Teaching Design Systems: Towards a flexible and scalable model for the UX classroom

Emma J. Rose
School of Interdisciplinary Arts & Sciences, University of Washington Tacoma
ejrose@uw.edu

Craig M. Macdonald
School of Information, Pratt Institute
cmacdona@pratt.edu

Cynthia Putnam
College of Computing and Digital Media, DePaul University
cputnam@cdm.depaul.edu

ABSTRACT

One of the most important emerging trends in the field of user experience (UX) is the creation and use of design systems, which are a collection of documented elements that embody an organization's design rules and principles. While design systems are becoming ubiquitous among organizations, especially those with mature design practices, few academic programs teach students how to use or create them. In this experience report, we share details on how we incorporated design systems into assignments and courses in three different academic programs. In this experience report, we provide a definition of design systems and introduce a scalable and flexible model for teaching them. We reflect on our motivations, insights, and lessons learned from implementing this model.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); • **Social and professional topics** → Professional topics; Computing education; Model curricula.

KEYWORDS

design systems, UX pedagogy

ACM Reference Format:
Emma J. Rose, Craig M. Macdonald, and Cynthia Putnam. 2022. Teaching Design Systems: Towards a flexible and scalable model for the UX classroom. In *The 40th ACM International Conference on Design of Communication (SIGDOC '22), October 06–08, 2022, Boston, MA, USA.* ACM, New York, NY, USA, 7 pages. https://doi.org/10.1145/3513130.3558985

1 INTRODUCTION AND IMPETUS

In the Spring of 2020, as the world was heading into a lockdown due to the COVID-19 pandemic, we were wrapping up the first part of a large-scale research project interviewing user experience (UX) practitioners about their work. The goal of the ongoing research project is to better understand industry practices to inform how we teach UX. We all teach UX in our universities, but our academic programs and student bodies are quite different; our programs include (1) undergraduate technical communication students, (2) graduate students in a design program and (3) graduate students at a Human-Computer Interaction (HCI) program. In the research project, we interviewed 71 experienced UX practitioners. Results of this research include skills expected of UX practitioners [1], insights into UX communication practices [2], how the industry has changed over the past decade [3], and how UX teams focus on accessibility [4].

During data analysis, we were struck by how important design systems were becoming in industry. Once we started hearing about design systems in our interviews, we saw them everywhere. Some students in our programs started mentioning they were being asked about design systems in job interviews and were not prepared to answer questions about them. Guest speakers from industry were emphasizing the importance of design systems and why students needed to understand them. While we were witnessing the rise of design systems in the field at large, we were seeing and hearing very little about how university programs and UX instructors were teaching design systems. This disconnect seemed like a case where industry practices had outpaced academic instruction. Given that one of the overarching goals of our research project is to align academic instruction in UX with industry trends, we were eager to examine how to teach design systems to our diverse student audiences.

In this experience report, we present a flexible and scalable model to teach design systems. First, we define design systems. Second, we articulate why they are challenging to teach while also encouraging instructors to embrace the challenge. Third, we present the model which is composed of three units on a spectrum of complexity: Deconstruct, Use, and Create. We define each unit and also present a case of how the unit worked in practice. We conclude by reflecting on the successes and challenges of the model.

2 WHAT ARE DESIGN SYSTEMS?

A design system is a collection of documented elements that embody the design principles and rules of an organization [5]. Design systems include reusable components that help create a uniform user interface (UI) and increase efficiency for cross-functional teams. This includes typographical hierarchies, color palettes, logo use, animation, UI components (e.g. buttons, forms, navigation menus) and rules describing visual and interaction design patterns.

Design systems tend to be used by organizations with mature design practices. Though design systems need "multiple cross-functional teams to actively participate and contribute to its creation and maintenance" [6], they offer a variety of benefits [7]. First, they help to ensure consistency across various interfaces, applications, and modes which provides for a more predictable

SIGDOC '22, October 06–08, 2022, Boston, MA, USA

ACM ISBN 978-1-4503-9246-4/22/10.
https://doi.org/10.1145/3513130.3558985

experience for users [8]. Second, they help designers and developers be more efficient with their design and coding by reusing system components and improving communication across design and development teams [9]. Third, they help organizations implement important standards, such as accessibility, to provide more inclusive design experiences [4].

Design systems may sound similar to other approaches for bringing consistency to communication. According to Shanbhag, different tools function at different levels of abstraction of a design language [6]. The lowest level is a style guide that defines colors, typography, logos, branding, and tone, and the purpose is to define the visual styling of components and the tone of a system. The second level of abstraction is a pattern library, which contains a style guide plus templates and code snippets with the purpose of defining both visual and interactive components and minimizing code discrepancies. The highest level of abstraction is the design system which includes style guides and pattern libraries plus design tokens and technical specifications [6]. Design systems, while growing in popularity, are still a flexible and fluid concept and subject to change over time as they are adopted and adapted.

One of the advantages of learning about design systems is that many companies that create them make them publicly available. This is helpful both as instructors prepare to teach them and for students to see examples in action. Some of the most popular design systems are: Material design from Google: https://design.google/resources/, Fluent from Microsoft: https://www.microsoft.com/design/fluent/, Atlassian's Design System: https://atlassian.design/, and US Web Design System: https://designsystem.digital.gov/ just to name a few.

3 WHY ARE DESIGN SYSTEMS CHALLENGING AND WHY SHOULD YOU TEACH THEM ANYWAY?

While there is a growing interest in UX pedagogy [10, 11], there is relatively little conversation about how to teach design systems within UX, HCI, or Technical Communication (TC) courses. Conceptually, many students lack a mental model for design systems. A mental model is a "relatively enduring and accessible, but limited, internal conceptual representation of an external system whose structure maintains the perceived structure of that system" [12]. We found that students often lacked a conceptual understanding of object-oriented approaches to programming or design which would help them understand design systems. In object-oriented approaches, each object is self-contained which allows for re-use of code, ease of troubleshooting, and flexibility. The exception here are students who have a computing background, but many of our students do not have coding experience or literacies which makes understanding the details of design systems challenging. While it is possible to learn about a design system without having deep coding knowledge, many students need scaffolding and bridging concepts to be able to do so.

Logistically, much existing UX coursework occurs at a tool or method level. Students are learning how to use tools and technologies to produce design deliverables such as documents, prototypes, and interactive designs. Students also learn how to conduct UX research such as interviews and usability studies. UX instruction also happens at an individual level as students work to acquire knowledge and practice their new skills. As students progress, they often engage in group learning experiences and learn valuable skills of communication and collaboration. However, students are still working in relatively small units and not in complex settings like those in which design systems are used, i.e., a multi-functional teams within a rhetorically rich and complex organizational context.

Practically, design systems pose problems for instructors who may lack both the content knowledge and the pedagogical content knowledge, meaning how to teach that particular concept [13]. Given the industry-centric nature of design systems, there are currently no best practices or agreed-upon methods for teaching them. Further, a recent study found that instructors teaching UX often doubted their ability to teach the subject due to a lack of training or industry experience [11]. Due to the highly technical nature of design systems, some UX and HCI instructors may not have the confidence or skills to teach coding and have to gain existing tool knowledge from tutorials. Finally, in regards to students working in teams, instructors may struggle to build successful collaborative projects when students have varying levels of coding and technical literacies.

Despite the complexity and challenges of design systems, we believe it is important to teach them in the classroom, which is the motivation behind this experience report. First, teaching design systems is an excellent opportunity to talk about designing for people with disabilities. Design systems make the move from accessibility being an ad hoc concern based on individual commitments to one that is institutionalized and literally coded into a system from the bottom up and the top down. Not only does this make for good design, it helps students appreciate the need to make structural change - in this case, to support accessibility - but it can also be a jumping-off point to discuss how access and inclusion can be built into systems at the foundational level rather than added on or retro-fitted. Second, design systems provide abundant opportunities to engage with complexity in the classroom. While they can be challenging, frustrating, and disorienting for students who have little experience with object-oriented thinking or technical coding, they can provide opportunities for students to stretch beyond their comfort level. In addition, by incorporating group work and collaboration, well-known to be high impact teaching practices [14], students can learn how to negotiate and support one another. Third, design systems are an illustrative example of how fast-moving the pace of industry practice is. It is helpful to share with students that if they want to be successful in UX it requires constant learning of new approaches and practices throughout their careers. Even if students aren't planning a UX career, learning about design systems can help introduce them to systems thinking and create conceptual connections between other aspects of writing and design.

4 DESIGNING A FLEXIBLE AND SCALABLE MODEL

Given that we teach in three very different programs, we wanted to develop a model that was specific enough to provide instructors with a focused plan for their curriculum but also flexible enough to modify depending on the institutional and learning context for the students. In this section, we describe the model and provide three

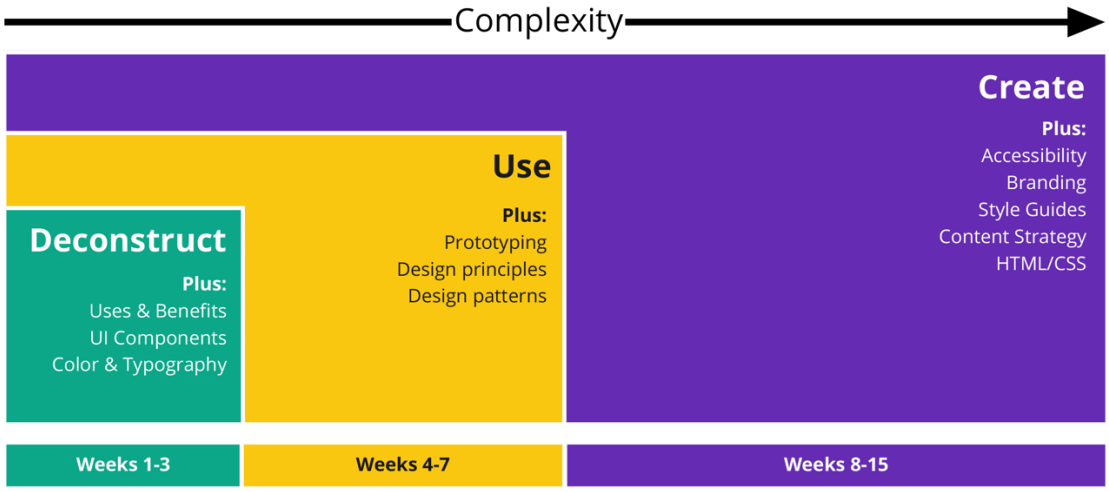

Figure 1: A model for teaching design systems

cases explaining how we implemented each piece of the model in our different contexts.

The model consists of three overlapping units on a spectrum of complexity: Deconstruct, Use, and Create (see Figure 1). In Deconstruct, students are asked to reverse engineer a design system by auditing an existing interface. In Use, students are asked to create something based on reusable components from an existing design system. In Create, students are asked to create a new mini-design system with the option of using an instructor-created template. In this section, we will define each unit and then provide a case of how the unit was implemented.

4.1 Deconstruct

In the first unit, students are asked to deconstruct an implied design system of an existing website by working independently to identify as many repeatable elements as possible. This assignment has three learning goals: 1. Understand and articulate the definition of a design system, 2. Notice how websites are being implemented, what components are used, where, and how, and 3. Audit a specific site and document understanding of the repeatable patterns. To do so, students examine an agreed-upon website and create a deliverable to document the implied design system of the website. The document should be well organized, highly visual, and include screenshots and descriptions of reusable components implemented by the website.

Choosing the right website for all students to work on is important. Many technology and consumer product companies that have mature design practices will have a robust design system in place and oftentimes the design system is posted publicly. These examples are less helpful for this assignment because they have coherent and consistent designs and if their system is publicly available, it gives all the details to the student. Rather, aim to choose a website that is large and complex enough that students can compare a variety of pages and templates and also one where the content or topic is relatively approachable and may resonate with students. Good examples here include websites belonging to universities or government organizations. It is helpful to choose one website that the class will focus on so students can compare their deliverables.

By completing this assignment, students will learn to notice repeating elements like color palettes, typography, content style, page templates, and more. It is also helpful to encourage them to identify areas of inconsistency where a design system would help rectify an existing issue. Using their deliverables, students can be placed in groups to look at what aspects of the design they noticed or did not notice. In addition, this activity can be paired with an accessibility audit of a website to identify areas that have issues that need to be corrected.

4.1.1 Case 1: An undergraduate technical communication course in a Writing Studies program in a School of Arts and Sciences. The first author teaches at a primarily undergraduate regional state university in the Pacific Northwest. She teaches in a technical communication track of a Writing Studies major. She introduced design systems into an Advanced Technical Communication class in the Winter quarter of 2022. This is an upper-level undergraduate course that primarily attracts students in the technical communication major or minor and all students were Juniors or Seniors. The ten-week class was designed as an in-person course that met twice a week. However, due to COVID-19 the class met synchronously online for the first 5 weeks and then transitioned to in-person for the last 5 weeks. This transition made for significant disruption to the class and may have impacted the students' experience. The unit on design systems was introduced in week 7 and students focused on this unit for the remaining 3 weeks of the class. In this class, both the Deconstruct and the Use units were included, but here we just discuss Deconstruct.

Prework and scaffolding. Earlier in the course, students spent time learning about using styles in Word. This concept was introduced in a section on document design and accessibility. Students

learn about the importance of separating form from content and how styles helped to create structured content to aid in accessibility and more easily transform the global look and feel of a document.

When introducing design systems, students were asked to read several articles, including an introductory text, "Design Systems 101" [15] , a conceptual reading, "Design System From a New Perspective" [16] which uses the metaphor of cells, and a reading on the connection to accessibility, "Building Accessibility into Your Design System" [17]. Students also completed an online training module that delved deeper into concepts of design systems. They completed an online course called "Design Systems for Everyone" [18] and were asked to write a reflection on the key concepts of what they had learned.

Implementation. To implement the Deconstruct unit, students were asked to deconstruct the implied design system of their university's website (https://www.tacoma.uw.edu). This site was a good choice for the assignment because it did not have a publicly available design system but did have a detailed and available style guide. This allowed students to find the official recommendations for elements such as colors and typography but it was not a fully defined design system. In addition, choosing a university website to focus on worked well because it was not overly technical and students had a good understanding of the content. Further, as we are one of three campuses that adhere to the branding guidelines, students were able to see how consistently or inconsistently they were applied across multiple related sites which helps to explore the challenges of maintaining consistency across large, complex websites.

Students created detailed documentation that helped identify patterns on the existing website and identify which patterns could be the building blocks of a design system. First, they created a draft document that contained details about the purpose and audience of the website and documented the implied design system including layout/components, fonts, colors, branding, and tone. Each element had to include an example screenshot, which was appropriately labeled, and an explanation. Second, students participated in a peer review session where they swapped documents with two other peers and provided detailed feedback. Third, they iterated the document to make improvements based on feedback from their peers and instructor. They turned in the final version with an accompanying memo that asked them to reflect on what they learned from completing the assignment, how they made changes based on feedback, and what they might do if they had more time.

Assessment. Overall, the assignment worked well. Students produced high-quality deliverables documenting the implied design system of the university's website. Students were able to take concepts from the readings and the online course and apply them to an existing website to speculate how a design system could be created from the existing components. The reflections showed that even though most students were not proficient coders or web designers, they reported that the activity provided them with opportunities to get more familiar with the intricacies of web design. Looking closely to analyze the website helped reveal inconsistencies and pointed out how a design system could benefit the site to ensure consistency and improve the user experience. Some students described the activity as fun and interesting; others described it as challenging and frustrating but appreciated learning about a concept that they had no previous experience with. Students also mentioned that larger websites were more complex than they had previously realized, and some noted how they were able to see how all of the individual components added together made up the larger systems. Below are some representative comments from students' final reflections which are presented here with student permission.

"I found this assignment to be quite fun. . .I now understand the importance of a design and in particular a very informative one. Currently, at my day job, I am in the midst of re-designing our website. Because of this assignment, I have been able to translate what I am doing for homework to my daily life."

"I wouldn't call this one of those whooping good time projects, rather it was a rip my hair out not sure what I'm doing or what I should include, but...at the end of the day...I'm thankful I went through the process. . ."

"I honestly feel like I learned a lot from this assignment. One of my biggest takeaways is definitely that web design is just as complicated as I suspected it was. There is so much work that goes into websites that we take for granted. . ."

The assignment was a helpful conceptual introduction to design systems that allowed students to build some foundational understanding of what they are and their benefits.

4.2 Use

In the second unit, Use, students use an existing publicly available design system to transform the look and feel of another website. This assignment has three learning goals: 1. Appreciate and demonstrate the portability of design systems, 2. Use (or attempt to use) an existing design system, 3. Learn a design tool of your choice to strengthen your technical skills.

This assignment was inspired in part by an article from the UX team at Atlassian, who documented their experience using their own design system to design something new as a way of building empathy for designers and evaluating how well the components were working [19]. Using Atlassian design system, the team developed new sites for other products (like Spotify, YouTube, and AirBnB).

For the assignment, students choose a publicly available design system, such as Microsoft's Fluent or the US Web Design System, and familiarize themselves with it by reading the documentation and looking at the visual examples. If available, students should download the public design files to use in a prototyping tool such as Adobe XD, Sketch, or Figma and use those components to make a new version of an existing website. They can use a prototyping tool like Sketch or Figma and work directly from the design files or, if the barrier of learning a new tool is too high, they can also mock-up a version in Google Slides or PowerPoint. This assignment can be combined with the Deconstruct assignment or students can choose a new site. Students are encouraged to choose at least two pages to redesign: the home page and then a deeper level page. They present their results in either a document or slide deck that includes screenshots of the new design and a list of the elements they implemented. An optional activity includes a peer review or presentation of their results. Finally, students produce a reflective memo that asks them

to think about what they learned, what feedback they received, and how the feedback helped make improvements to the final version.

While it is possible to work in teams, students benefit from completing this assignment individually. The technical nature of the assignment encourages them to engage with the real struggles they might encounter when using a design system. Putting students into peer groups to help support and provide feedback can be a productive way to give students support for the technical hurdles they encounter.

4.2.1 Case 2: A Graduate UX Design Program. The second author teaches at a private university in the Northeast specializing in art, architecture, and design education. He teaches in a graduate-level masters program in UX design that emphasizes preparing students for professional UX careers. A new UX Design Systems course was developed in 2021 but its offering was postponed from spring 2022 for administrative reasons. Instead, the teaching model was piloted with two students working with the second author as part of their graduate assistantship with the Center for Digital Experiences, a university-affiliated research center that connects students with real-world UX projects. The project was introduced to the students in mid-February of 2022 and lasted for approximately 11 weeks (out of a 15-week semester). Each student devoted 4-6 hours to the project each week for the duration of the project, though they each had additional responsibilities that occasionally took precedence. Since it was not a course-based project, there were no lectures or graded assignments; instead, we had bi-weekly check-ins where the students provided updates on their progress, asked questions, and received feedback and direction. At the conclusion of the project, each student was asked to complete a brief reflection about their experience.

As an example of the Use unit, the two graduate students were directed to choose any page from the Center's website and redesign it (both a desktop and a mobile version) using any publicly available design system. They were instructed to adopt the branding assets and guidelines from whatever system they chose to use. Each student completed this exercise independently, though they were encouraged to communicate with each other if needed.

Prework and scaffolding. Prior to doing this exercise, the prework phase included giving students a Google document with a list of relevant resources about design systems, direct links to 11 publicly available design systems, and a high-level summary of what a design system typically consists of. They were directed to spend time reading through the articles and exploring one or more design systems until they felt confident that they understood what they were, how they're structured, and what's in them. Next, the students also completed the Deconstruct unit on the research center's website. Both students had already taken at least two design-focused courses prior to starting this project so they were both comfortable with Figma and had a solid understanding of UX design principles and patterns.

Implementation. For the exercise, one student chose to use Adobe's Spectrum design system while the other used Microsoft's Fluent design system. Both chose to redesign desktop and mobile versions of the Center's homepage. Although the students weren't given any explicit instructions or step-by-step guidance, they both followed a similar approach: first, they each created a reference frame in Figma that contained the relevant elements from the chosen design system. Next, they added screenshots of the page being re-designed (one desktop, one mobile). Finally, they re-designed each page using the elements from the reference frame.

Students created their redesigned pages directly in Figma and shared them for review and discussion in one of our bi-weekly meetings. They were asked to walk through their process, describe which components they used and why, discuss any challenges they faced, and explain what they learned from the experience.

Assessment. Both students were able to complete the exercise successfully. Both the Spectrum-inspired and Fluent-inspired versions of the center's homepage were cleaner and more consistent than the original version. Both students effectively applied the guidelines related to typography, color, button style, and layout, on both mobile and desktop screen sizes. The students noted that although this exercise was challenging, they found it useful in helping them better understand how systems guide but don't dictate design work. As one student explained:

"I think that redesigning a page using an existing design system was a really useful exercise to help me understand how a design system works and how to apply those design guidelines to an interface."

Importantly, the exercise demonstrated to students that using a design system is not about simply choosing from a set of components and placing them on a page. Rather, it is a challenging, multi-step process that requires a deep understanding of (1) the design system, its components, and its principles; (2) the page(s) and the content being re-designed; and (3) the prototyping tool (in this case, Figma).

4.3 Create

In the third unit, Create, students create their own mini-design system. This assignment has three learning goals: 1. Create a new UX mini-design system that adheres to usability and accessibility best practices, 2. Effectively apply choices about color, type, layout, and imagery to create a cohesive and aesthetic set of reusable components, and 3. Show proficiency in the use of digital tools for the creation of digital interfaces.

This assignment is an opportunity for students to pull together all the design and prototyping knowledge and skills they have learned throughout the program and apply it to the creation of a novel mini system. For continuity, the project can be combined with the Deconstruct or Use unit or students can focus on creating a design system for their own personal website/portfolio, another website or product they are familiar with, or one chosen by the instructor.

Due to its size and complexity, instructors should purposefully guide students through the process by breaking the project into clear milestones tied to achievable goals. For example, students can first create a style guide with basic UI elements (i.e., typography, colors, buttons, navigation) and then gradually expand the system over a period of weeks with more complex UI components (forms, cards, articles, etc.), design principles, page templates, and usage instructions.

A major consideration for instructors is the desired final format for the design systems. If the students have more of a technical

focus, instructors can have them design and code their entire system using Bootstrap or a similar CSS framework. If students are less comfortable with coding, instructors can have them design the system entirely in Figma (or another prototyping tool). Instructors should carefully weigh this decision and ensure that students have the requisite knowledge and skills prior to starting the assignment.

Another important consideration is whether students work in teams or independently. Having students working independently is appropriate when the Create unit is limited in scope or if students are free to select a project of their choice (e.g., their own personal website). Using a team-based structure is useful because it reflects real-world industry practice, where creating design systems is a highly collaborative process involving individuals from multiple disciplines. If instructors choose a team-based approach, they should assign some portions of the work on an individual basis to ensure each student has an opportunity to apply their skills.

4.3.1 Case 3: A graduate HCI program in a School of Computing. The third author teaches at a non-profit private university in the Midwest. She redesigned an advanced design course in Fall 2020 to include design systems. Due to COVID-19, the eleven-week course was initially designed as an online course with recorded lectures and online meetings once a week. Meetings focused on Q and A, workshops and critiques. The course has gone through minor iterations through the nine times it has been offered to date. Additionally, post COVID-19, three of the online meetings have been replaced with recorded on-campus meetings.

Prework and scaffolding. Prerequisites for the course include introductory courses in HTML/CSS, JavaScript and an introductory design course. Early in the quarter students complete several tutorials on software tools that include Bootstrap which is typically new to them. Other assignments in the first five weeks include the creation of typographical hierarchies, color palettes and logo designs, all of which are later incorporated in their mini systems.

Implementation. For the Create unit, students focus on a website of their choice, which most often is their portfolio. Their mini-systems are required to include (1) a 'Foundation' area with typographical hierarchy based on a modular scale, a color palette, and a logo, (2) a 'Components' area in which they detail at least three Bootstrap components (e.g., buttons, navigation) they are using including how their components consider accessibility and how to code them, and (3) a 'Patterns' area in which they mockup two pages of their website in three sizes, phone, tablet and desktop.

While introduced early in the quarter, the lectures in the sixth week of the quarter focus solely on design systems. We discuss why they are becoming common in industry, what they typically contain, and walk through several examples. In the seventh week of the quarter, we invite professionals who have implemented and/or worked with design systems to speak about their experiences.

In the last four weeks, students focus on their mini system through four phases. In the first two phases, they lay out their website design in an interface design tool (Adobe XD or Figma). In the third phase, they create their mini systems by leveraging the previous week's assignments for the 'Foundations' area and exporting their artboards from the design tool for the 'Patterns' area. In the final phase, they create two pages of their website (content placeholder) using their mini system as a guide.

This course required some iteration and refinement in response to a spectrum of students' understanding of HTML/CSS. As such, the instructor created multiple video tutorials in Bootstrap to supplement their learning. Additionally, she created a Bootstrap template for their interactive systems (they can choose not to use it) to help them focus on their design rather than the coding of the system itself.

Assessment. The course generally goes well for students. In an end-of-quarter reflection, many include comments about how learning about systems improved their technical skills and increased their confidence. For example, in a submission in winter 2022, a student wrote:

"I feel more confident in choosing a certain path for a project because I have learned the concepts that explain what needs to be done, even if they do not show you how to do it. For example, I know the reasons a design system is useful and the important elements to include in a design system. I would feel comfortable putting together a design system now because I know the process."

Three excellent student examples of a mini system all using the instructor-provided template can be found at:

- https://www.cyputnam.com/StudentDesignSystems/Anh/
- https://www.cyputnam.com/StudentDesignSystems/Dana/
- https://www.cyputnam.com/StudentDesignSystems/Rahul/

5 CONCLUSION

Overall, we learned a great deal about design systems both in terms of content knowledge and pedagogical content knowledge by developing and implementing this model. One of the key strengths of developing this model was based on developing an approach that could work in our three unique programs. A key part of our development process were weekly meetings in which we shared approaches, successes, and challenges. These ongoing discussions helped us deepen our own understanding of how to teach design systems and also reflect on the uniqueness of our students and the learning goals for each class.

Reflecting on the model itself and our experiences using it to teach about design systems, it was clear that the technical background of students was a key factor in introducing design systems. We learned that providing students with hands-on experience, whether taking an online course in design systems, using prototyping tools, or coding, was key to building a solid foundation of knowledge and skills. That said, given the range of students we were teaching, it was important to meet them where they were in terms of conceptual and technical skills and scaffold the concepts for them. We plan to continue to apply and iterate this model over the coming terms and plan to share our experience and lessons learned in future publications. We hope this model is helpful to other instructors and look forward to hearing feedback and adaptations of this model in other learning contexts.

ACKNOWLEDGMENTS

The authors would like to thank DePaul University for their financial support of the research that led to this pedagogical model. They would also like to thank the following students who agreed

to have their assignments or words shared in this paper, including Kassandra Jones, Croix Stone, Denise Tucker, Cathy Hu, Ali Ciftci, Anh Nhut Bien, Dana Ardell, Beeta Sabbithi, and Rahul Kapoor.

REFERENCES

[1] Emma J. Rose, Cynthia Putnam, and Craig M. McDonald. 2020. Preparing future UX professionals: Human skills, technical skills, and dispositions. In *SIGDOC 2020 - Proceedings of the 38th ACM International Conference on Design of Communication*. DOI:https://doi.org/10.1145/3380851.3416774

[2] Craig M. MacDonald, Emma J. Rose, and Cynthia Putnam. 2021. How, Why, and with Whom Do User Experience (UX) Practitioners Communicate? Implications for HCI Education. *Int. J. Hum. Comput. Interact.* 00, 00 (2021), 1–18. DOI:https://doi.org/10.1080/10447318.2021.2002050

[3] Craig M MacDonald, Emma J Rose, and Cynthia Putnam. 2022. An Industry in Flux: Where Does UX Go from Here? *Interactions* 29, 2 (February 2022), 54–58. DOI:https://doi.org/10.1145/3511671

[4] Cynthia Putnam, MacDonald, Craig M., and Emma J. Rose. "It could be better. It could be much worse": Understanding Accessibility in User Experience Practice with Implications for Industry and Education.

[5] Sarrah Vesselov and Taurie Davis. 2019. *Building Design Systems: Unify User Experiences through a Shared Design Language*. Apress.

[6] Adi Shanbhag. 2019. Difference between a style guide, pattern library and a design system in pictures (with Pokemon). *UX Collective*. Retrieved May 23, 2002 from https://uxdesign.cc/difference-between-a-style-guide-pattern-library-and-a-design-system-in-pictures-and-with-2681bf1d40a4

[7] Elizabeth F Churchill. 2019. Scaling UX with Design Systems. *Interactions* 26, 5 (August 2019), 22–23. DOI:https://doi.org/10.1145/3352681

[8] Jenya Edelberg and Joseph Kilrain. 2020. Design Systems: Consistency, Efficiency, Collaboration in Creating Digital Products. In *Proceedings of the 38th ACM International Conference on Design of Communication (SIGDOC '20)*, Association for Computing Machinery, New York, NY, USA. DOI:https://doi.org/10.1145/3380851.3416743

[9] 2020. Hack the Design System: Revolutionize the Way Your Organization Scales Design.

[10] Guiseppe Getto and Fred Beecher. 2016. Toward a Model of UX Education: Training UX Designers Within the Academy. *IEEE Trans. Prof. Commun.* 59, 2 (2016), 153–164. DOI:https://doi.org/10.1109/TPC.2016.2561139

[11] Heather Noel Turner and Emma J Rose. 2022. What do We Teach When We Say We Teach UX? A Study of the Practices of TPC Instructors. *Program. Perspect.* 13, 1 (2022), 61–102.

[12] James K Doyle and David N Ford. 1998. Mental models concepts for system dynamics research. *Syst. Dyn. Rev. J. Syst. Dyn. Soc.* 14, 1 (1998), 3–29.

[13] Alannah Oleson, Meron Solomon, and Amy J Ko. 2020. Computing Students' Learning Difficulties in HCI Education. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1–14. Retrieved from https://doi.org/10.1145/3313831.3376149

[14] George D. Kuh. 2008. *High-Impact Educational Practices: What They Are, Who Has Access to Them, and Why They Matter*. Association of American Colleges and Universities.

[15] Therese Fessenden. 2021. Design Systems 101. *Nielsen Norman Gr.* (2021). Retrieved May 23, 2022 from https://www.nngroup.com/articles/design-systems-101/

[16] J. Park. 2022. Design system from a new perspective. *Des. Compass* (2022). Retrieved from https://medium.com/@designcompass/design-system-from-a-new-perspective-6f417bcf4f7

[17] Linn Vizard. 2020. Building Accessibility into Your Design System. *Adobe Blog* (2020). Retrieved from https://xd.adobe.com/ideas/principles/design-systems/accessibility-in-design-systems/

[18] Design Systems for Everyone. *Gymnasium*. Retrieved July 20, 2022 from https://thegymnasium.com/courses/course-v1:GYM+017+0/about

[19] D. Lindeberg. 2021. Designing Something New with the Atlassian Design System. *Des. Atlassian* (2021). Retrieved July 19, 2022 from https://medium.com/designing-atlassian/designing-something-new-with-the-atlassian-design-system-42bc65d6c43e