think through the layered complexity present in such cases. Students should practice using CLA as an analytical tool.

Provide CLA-Inspired Applied Design Exercises

Informed by the detailed CLA case studies, students would then do applied design exercises. The applied design exercises help students learn to use CLA as a generative tool to find strategic design opportunities.

Differentiate CLA Applications in Design

Students should learn to apply CLA to different kinds of design, such as short-term form giving (traditional design) and design for long-term societal level problems. First, regarding traditional core design studios, Futures Thinking methods such as CLA can be used to understand how to situate products/services/environments within specific cultures. Also, how might a particular product/service be modified to fit into a different culture or market segment? Course instructors should coordinate case studies with the required core design studios. Second, for long-term design problems, CLA could be used to understand the status quo situation and imagine the future desired situation. Each level of CLA could be a starting point to brainstorm layered strategic design opportunities.

Required Design-Major Courses: More Personal Reflections, CLA Details, and Other Codes

Personal reflections focused on students' future careers were more common in the undergraduate Required design-major sections. CLA allowed students to explore career options at depths previously inaccessible, yielding new insights. Their reflections tended to comment on how powerful the CLA tool was in providing new insights. In the Elective section, undergraduate students wrote most of their *personal reflections*. Perhaps, undergraduate students were more concerned by the uncertainty of their post-graduation careers compared to graduate students with previous work experiences?

More codes for the *CLA details* and *other* codes were counted in the Required courses. One explanation might be that 11% of the undergraduate students in the Required course focused on the inner workings of CLA. In so doing, they avoided the more complex task of seeking connections between CLA and design methods and processes. Teaching assistants graded the reflections as done, not the correctness or specific content discussed.

In the Required courses section, close to 10% of students' reflections were coded as *other;* they described tangential aspects or misconceptions of CLA. Why are approximately three times more *other* codes in the Required course sections compared to the Elective sections? Possible explanations previously discussed include different class populations leading to differences in initiative, life experiences, classroom discussion, and links to design practices. In the Elective sections, the classroom discussions involved innovative uses of CLA. Given the livelier class discussions, when students came to writing their weekly reflections, they had more ideas to write. Instead, in the Required design-major class, a more homogeneous student population might have limited discussion topics around possible applications of CLA. Perhaps, the little discussion led students on tangents, and their comments ended up coded as *other.*

One of the stated goals of the Dexign Futures courses was to get students to fuse Futures Thinking methods into their Design Thinking methods and processes. However, suppose we add the percentages of *personal reflections, CLA details,* and *others*. In that case, it becomes clear that approximately 53.2% of the design-major students and 29.2% of the non-major students failed to reflect meaningfully on applications of CLA to design methods and processes. Therefore, I interpret such percentages as invitations to change how I teach CLA in the Dexign Futures courses.

Suggestions for Improvement for Design Majors

What are some implications for teaching CLA and other futures thinking methods that emerge from the discussion of the *Personal Reflection* codes? I chose the alternative futures assignment because students are experts in past decisions about the studies and careers they considered pursuing. Students used CLA to understand a possible future for themselves much more profound than they had experienced previously. It was motivating for students to focus on questions that had personal relevance.

While the exercise was good because it built on preexisting material that the students understood and cared about, an explicit limitation emerges. Undergraduate students greatly appreciated how CLA could be used in their own lives but missed the opportunity to apply CLA to design for societal problems.

Close to 32% of the Design majors in the Required course sections and 23% of the non-design majors in the

Elective course sections focused on using CLA to explore their personal futures; missing the more significant opportunity to explore how CLA can inform design methods and processes or as a thinking strategy to mine complex societal challenges for design opportunities. In the next iteration, I plan to replace the personal alternative futures exercise with a societal level problem as a case study. In addition, future research will allow me to determine if the content of the alternative futures assignment leads students to different insights when learning to apply CLA.

What insights might we infer from the *other* codes discussion regarding teaching CLA? As mentioned previously, it seems clear that the students benefited from more opportunities to delve into applying CLA to design problems. Students could learn specific design methods that have CLA embedded into the design processes.

Limitations and future work

This study was a natural experiment. One instructor taught the same course to two different types of students. However, given the three differences between the two groups, it is difficult to untangle the effects that each variable might have had (a) required/elective course; (b) design majors/non-design majors; and (c) only undergraduate vs. a mix of undergraduate and graduate students. Future work is needed to test each variable. However, changing the CLA assignments and randomly assigning students to different reflection questions can provide insights into the efficacy of the proposed changes. Next, I summarize the key insights from this article.

Summary

Traditional Design Thinking methods are insufficient for societal-level challenges such as transitioning to Zero-Carbon goals by the year 2050. New design methods are needed to align short-term design actions with long-term vision goals. This article illustrates how the field of Futures Studies can play a critical role in Design practice and design pedagogy.

I described a course called *Dexign Futures* that teaches students to combine Futures Thinking with Design Thinking to create new design methods for societal-level challenges. I teach *Dexign Futures* with an active learning flipped-classroom pedagogy through five activities: online learning, mini-lectures, demonstrations, small group in-class workshop activities, and a weekly reflection/discussion.

Students learned about CLA online by watching videos, reading, and answering interactive questions with correctness feedback. In one class session, students explored their personal futures through an alternative futures exercise. Then, students used CLA to explore one possible future in the next class session. Each class session had an in-class discussion about the CLA material covered online before the in-class sessions. Finally, students wrote an end-of-week reflection on alternative personal futures using CLA and were asked to consider how CLA could be used in design methods or processes. I coded the student reflections with five codes: *personal insights, thinking structures, design insights, CLA details,* and *other*.

I described how non-design and design majors engaged with CLA in their reflections in two separate versions of *Dexign Futures* courses taught in 2019 and 2020. On the one hand, in the Elective course, non-design majors' sections had higher percentages of *design insights* and *thinking structures* than the Required design-major course sections. On the other hand, the undergraduate students in the Required design-major sections wrote more texts coded as *personal reflections, CLA details,* and *other*.

Four differences in the Required and Elective student populations likely explain part of the differences observed: (a) undergraduate vs. graduate student real-world experience; (b) homogenous learning experiences for the design-major students in the required course sections vs. diverse student experiences for non-design majors in the elective course sections; (c) self-selection bias in the elective course sections possibly lead to students seeking more agency over learning; (d) on the one hand, as a required course, the *Dexign Futures* course was part of the design school's curriculum, leading students to question the limited integration into the more traditional design methods taught in core studio courses. On the other hand, students in the elective course sections had no such expectations, and more speculated about how CLA might be used in new design methods and processes.

Key differences observed between the Required and Elective course sections lead me to propose three changes to how to teach CLA to undergraduate students. First, the current teaching methods described work well to engage students but could be more successful in getting students to apply CLA to design methods and processes. In the

future, the Required course sections should align Futures Thinking methods with assignments taught in core design studio courses. Second, instructors should provide case studies with real-world examples of how to use CLA for design problems. Such case studies allow students to appreciate the layered complexity that CLA uncovers. Third, provide practical design exercises that enable students to practice using CLA within design methods and processes. Like this, students can use CLA to make sense of real-world examples and apply CLA to design projects that require short-term design action alignment with long-term vision goals. Future research is needed to assess the validity of these teaching recommendations. In conclusion, when and how design students learn Causal Layered Analysis matters, but more research is required.

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