Compass:
A System to Guide Adaptive Planning Practice in HCI Studios

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Abstract

Learning to iteratively plan is a metacognitive skill core to leading design-research work. There exist many socio-technical scaffolds to train component skills of planning (e.g. tools and processes to visualize the design problem, diagnose design risks, form iterations plans that address risks). Recent work weaves multiple planning supports into learning ecosystems that layer tools, processes, and feedback venues to promote authentic iterative planning. Despite such designs in place, our needfinding reveals students often struggle to recognize and act on opportune moments to adapt plans before and after feedback venues. Few works consider how to train students to regulate through these replanning moments by flexibly adapting iteration plans mid-execution. We thus introduce Compass, a system that guides design-research students to recognize and act on replanning moments as they execute a project plan. An 8-week deployment demonstrates that design-research students using Compass adapted their plans more before and after feedback venues, and executed plans that were more structurally aligned and better integrated feedback. These findings suggest a need to design frameworks that guide learners to build deeper metacognitive practice, by engaging with the learning interactions and supports designed to help them regulate.

CCS Concepts

• **Human-centered computing → Collaborative and social computing systems and tools**.

Keywords

learning ecosystems, agile research, design studios, metacognitive strategies, HCI education

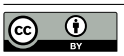
ACM Reference Format:
Leesha Shah and Haoqi Zhang. 2026. Compass: A System to Guide Adaptive Planning Practice in HCI Studios. In *EduCHI 2026: 8th Annual Symposium on HCI Education (EduCHI '26), May 20–22, 2026, Toronto, ON, Canada.* ACM, New York, NY, USA, 16 pages. https://doi.org/10.1145/3803869.3803875

1 Introduction

Learning to iteratively plan is a core metacognitive skill for leading design-research work. Planning is an expert practice, composed of different skills: represent the general structure of the problem, identify risks within the problem, and then focus their iteration on a plan that de-risks the most critical aspects of the design [7]. Many design-research learning environments implement socio-technical supports that scaffold students in these component skills. For instance, novices may use tools like design canvases to scope and structure the rationale of their design, such as user needs, desired outcome, challenge, proposed solution [2, 10, 14, 17, 18, 20, 30]. More recently, researchers have introduced risk-assessment tools to help students diagnose risks in their design argumentation, indicating where they should focus their next iteration [6, 8, 15, 31, 33]. Design sprints have also become a popular pedagogical approach for iterative sprint planning [25]. Some recent design-research studios take a learning ecosystems approach, where they integrate multiple socio-technical supports (i.e. processes, tools, and feedback venues) to support training the various components of metacognitive skills such as planning [27, 35, 39].

However, literature suggests that in practice experts do not follow this planning process procedurally. Rather, they flexibly regulate through their planning process – maintaining focus on their goal, but continuously adapting their plans to changing context [21, 23, 38]. While existing scaffolds introduce students to the core components of planning, they often overlook the need to train students to adapt plans in the moments when plans need to change. For instance, our needfinding demonstrates that design-research students often struggle to recognize and act on opportune moments to replan, or struggle to strategically realign the structure of their plans and implement feedback, even when an ecosystem rich with planning supports surfaces key feedback throughout the week.

To address this gap, we introduce ***Compass*** - a system that guides students to continuously adapt their plans at the opportune moments when the core components of the plan structure shift throughout the week (see Figure 1). Compass helps students (1) recognize moments for adapting their plans before and after feedback venues; and (2) strategically adapt plans mid-execution, in ways that implement planning feedback and continuously realign their project risks, weekly deliverables, and concrete next steps. Compass does this via (1) in-action cues and (2) an on-action dashboard. The in-action cues are implemented as an automated Slackbot that prompts students to adapt their plans at opportune replanning moments during the week (e.g. cueing students to implement plan feedback after a planning meeting, or reassess their plan before leveraging a feedback venue). The interactive on-action dashboard helps students structurally adapt plans in ways that implement planning feedback and continuously realign their project risks, weekly deliverables, and concrete next steps. Together, the cues and the dashboard train students in the expert practice of continuously monitoring and adapting their plans as they execute.



EduCHI '26, Toronto, ON, Canada

ACM ISBN 979-8-4007-2430-5/2026/05
https://doi.org/10.1145/3803869.3803875

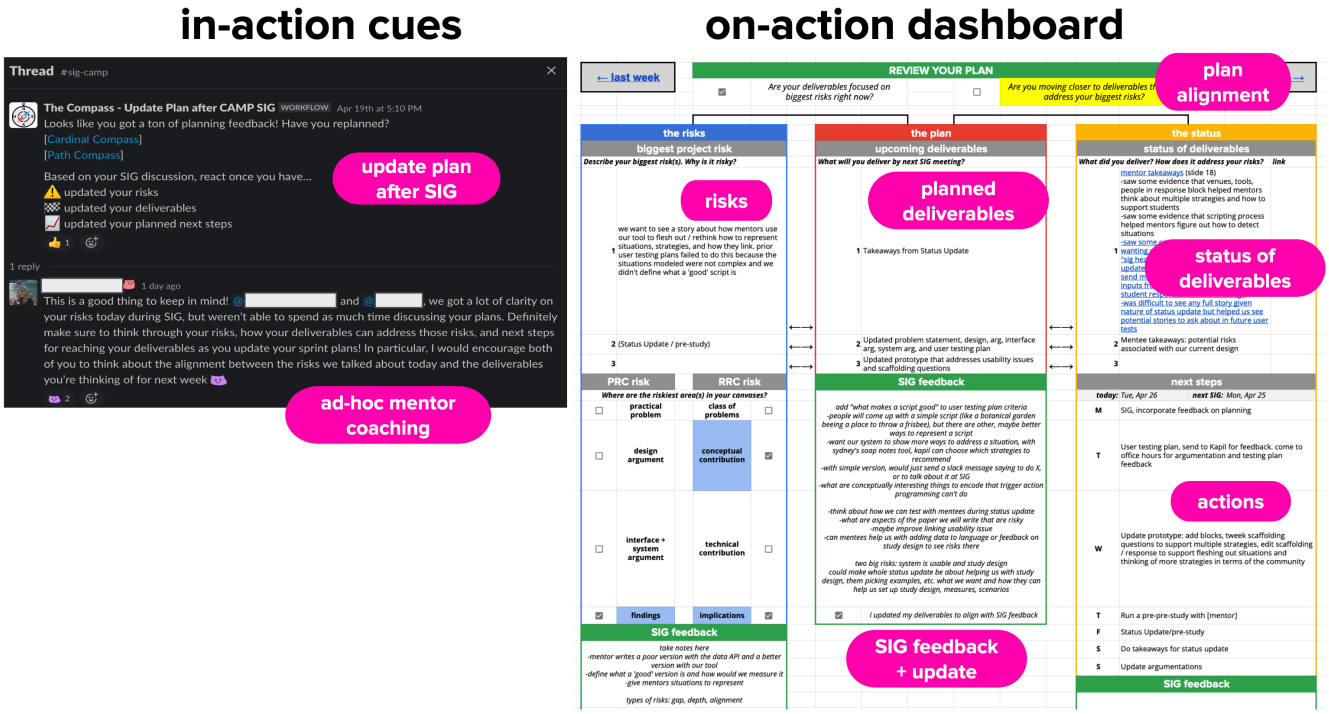


Figure 1: Compass System to Guide Adaptive Planning. We contribute Compass, a system to guide adaptive planning practice, implemented as (1) in-action cues and (2) an on-action dashboard. The in-action cues prompt students to adapt their plans at opportune moments during the week (e.g. cueing students to implement plan feedback after a planning meeting, or reassess their plan before leveraging a feedback venue). The on-action dashboard helps students structurally adapt plans in ways that implement planning feedback and continuously realign their project risks, weekly deliverables, and concrete next steps.

To evaluate Compass, we conducted an 8-week deployment study, where four student teams conducted their planning process using Compass. We removed Compass for one week in each team timeline to compare student planning processes with and without the framework in place. Findings demonstrated that when students used Compass, they adapted their plans more before and after feedback venues, and continuously adapted and executed plans that were more structurally aligned, and that better integrated mentor feedback. These findings suggest a broader need to emphasize process execution and management when designing HCI learning ecosystems, to promote desired sequences of learning interactions across ecosystem supports. In this way, such ecosystems can better model how novice HCI students can build a deeper metacognitive practice through reflective action.

2 Background

We first review how experts practice the metacognitive skill of planning generally, and then specifically in the domain of design-research. We then review limitations to training planning practice in current HCI pedagogy, and the limitations of existing tools for scaffolding adaptive planning practices.

2.1 How Experts Adapt their Plans as they Execute

At its core, leading design research is about learning to solve complex, unstructured problems. To make meaningful progress on such problems, strategic planning is a necessary skill to master [1, 3, 9, 23]. A long history of literature across cognitive and educational psychology defines generalizable models of the planning process when solving problems [5, 16, 19, 28]. For instance, one foundational model breaks down planning into a four step process: (1) understand the problem (i.e. what is being asked for, is there enough information?); (2) make a plan (i.e. look for patterns, organize information); (3) carry out the plan; and (4) evaluate its effectiveness [16].

However, literature across cognitive science, HCI, and the learning sciences suggests that in practice, planning is not quite so procedural or generalizable across contexts [21, 24, 38]. The ways in which experts execute their planning process depends on the specifics of the problem they seek to address. Experts use mental models of the problem to simulate different scenarios, predict breakdowns, and plan next steps. For instance, the way an ER doctor strategically plans when triaging a patient looks very different from how a math student strategically solves a geometric proof. These mental models vary widely across different problem domains, which suggests practical limitations to generalizable models of expert planning [24].

Further, even when skilled planners have procedural roadmaps for problem solving, in practice, they flexibly adapt their plans as they execute them. Specifically, expert planners orient their plans around primary objectives. Then, as situational context changes or new opportunities arise, they dynamically revise their plans in response to new information to achieve the objective, or adapting the objective when needed [21, 38]. While the planning process has been extensively studied and modeled for domains with simpler, more structured problems like math, less work has been done to understand how to model the planning process for complex design and design-research problems, for which there are no known solutions [24].

2.2 How Expert Designers Manage their Planning Process

Within the domain of design-research, experts practice iterative planning to incrementally build the knowledge required to solve a problem. Over the years, researchers have examined different components of iterative planning, such as how expert designers visualize what they know about the problem space [10, 26], diagnose risks in their design rationale [8, 9, 12], and focus their plans on addressing critical risks [6]. More recently, the design risks framework weaved component skills together to illustrate how expert designers practice the overall iterative planning process (see Figure 2, first row). In this framework, experts (1) use knowledge of design problem structure to focus attention on key areas of the project; (2) use knowledge of common risks to diagnose project risks; and then (3) use knowledge of iterative strategies to plan next steps that mitigate these risks [7].

In practice, expert designers do not follow these planning processes procedurally. Rather, they develop an intuitive understanding of how to adapt and execute their plans as information about the problem space changes. Expert designers take an adaptive approach that is a "goal-directed, non-linear process that utilizes heuristic reasoning processes and strategies" [1]. For instance, an expert designer may be in the middle of executing their plan when they learn about a new critical risk in their design problem. At this point, they also realize that their plan is no longer focused on the most critical risk in the design problem. In response, they may adapt their planning by popping back out to visualize what they know so far about the design problem and re-assess current risks. Management literature refers to this adaptive problem solving approach as strategic doing [29]. In addition to honing the component skills of planning, experts also master this skill of *adaptive planning*, where they continually adapt and focus their planned next steps in response to shifts in the problem space, to advance the most critical parts of the design problem.

2.3 Existing Pedagogy and Tools around Planning Process

Existing design and design research pedagogy primarily focus on training novices in the component skills of planning. For example, literature emphasizes the need to train design problem structure [14, 30], and introduces representational tool scaffolds for visualising design problem structure [2, 10, 17, 18, 20]. Literature also explores the benefits of training learners to identify critical risks in their designs premortem, and introduces risk assessment tools scaffold identifying critical issues in their designs [6, 8, 15, 31, 33]. Agile methodologies and sprint tools have also been used in design classrooms to decompose plans into actionable tasks [25, 33, 39].

Providing direct coaching or mentorship is an effective way to train novices in the expert practice of adaptive planning. Experienced design mentors with extensive domain knowledge and knowledge of planning strategies are skillful at managing their iterative planning process [7–9, 12], and can effectively observe, critique, and model these skills. Literature in metacognitive skill development also argues that students can gain competence in such skills when they are "given opportunities to use them [the skills] in a variety of learning environments, and to receive informative, corrective feedback concerning their use" [11]. Thus, apprenticeship-style coaching can be highly effective for students being able to deliberately practice [4] skills like planning, where mentors provide specific, corrective feedback that makes explicit the moments where adapting a strategy is needed.

However, such experienced mentors are a limited resource in most design-research learning communities [27, 39]. To help scale limited mentoring resources, socio-technical approaches use a combination of coaching and tools to scaffold novices in their design planning (e.g. canvases, planning meetings, kanban boards, stands, and design sprints) [34, 35, 39]. Tools and social structures like sprint logs and planning meetings provide externalized and generalizable models that, when paired with expert coaching, have the potential to train students to practice managing their planning process like experts. Recent research has explored design-research studios that have proposed learning ecosystems that intentionally weave socio-technical supports together to form an environment for training each component of design-research planning [33, 39].

While well-intended, learning ecosystems rich with supports can also overwhelm a student trying to engage in desired learning interactions. Our empirical findings suggest that even with many planning supports in place, novices can still struggle to continuously monitor their progress for shifts in problem information, and adapt their plans to focus on these critical project issues as they work. For instance, students experienced critical process breakdowns in their planning, such as challenges with extracting the planning feedback made explicit via the planning supports, and implementing feedback into a revised planning process. Consequently, students would continue to execute old plans, despite receiving new planning strategies as feedback.

In the following section, we present empirical findings from a needfinding study that explores challenges students face trying to manage their planning process across existing planning supports.

3 Challenges in Managing Planning Process within a Learning Ecosystem

We situate our study in the Agile Research Studio (ARS) [39] learning ecosystem to gain practical understanding of challenges learners face when managing their planning process. The planning scaffolding in an ARS is composed of a series of studio tools, social structures, and processes, designed to help students practice specific metacognitive skills, such as planning [37]. The ARS Ecosystem

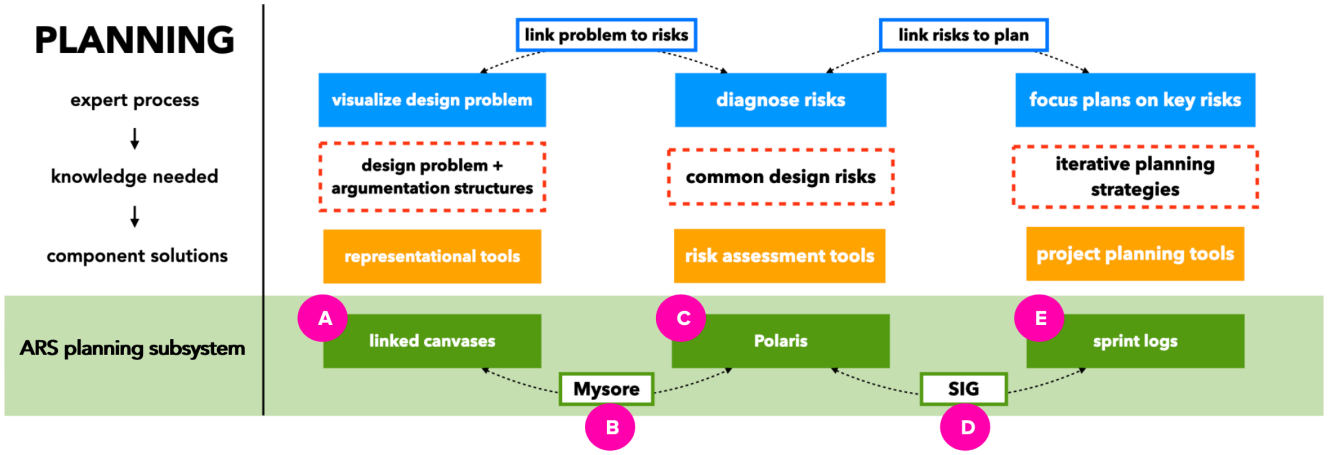


Figure 2: Planning Supports in an ARS Ecosystem. The ARS Ecosystem provides a series of socio-technical supports that scaffold the expert process of planning, including (A) linked canvases for visually representing design and research argumentation, (B) Mysore venue for argumentation feedback, (C) Polaris tool for diagnosing risks in argumentation, (D) SIG venue for planning feedback, and (E) sprint logs for iterative planning to address risks.

provides a series of socio-technical supports that scaffold the expert process of planning, including:

(1) *linked canvases* - a series of templates for visually representing design and research argumentation structure, (see Figure 2A);
(2) *Mysore venue* - a bi-weekly feedback venue focused on argumentation risks, offered by the team's graduate student mentor in office hours and faculty mentor during the weekly studio meeting (see Figure 2B);
(3) *Polaris tool* - a diagnostic tool for independently identifying risks in argumentation (see Figure 2C);
(4) *SIG venue* - a weekly feedback venue organized around a Special Interest Group (SIG), where faculty mentor, graduate student lead, and student teams in the SIG gather for planning feedback specifically (see Figure 2D)
(5) *sprint logs* - an project planning tool for composing iterative plans to address risks (see Figure 2E).

Despite several planning supports to the ecosystem, students faced practical breakdowns in how they managed their planning process across existing supports. To better understand these challenges, the first author conducted a series of 30 minute, semi-structured interviews with a subset of studio members (n=10). Interviews focused on students enrolled in the studio for multiple terms, thus factoring out challenges related to being a student new to design research, planning practice, and the learning ecosystem. Interviews were conducted within one week in the middle of the term and mid-sprint. The goal of the needfinding was to understand (a) how different students would ideally manage their planning process during a week in the ecosystem (across canvases, Polaris, sprint logs, SIG meetings, and Mysore); (b) what their planning process management actually looked like midway through their sprint that week; and (c) the hardest or most painful parts of managing their planning process.

Below we illustrate two common challenges that emerged – (1) students struggle to recognize moments where replanning is needed, and (2) students struggle to structurally adapt their plans when replanning.

3.1 Students Fail to Recognize Moments where Replanning is Needed

Many students failed to recognize and act on opportune moments for replanning throughout the week. Specifically, students described struggling to recognize replanning moments after receiving feedback (e.g. after a planning meeting), and in preparation for a feedback venue (e.g. planning to complete a slice of a deliverable before a feedback venue).

For example, Participant P1, Naina, described how her team missed out on two key replanning moments. Naina said her team recently solicited feedback on their needfinding insights during a planned project feedback session with the research studio. They received specific planning feedback to move forward and define precise use cases for their system, based on their user interviews. Later in the week, their team had an opportunity to get argumentation feedback from their coach on proposed use cases via the Mysore feedback venue, but instead sought feedback on an unrelated risk. Naina shared the following: *"We didn't really think about the planning process when going into Mysore. It's more 'what are the things we need help on right now'. We have the plan all laid out at the start but new risks and blockers come up, and I think we weren't able to update our canvas and the sprint log to reflect that."* Naina then shared her mindset about replanning, after retrospectively identifying different moments where they failed to replan. She said *"We thought it [planning] was a thing you just do once a week, versus having a mindset of this being a dynamic process every time you come up with new risks and blockers. I internalized this idea of 'okay I do this [process] once every week.'"*

Here, Naina highlights a common misconception among students – **students think of plans as fixed, rather than recognizing that planning is a continuous process that one should regulate through in the moments where the core components of the plan shift (e.g. risks, deliverables, next steps)**. These findings suggest a need for highlighting these opportune moments of replanning to students, such as prior to leveraging a feedback venue, or after having received planning feedback.

3.2 Students Fail to Structurally Adapt Plans when Implementing Plan Feedback

Students also struggled to understand how to concretely implement planning feedback - namely, how to re-align the overall structure of their plan when part of their plan shifts (i.e. the risks, deliverables, or next steps). We found that students often enacted ineffective plans, despite receiving clear feedback via ecosystem supports that plans should shift (e.g. via an independent risk assessment with Polaris, or mentor coaching in a SIG meeting or Mysore venue). Multiple students reported continuing with previous plans that were now out of date, appending new deliverables to old plans without reprioritizing or re-allocating the limited time they had, or replanning with vague risks, deliverables, or next steps that made it challenging to maintain focus in the remaining time. Students described how it was difficult to adapt their plans on the fly, when it was not always clear how the feedback would practically change structural components of their plan (e.g. risks, deliverables, or next steps) that week.

For example, Participant P4, Ren, explained how he received feedback to focus on his study design, and failed to implement that feedback into a concrete revised plan. Ren's goal was to run a study to evaluate his system, and prepare a manuscript in the second half of the term. Ren composed an initial plan to work on his study design, but was stuck on articulating measurable outcomes for his interface. In his SIG planning meeting, his mentor noted: interface arguments will be 3 paragraphs in a 10 page paper, move on to other critical areas. At a feedback venue later that week, Ren again decided to ask for feedback on measurable outcomes of his system. Instead, Ren's mentor reiterated the same feedback. *"He basically said 'okay you need to be flying with your research and finish your interface arguments. It seems like you are just perfecting this one piece and that is maybe one slice of it. The bigger risk is discussing how you plan to conduct your study' – Well, okay, that is useful in terms of planning. Mysore helped me see more of that ideal planning process. [I am] focusing too long on certain deliverables."* Ren understood he needed to adapt his plans in this moment. However, he noted that his revised plans for the week remained vague, and failed to capture the specificity of his mentor's feedback – focus on the execution details of the study and how to run it before the term ends. He said:

> *"Saying study design is a task [in my sprint log] and then starting a new document – that becomes too overwhelming. [...] Really, I should have had in my mind this week – forming the whole study design. [...] But this week was just kinda like 'okay, gotta do study design, and more conceptual. [...] My sprint plan this week is not super clear. [...] I knew I needed a deliverable that was presentable [i.e. the study design], but yeah – am I getting closer to the updated understanding I need? and if I don't have that, that's risky. I am putting in half the week's work without being aimed at that specific intention [the deliverable]."*

Here, Ren explains another common challenge faced by students – **when revised plans remain vague (e.g. the risk of a missing study design) and fail to precisely implement planning feedback (i.e. the risk of not having practical details of a study design that he can execute in the coming weeks), it becomes difficult for students to monitor whether or not they are track with completing deliverables.** Further, Ren highlights that re-planning work, while necessary, can consume valuable time of students mid-execution, if concrete changes to their plan structure are not clear. These findings suggest a need for lightweight ways to help students capture feedback and concretely implement it as they adapt their plans, in ways that are minimally disruptive to their plan execution.

3.3 A Need for Process Management Frameworks in Learning Ecosystems

These challenges suggest a need for *process management frameworks* that can guide students through the adaptive practice of planning, helping students recognize and act on moments of replanning, and enabling them to capture and integrate the planning feedback that ARS supports are designed to surface during the week. In this way, students and mentors can anchor their planning feedback conversations around the ways in which a student's plan may structurally shift *as they work*. What are the opportune moments for replanning in the learning ecosystem? Did their risks, deliverables, and/or next steps shift from new information that surfaced during the week? If so, how should their plan structure change? And what does that practically mean for how they execute that plan in the remainder of the sprint? By training students to treat their plans not as fixed contracts, but flexible resources, we can guide students to continuously adapt their plans when new information arises.

If students can recognize opportune moments to revise their plans, and have a clear and simple process for realigning their plans and implementing feedback, we hypothesize that students can plan increasingly impactful iterations that flexibly adapt to tackle the most critical areas that emerge in their design and research work, and effectively execute these plans across available ecosystem supports.

4 Compass: A Process Management System for Adaptive Planning

To help students better manage their planning process, we introduce ***Compass***, a system to guide adaptive planning practice, implemented as (1) in-action cues and (2) an on-action dashboard. The in-action cues prompt students to evaluate and adapt their plans at opportune moments during the week (e.g. cueing students to implement plan feedback after a planning meeting, or reassess their plan before leveraging a feedback venue). The on-action dashboard helps students structurally adapt plans in ways that implement planning feedback and continuously realign their project risks, weekly deliverables, and concrete next steps. Inspired by Schön's theory of reflective practice [36], the combination of the cues and dashboard

Figure 3: In-Action Cues before and after SIG planning meeting. In-action cues prompt students to enact planning strategies at opportune moments for replanning. Here, we see examples of two types of cues – before and after a SIG planning meeting, each designed to prompt students to enact a desired planning strategy at an opportune moment. (A) Before the planning meeting, students are cued with the context of their risks and deliverables from the previous week, preparing them to come into the meeting ready to share their completed deliverables and share their new plan. (B) After the planning meeting, students are cued to update their plan based on planning feedback they just received.

provides students with in-action and on-action reflection opportunities where they are cued to continuously monitor, assess, and improve their overall planning process. Using the Compass system, students are guided to reflect on and revise their plans as they work, continuously adapting them as experts do.

4.1 In-Action Cues

The planning cues (see Figures 3 and 4) are in-action messages that cue students to adapt their plans at opportune replanning moments each week, before and after key feedback venues. Compass cues are *responsive to the team's unique context* in these replanning moments. Each team has unique risks, deliverables, and next steps that are extracted from the dashboard and embedded in a cue for students and mentors to easily review. Each team also has different meeting times for feedback venues like SIG and office hours, so the cues are sent relative to each venue time. To illustrate, students receive a cue a day prior to their SIG planning meeting to share their deliverables and update their plan (see Figure 3, A). This cue also carries the context from last week's plan (i.e. their risks and deliverables) as a snapshot to remind the team and mentor what the students set out to achieve this week. By cueing students with context a day before their planning meeting, students can self-assess whether they have fulfilled their deliverables and addressed the risks they planned to address. If not, they have some time to either focus their deliverables, or can consider this as they plan for the following week. Further, all cues include a link to the on-action dashboard for the team, enabling quick access for viewing and revising plan details.

Compass cues are also designed to be sent within *shared Slack spaces that mirror social structures* of the studio, enabling increased socially shared regulation [22] of planning activity among students, their mentors, and peers. For instance, the cues before and after the SIG planning meeting are sent in the SIG channel where mentors and peers are present. Before the meeting, the SIG members are thus prompted to collectively think about what they should expect going into their meeting tomorrow (i.e. according to the plan, I expect the team addressed these risks, by completing these deliverables), and even review deliverables before the meeting. After the meeting, students are prompted again to make concrete changes to their plan based on the feedback they captured in their Compass dashboard (see Figure 3, B). Here, coaches can easily address all teams to reiterate general planning strategies that they discussed as a SIG a few moments prior (see Figure 1, left). Students can also send their revised plans here, prompting their peers to revise their own plans and do the same. The cue sent prior to office hours in the team channel also has the team mentor included, who can jump in to give ad-hoc feedback, respond to student questions, or ask for more information about their status (see Figure 4).

4.2 On-Action Dashboard

The on-action dashboard is a plan template designed to help students continuously assess the structural alignment of their plans for the week, across three sections: (1) the risks, (2) the plan, and (3) the status (see Figure 5). Prior to Compass, students would compose these plan components in isolated views across planning tools (see Figure 2). By design, the dashboard gathers components into one view, allowing students to visualize plan structure and evaluate alignment across components.

The *risks* section guides students to focus on and prioritize, at most, the three most critical risks to address that week. Students then identify where their risks are within the larger practical and research canvases, helping students conceptually link their plans

Figure 4: In-Action Cues before Office Hours. Here, we see another type of cue – (C) before office hours, a feedback venue with their graduate student mentor. These prompts are designed to promote another replanning moment – assessing progress towards your deliverables and what you might need help with, prior to leveraging a mid-week feedback venue with your mentor. Here, we see how Compass cues integrate into existing ecosystem supports, by embedding plan context directly into the cues, and by being sent on existing Slack SIG channels, where mentors can follow up with ad-hoc coaching.

back to their overall project argumentation. The *plan* section, guides students to commit to up to three clear deliverables to bring into the next planning meeting. These deliverables are horizontally aligned with the three risks, to emphasize that each deliverable should be addressing a critical risk they have identified. The *status* section includes next steps and status of deliverables. Under next steps, students are given a daily timeline of the week, where they can visually pace out the tasks required to complete deliverables in the time available. Further, it helps students situate their planned actions relative to the other weekly socio-technical supports that exist in their ecosystem (e.g., I likely want a draft of my arguments ready before a Mysore argumentation feedback venue on Wednesday.) Under the status of deliverables, students link to the concrete deliverables that they have completed by the end of the week. Similarly, these completed deliverables are visually linked to their planned deliverables, to help students assess whether what they completed is aligned with the overall plan. Finally, there are two *alignment prompts* that guide students to assess the structural alignment in their plan. One prompt visually links the risks and the plan and asks "Are your deliverables focused on the biggest risks right now?" The other prompt visually links the plan and the status, and asks "Are you moving closer to deliverables that will address your biggest risks?" When left unchecked, the prompts are highlighted to draw attention to the task of checking for alignment in the plan structure. By promoting reflection on the alignment between these plan components, the dashboard models how experts evaluate their own plans for structural soundness as the week progresses. What are the components they monitor as they execute a plan? And if one component shifts (e.g. a deliverable changes), what impact does that have on the rest of the plan? Are they still addressing the same risks? How should they revise their next steps to account for the changed deliverable? In this way, Compass seeks to embed the ways in which experts continuously evaluate the structure of their plans as they work into the dashboard, so that students can model a similar process as they revise and execute their plans.

Below each section, the dashboard provides a *mentor feedback* space where students are instructed to capture feedback during their planning meeting that is specific to each structural component of their plan (e.g. feedback on their risks). During the SIG planning meetings, students and mentors use the dashboard as a shared view and conversational scaffold to discuss students' practical plans and metacognitive planning strategies. Typically, mentors guide students to move left to right, starting the discussion with the risks students chose to focus on, then moving towards the deliverables they want to complete, ending with their next steps and how they

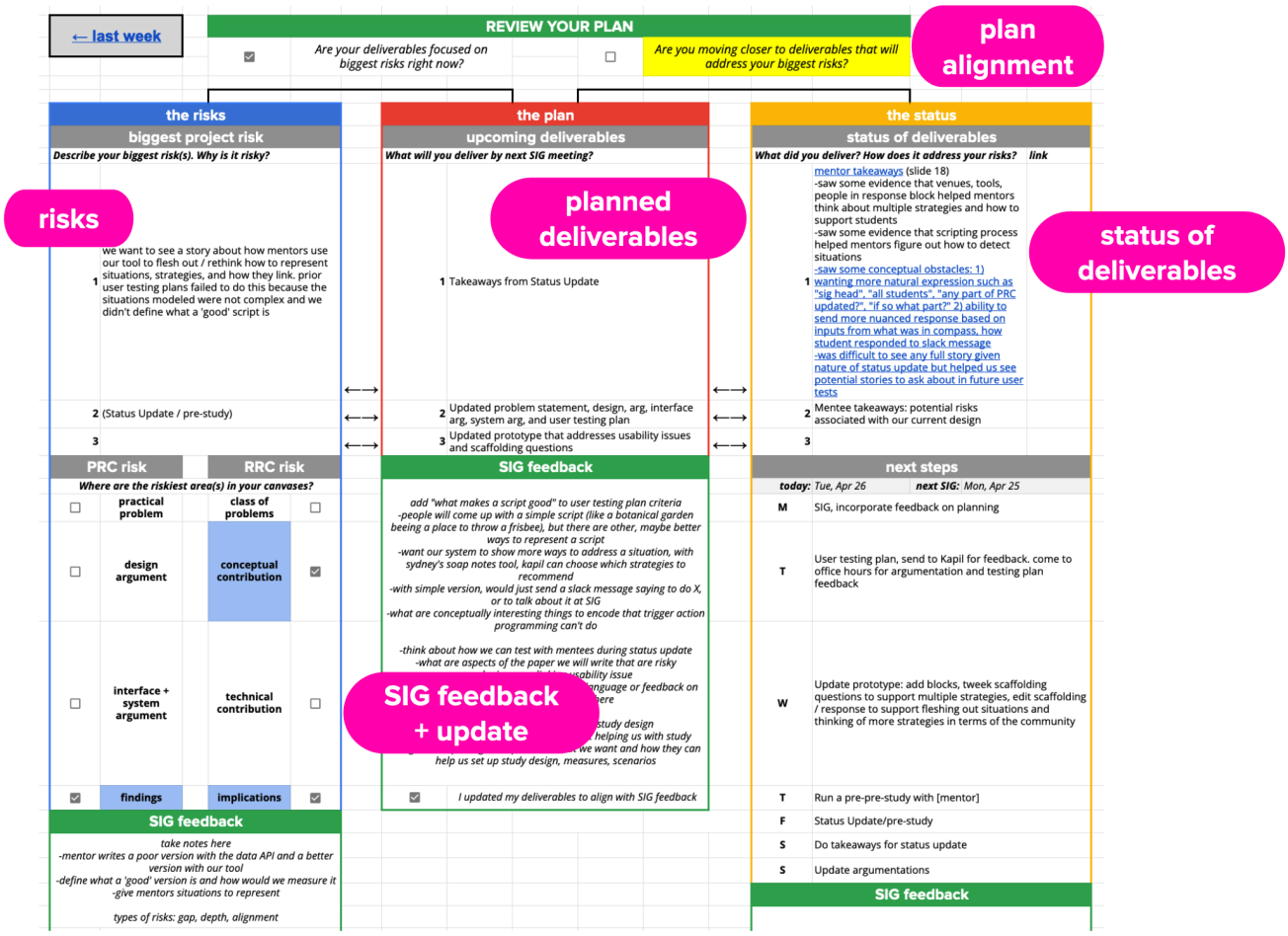


Figure 5: On-Action Dashboard. The on-action dashboard helps students assess the structural alignment across key components of their plan, as they replan (i.e. whether their weekly deliverables will address their project risks, and whether their next steps move them towards their deliverables). Further, the dashboard allows students to capture planning feedback within the view, as it relates to these core structural components, simplifying the replanning process when integrating mentor feedback.

plan to break down the actions required to complete their deliverables. Students are advised to capture feedback *within the structure of the plan* (i.e. as they are discussing risks, students can take down risk-specific feedback in that section). In this way, suggested plan revisions become explicit, and clearer to implement when students leave the planning meeting. Further, mentors can monitor as students capture their understanding of the feedback as they go. This gives mentors the opportunity to correct any misconceptions before the meeting ends. Thus, students and mentors can leave the planning meeting closer to collective agreement on the plan for the week. When students are cued to return to their Compass to concretely revise their plans after the planning meeting, the dashboard also includes *update prompts* under each section, where students can explicitly log whether they have implemented the feedback as a revised plan.

Using this visual scaffold during the meeting, mentors and students explicitly discuss these structural pieces, and how one change (e.g. a changed risk) affects another component of the plan (e.g. how the corresponding deliverable changes). The dashboard gives a shared view of the pieces experts typically consider when managing their plan. Using the dashboard in SIG planning meetings models these structural pieces of an expert plan for students, and gives them the chance to methodically capture structural feedback and practice the expert skill of checking how plan components align.

4.3 Integrating Compass into a Learning Ecosystem

Implementing a process management system like Compass that is meant to guide practice across supports requires one to consider how that system will practically integrate into the existing ecosystem. Here, the Compass in-action cues and on-action dashboard both integrate into available socio-technical supports.

For instance, the in-action cues are implemented as an automated Slackbot, that plugs into existing Slack channels that represent social structures in the studio design (e.g. team channels,

SIG channels). Further, the cues are designed to be responsive to each team's unique planning context at that particular replanning moment (e.g. embedding the next steps from the dashboard into a cue before office hours for students and mentors to assess if they are on track or need to replan). To do this, the cues extract data from tools like the Compass dashboard, using existing Slack and Google Sheets APIs. The cues are also responsive to each team's planning timeline (e.g. timing of their SIG planning meetings, office hours opportunities, etc.). To do this, the cues connect with existing data about the timing of support venues in a learning ecosystem, for instance by using technologies like orchestration scripts [13] that provide API-like access to data about the learning environment (e.g. when and where a team's office hours opportunity might be each week).

Similarly the on-action dashboard, implemented as an interactive Google Sheet, interweaves with existing socio-technical designs in the ecosystem. The cues include hyperlinks to the dashboard, enabling students to jump in and revise the plan from the cue itself. Sections of the dashboard conceptually link back to other planning scaffolds to reinforce concepts, e.g. identifying the area of the argumentation canvas that contains the risk. In the next steps section, students are guided to consider the timing of their feedback and support venues as they map out their week's timeline. Finally, the dashboard is used as a conversational scaffold in SIG planning meetings, and enables students to capture replanning feedback notes within the tool itself.

5 Compass Deployment Study

We tested Compass in an 8-week deployment study with six undergraduate design-researchers who led four HCI research projects, mentored by three graduate students. The primary goal of the study was to understand how Compass might guide students to effectively manage their planning process across ecosystem supports throughout the week, as compared to their planning process management, sans Compass. Our core hypotheses were as follows:

(1) Students will revise their plans before and after key feedback venues throughout the week when using Compass (as opposed to the beginning and end of the week).
(2) The plans that students compose and execute with Compass will be more structurally aligned throughout the week (i.e. their risks, deliverables, next steps will be aligned as the week progresses).
(3) The plans that students compose and execute with Compass will be more aligned with mentor feedback throughout the week (i.e. their plans will incorporate the mentor feedback surfaced through ecosystem supports).

We detail our deployment study methodology below.

5.1 Study Setting and Procedure

To assess how Compass might guide students to practice adaptive planning in an ecosystem rich with planning supports, we tested the system in an Agile Research Studio [39], where students learn to lead systems HCI research with the support of faculty and graduate student mentors. Student participants were undergraduate Computer Science majors, and had been working on their projects between 0 and 4 terms. Graduate student mentors (or SIG heads) were HCI PhD students that had between 3 and 15 terms of experience mentoring HCI research.

Student teams were selected from three different SIG groups, led by three different SIG head mentors (2 senior PhD students, 1 novice PhD student) to account for differences in mentoring style. The student teams were selected to represent a spectrum of expertise with design-research and familiarity with ecosystem supports –, Team B had 2 experienced undergraduate students (i.e. 3 terms in the studio), Team A had 2 somewhat experienced undergraduate students (i.e. 1 term in the studio), and Teams C and D each had 1 novice undergraduate student (i.e. first term in the studio). Diversifying participants in this way helps mitigate against a risk of an "expertise effect", where one team may show better process management simply because they are more experienced with design-research planning, or leveraging the ecosystem supports.

During the 8-week study, students and mentors were instructed to use the Compass dashboard and cues to manage their planning process. To mitigate against any confounding factors related to starting the term, especially for students new and orienting to the studio and their project, we focused our study on weeks 3-10. All participants used Compass during weeks 3-5, as a way to train students and mentors on how to use the Compass dashboard and cues in their planning process. During weeks 6-8, all participants continued to use the Compass system, with the exception of one week, where each team had the Compass system removed from their practice to see how their process management would change in the absence of the framework. Student teams did not know which week they would have Compass removed until the day before their SIG planning meeting, in time for them to compose their plan for the week. Mentors were not informed which week their students would not use Compass until the start of the SIG meeting itself, where they would present their plan. All participants returned to using the Compass during weeks 9-10.

Each week that students used Compass, they were instructed to use the Compass dashboard to compose their plan for the week, prior to their SIG planning meeting. Students and mentors were instructed to use the Compass dashboard to start their planning discussion at the start of each SIG meeting, and as it was useful through the rest of the meeting. Students were further instructed to take their SIG feedback notes within the Compass dashboard, using the Mentor Feedback sections. Students and mentors also received Compass cues in their SIG and project channels at opportune moments to update their plan throughout the week. During the week that students did not have the Compass dashboard or cues, they were instructed to use their usual planning tools (i.e. their canvases, Polaris, and sprint logs, see Figure 2, bottom row) to compose their plan for the week, as they previously used to, prior to their SIG meeting. Other than the reminder to not use the Compass dashboard a day before their planning meeting, students did not receive any cues as part of the control condition.

5.2 Data Collection and Analysis

To get detailed insight into how students managed the planning process week to week, we collected the following data.

(1) Weekly planning tool usage data was collected from weeks 3-10, including detailed revision histories for each team's

Compass dashboard, Planning View, Sprint Log, and Design Log when relevant (i.e. when students captured mentor feedback in SIG the week they did not have Compass).

(2) Weekly Slack interaction data was collected from weeks 6-10, including any posts, replies, and reactions from team and SIG channel, as well as relevant planning discussions over direct messages that were shared by participants in their weekly retrospective interviews .

(3) Weekly mentor assessments were collected from weeks 6-9, where mentors spent 30 minutes per team evaluating the quality of the plans, plan revisions, and plan execution at the end of each week. To minimize a risk of mentors revising how they planned to coach their students after formally assessing their student's planning process, mentors completed assessments at the end of the week, rather than throughout the week.

(4) Weekly retrospective interviews were conducted separately with students and mentors from weeks 6-9, where participants were guided to recount planning process, and planning coaching from the week respectively. The primary author asked participants to replay the week, prompting their memory by visually walking through planning tool data, Slack interaction data, and recounting participation in feedback venues.

To analyze when students revised their plans during the week relative to replanning moments, we review how their replanning activity was distributed across the week, based on logged revisions in their planning tools. Specifically, we define a "revision session" as a continuous block of time where students are revising one of their planning tools. For instance, 35 revisions done from 1-2p count as one revision session. All planning revisions that may have occurred across planning tools each week are included. For each team, we analyze the frequency and distribution of revision sessions each week, and compare both conditions. We coded individual revisions and revision sessions relative to when Compass cues were sent, and when planning feedback venues occurred (e.g. SIG meetings, office hours, and Mysore). With or without the Compass in place, we expect that students will revise their plans before their SIG meeting, to prepare to discuss their completed deliverables, and their plans for the following week. Thus, we focus on "midweek" revisions that may occur relative to other planning feedback venues (i.e. during SIG, after SIG, before office hours, after office hours, before studio, after studio).

To analyze the quality of the revised plans each week, we use the weekly mentor assessments to identify whether plans (a) are structurally aligned and (b) integrated the mentor feedback received. Plan contents were extracted out of the tools and put into a standard table so as not to bias mentors in their weekly evaluations.

To evaluate structural alignment of plans, mentors used rubrics to assess (A) the alignment of risks and deliverables and (B) the alignment of deliverables and next steps at three snapshots from the week: (1) before SIG planning meeting (2) after SIG feedback (3) end of the week, prior to next planning meeting. Mentors rated the alignment between two components on a scale of 1-5, where 1 meant "not aligned at all" and 5 meant "highly aligned".

To evaluate the alignment of student plans to mentor feedback, mentors used rubrics to assess plans weekly, at two snapshots moments – (1) the alignment of the team's revised plan with the mentor's planning feedback after SIG meeting and (2) the alignment of what the team actually delivered with what the mentor and team initially agreed they should deliver at the end of each week. Mentors rated alignment of revised plans to the mentor feedback captured by students on a scale of 1-5, where 1 meant "not aligned at all" and 5 meant "highly aligned". Further, mentors qualitatively documented the ways in which a team's completed deliverables were aligned or misaligned with what the mentor and students agreed they should deliver by week's end.

Through this data, we were able to measure replanning activity, relative to replanning moments surfaced by the ecosystem, and the quality of those plan revisions in terms of structural alignment of students plans, and alignment of the plan revisions with mentor feedback. In doing so, we will be able to see how students practice managing their planning process across existing socio-technical supports in the ecosystem – both in the absence of a planning process management framework, and with a framework in place.

6 Compass Findings

6.1 Students adapt plans before and after key feedback venues with Compass

We found that on average, students adapted plans before and after key feedback venues more often in the weeks they used the Compass. Teams averaged 2.92 midweek plan revision sessions per week with Compass, compared to 1.25 sessions per week without Compass. As expected, our data confirmed that with or without the Compass system in place, students regularly revised their plans at the beginning and end of the week, in preparation for their SIG planning meeting (see Figure 6, first and last columns). When we focus on *midweek* replanning activity, data shows that all 4 teams continuously engaged in replanning sessions before and after feedback venues during the weeks they used Compass (see Figure 7, in blue, a total of 11.67 replanning sessions), and generally engaged in little to no midweek replanning sessions in the week without Compass (see Figure 7, in pink, a total of 5.00 replanning sessions). In their week without Compass, Team B did not revise their plans at all midweek. Teams A and C revised their plans to incorporate mentor feedback during SIG meeting, but not beyond this moment. Team D had a similar revision pattern to Teams A and C, but also engaged in several replanning sessions before the studio venue the week without Compass (see Figure 7, bottom right). In the weekly retrospective interviews with both the team and mentor, we discovered the week without Compass was also the week of their once-a-term status update, where they ran a user test with the whole studio. Typically the week where students have a status update in studio, teams heavily leverage mentor office hours and revise their plans to prepare for and make the most use of this once-a-term feedback opportunity. Thus, the unexpected peak in revision sessions for Team D is due to their studio presentation the next day.

Overall, these findings suggest that using Compass prompted students to continuously recognize and act on moments of replanning surfaced by ecosystem supports. These pre- and post-venue

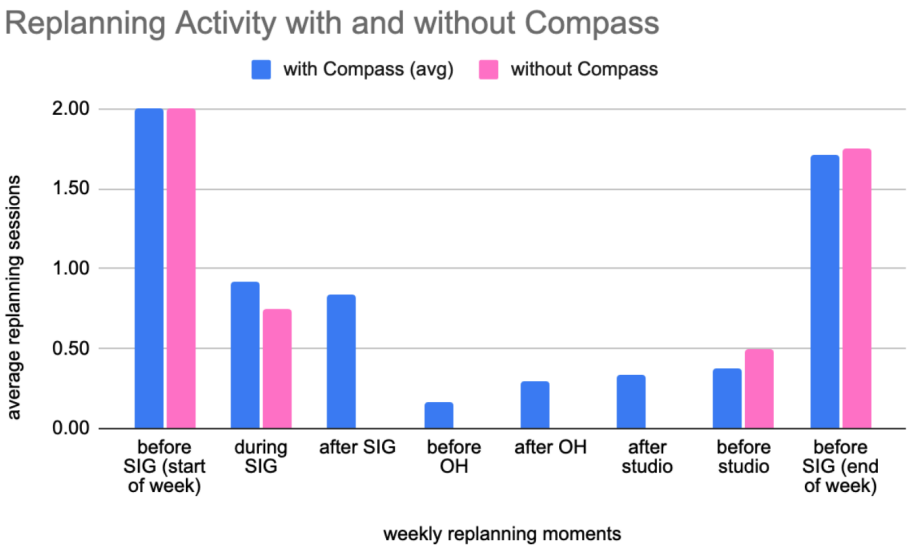


Figure 6: Weekly Replanning Activity. This graph shows the distribution of replanning sessions across the week, relative to key replanning moments emphasized by Compass. Here, we see that on average, students continuously engaged in replanning activity the weeks they used Compass (in blue). Further, when Compass was removed, students reverted to replanning activity at the beginning and end of the week, in preparation for their planning meeting (i.e. summarizing what they completed and plans for the next week).

replanning sessions reflect students replanning to better leverage a feedback opportunity, and students incorporating feedback from a venue into a revised plan afterwards.

6.2 Students structurally adapt plans when replanning with Compass

Students did not only engage in adaptive planning with the Compass system in place - they also *structurally* adapted their plans when replanning in these moments, leading to higher quality plans and plan execution. Here, we illustrate how the quality of replanning differed with and without the Compass framework in place. Specifically, findings showed that during the weeks students used Compass, they (a) maintained more structurally aligned plans and (b) produced revised plans that more clearly implemented mentor feedback.

6.2.1 Students plans were more structurally aligned when using Compass. Findings show that mentors of Teams A, B, and C considered student plans to be more structurally aligned the weeks they used Compass to manage their planning process. Where 5 means highly aligned, Teams A, B, and C had average alignment scores of 4.00, 4.46, and 3.64 with Compass, and 3.17, 3.17, and 2.5 without Compass, respectively. Team D received slightly higher alignment scores for the week they were without Compass (2.33 compared to 1.95 the weeks with Compass). In retrospective interviews with Team D and their mentor, we learned that the student struggled to proactively plan and use planning supports throughout the term, with the exception of the week of their status update presentation to the studio, which was also their week without the Compass system. As a result, we see higher alignment scores that week. Figure 8 compares detailed alignment data with and without Compass for each team. Alignment data is shown between different components, and at different moments across the week. For Teams A, B, and C, the figure demonstrates that plans were consistently more aligned in the weeks students used Compass. For Teams A and B (which were composed of more experienced students), mentors generally considered components of student plans to be "aligned" or "highly aligned" with Compass, and "somewhat aligned" or "aligned" without Compass. For Team C (which was composed of a novice student), the mentor generally considered plans to be "somewhat aligned" or "aligned" with Compass, and "not aligned" or "somewhat aligned" without Compass.

A closer look at student plans week to week demonstrates a similar story, where Teams A, B, and C generally maintained plans that were more structurally aligned the weeks they used Compass. To understand how teams maintained structural alignment in their plans, we examined data at 3 assessment moments during the week: before SIG planning meeting, after SIG feedback, and at the end of the week. Teams A, B, and C all composed and maintained plans that were generally more aligned in the weeks where they used the Compass framework to scaffold their planning process management. These findings demonstrate that, irrespective of the level of experience of students, Compass was able to help students structure plans that were better aligned. Notably, the findings not only show that students could compose structurally aligned plans prior to any feedback (i.e. before the planning meeting), but that their plans remained aligned throughout the week, in the weeks they used Compass. These results suggest that process management frameworks like Compass can not only help students come up with sound

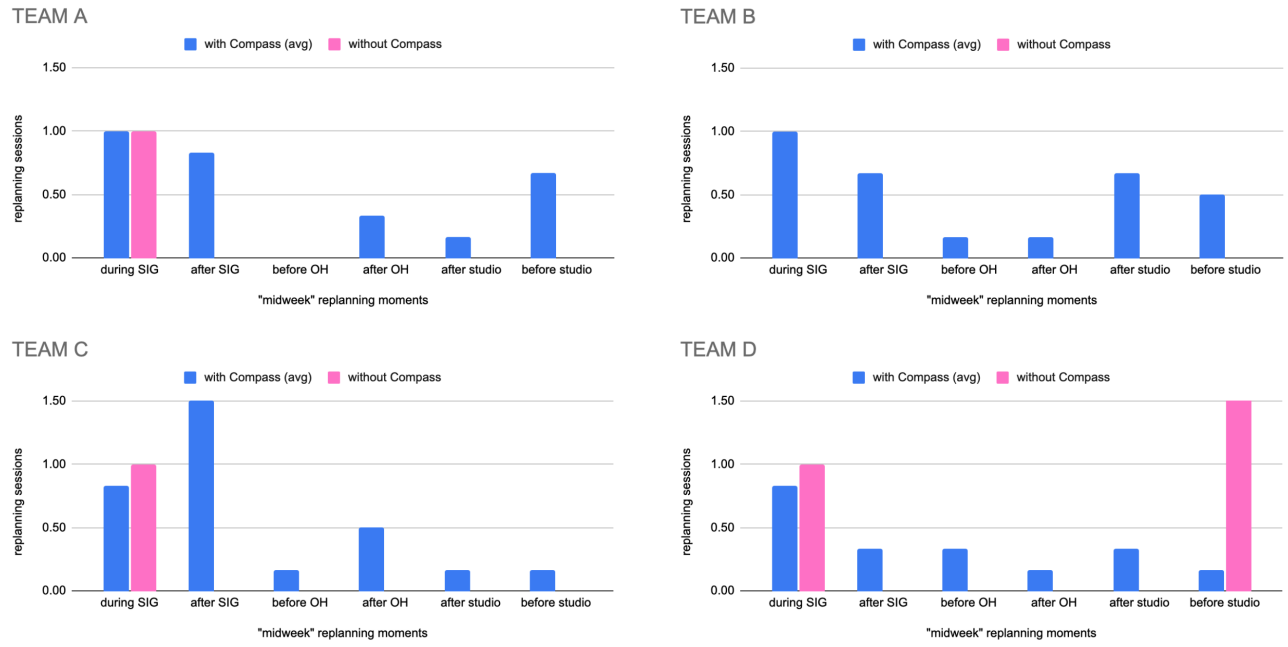


Figure 7: Per-Team Breakdown of "Midweek" Replanning Activity. These figures show replanning activity per team, during the "midweek" moments. Weeks with Compass are indicated in blue, while weeks without Compass are indicated in pink. We see a pattern of continuous replanning activity across midweek moments with Compass (blue), and replanning moments primarily during the SIG meeting, if at all, without Compass (pink).

plans (i.e. next steps that move them towards a deliverable that addresses a critical risk). They also suggest that such scaffolding can help students revise their plans throughout the week, such that their next steps still move them towards the deliverable and focus on their critical risks.

To illustrate differences in the structural quality of plans, consider Team B as an example, who is working on a system that seeks to build social connection between individuals by detecting and surfacing shared situations between them (e.g. connecting students who are all approaching midterm season). Below, we contrast the mentor's assessment of team plans prior to any SIG planning feedback in a week with, and a week without Compass.

When assessing a snapshot of the team's plan one week without Compass (Week 7), their mentor noted multiple misalignments in the plan structure. First, the risks and deliverables were misaligned in two ways: (a) *"While [team name] hoped to investigate on the practical side what their new ideas for connection goals are, their stated focus doesn't explicitly describe a user test."* and (b) *"While they mention their focus to be "how we might be able to leverage context with [prompts]", it's not clear what risk this is addressing."* Second, the next steps were misaligned with the risks and deliverables: *"There are several sprint stories + tasks which do not seem immediately aligned [to other plan components]."* This assessment highlights a critical misalignment: even if the student stories/tasks lay out building and testing a revised prototype, the focus of their sprint does not capture specific issues in their argumentation. Without this understanding, students may go through their design sprint, moving from revised argumentation to revised prototype to testing, but will not focus their efforts on their biggest risk: addressing these conceptual gaps in their work. Further, as their mentor points out, while some sprint tasks may be aligned with this risk and goal (e.g. "Research into why asking certain reflection questions at certain locations/contexts is more meaningful"), there was a long list of additional tasks, many of which were not aligned with the core risk identified above. In such a situation, our needfinding suggested that it's likely that the student may get distracted by other tasks, derailing them from the intended mission of their sprint.

In contrast, the mentor assessment of Team B's plan one week with Compass (Week 9) shows several structural alignments. First, their risks and deliverables were aligned: *"Their project risk is to test if parallel prompt using context will be effective for connecting, and so they will need to prepare by creating a prototype of their design idea and test that with users."* Second, their deliverables and next steps were aligned in two ways: (a) *"The next steps are aligned with the goal of building a tech prototype that can be deployed for a test."* and (b) *"the end steps are aligned with the goal of deploying and collecting feedback."*. The mentor did note a structural misalignment in this Compass week: *"Small – but they failed to mention the one underlying risk was not working on their learning goals of testing technology prototypes. They could have made a prototype that was not tech deployable to get at this risk."* The one misalignment the mentor found was minor, as they noted, and related to the personal learning goals of the students (i.e. building tech proficiency), which Compass is not designed to incorporate.

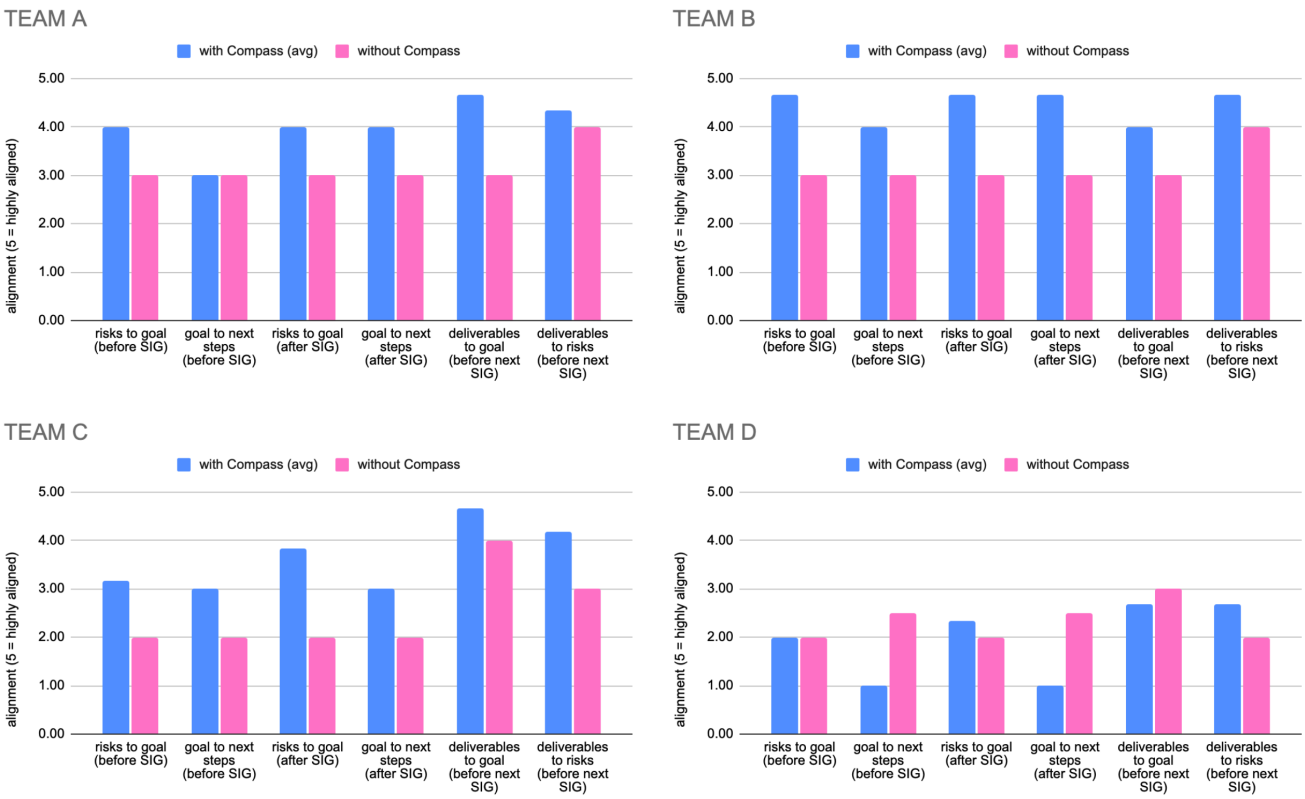


Figure 8: Structural Alignment of Plans with and without Compass, per Team. Here, we see that when teams used Compass (in blue) they generally maintained higher structural alignment throughout the week, when compared to when they did not use Compass (in pink).

When comparing the plan alignment of Team B with and without Compass, these examples suggest that when students lack alignment between their risks, deliverables, and next steps, and fail to adapt their plans throughout the week, they will continue forward while lacking a clear direction or focus for the way they will work that week, leading to a higher likelihood of getting off track in their work. As a consequence, students likely won't deliver what they initially set out to deliver, resulting in not addressing the risk they originally planned to mitigate. With process management frameworks like Compass in place, students adapt their plans within a structure that guides them to maintain the alignment of that plan, prompting them to find ways forward that still meet their deliverables and address their critical risks.

6.2.2 Students plans were better aligned with mentor feedback when using Compass. When students used Compass to manage their planning execution, mentors generally considered the revised plans of all four teams to be more aligned with the mentor feedback captured by students, with an average of 3.54 the weeks with Compass and 1.50 the weeks without Compass (where 5 = highly aligned). Figure 9 compares alignment data with and without Compass for each team. For Teams A, B, and C (which were a mix of both experienced and novice students), mentors generally considered the revised student plans to be "aligned" or "highly aligned" with their feedback the weeks they used Compass, and "somewhat aligned" or "not aligned at all" without Compass. For Team B, students failed to capture any mentor feedback during the meeting the week without Compass, which we verified in their retrospective interviews. These findings demonstrate that when student teams used the Compass dashboard and cues, they were able to not only capture, but implement the feedback they received from their mentors into a revised plan. Further, the ways in which students implemented the feedback and revised their plans aligned with the planning strategies the mentors had coached to them during their planning meetings.

To illustrate differences in alignment between student revised plans and mentor feedback, consider an example from Team C, who is working on a system that helps introductory CS students reflect on and improve ineffective mindsets and ways of working as they make progress on an assignment.

In the week without Compass (Week 6), the team's mentor noted a critical misalignment between what the students had delivered, and the planning feedback the mentor gave them throughout the week. The team had discussed using a design probe with their mentor that week, and even delivered a design probe according to their plans, but their mentor noted that the *"design probe is focused more on offering general misc. solutions rather than being specific about what the characteristic being tested is - i.e. not considering how*

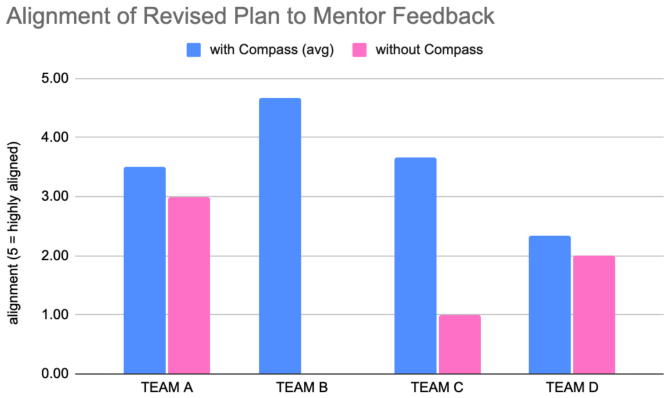


Figure 9: Alignment of Plans to Mentor Feedback with and without Compass, Per Team. Here, we see that across all four teams, students implemented changes to their plans that were more closely aligned to their mentor's feedback the weeks they used Compass (in blue), compared to the weeks without Compass (in pink).

helping students deepen their understanding of their own process/link between underlying causes and their process can help them change their process." Here, the mentor points out that the team's design probe, and the design of the user test itself, is not focused on testing and building knowledge around the critical project risk at the time: evaluation of a specific design characteristic. Due to this misalignment, the student was unable to conduct a test that resolved the critical project risk, and would need to conduct a more precise user test next week.

In contrast, the following week with Compass (Week 7), their mentor noted high alignment between what the student actually delivered, and what they discussed with the mentor throughout the week: *"Basically exactly what we talked about - user testing with a new prototype that tries to get at students' process journeys, as well as learning more about how experts handle these problems."* In terms of misalignment to plan feedback, their mentor noted the following: *"Not much, really."* Unlike the week without the Compass, the mentor considered the students' completed deliverables to be highly aligned with the plan feedback that they gave to the team throughout the week, now planning a user test that addresses their core risk.

This example illustrates how even with students who are novice to design research and the learning ecosystem in which they practice, the Compass system enabled them to revise their plan in ways that implement the planning feedback they received in a feedback venue that week, resulting in completed deliverables that were highly aligned with what the mentor expected.

7 Discussion and Future Work

Our findings demonstrate that the Compass system supported students in managing their planning process effectively, guiding them to continuously adapt plans as experts do in practice. First, when students used Compass to manage their planning process, they successfully adapted their plans throughout the week before and after key feedback venues. By identifying these opportune moments where students are likely to receive planning feedback, we can design interaction sequences that guide students to enact best planning practices in concert with these existing feedback venues.

Further, when students adapted their plans in response to feedback throughout the week, our findings demonstrate that students maintained plans with sound structure, where their next steps moved them towards completing the deliverables that would mitigate their critical project risks. Literature describes how expert design-researchers set an initial objective, but then flexibly and continuously adapt their plans in response to changes in problem information (i.e. new risks, focusing on one of many deliverables, etc), so that they can still meet the objective [1]. By providing students with a lightweight template that reflects the core components of a plan (the risks, the deliverables, and the next steps to complete them), Compass scaffolded students to initially structure and then periodically monitor the alignment of their plan, and whether they maintain focus on the intention of their iteration.

Finally, our findings showed that Compass enabled students to revise their plans in ways that accurately implemented the planning feedback surfaced via ecosystem supports throughout the week. This is because Compass focused on lightweight interactions (i.e. a dashboard that enabled students to capture feedback within the structure of the plan itself), and interaction sequences, reinforced by cues within existing communication tools that model social structures (i.e. SIG channels in Slack) to implement that feedback at opportune moments, such as prior to leveraging a feedback session. These findings suggest that process management frameworks like Compass can guide students to successfully monitor and revise their plans in ways that reflect the planning strategies surfaced to them through their learning interactions within the planning ecosystem.

This research demonstrates a need within learning ecosystem design – as we extend the supports and corresponding learning interactions that enable students to practice metacognitive skills like planning, it's necessary to also scaffold students to enact their practice as they execute within the ecosystem. By extending such ecosystems with process frameworks like Compass, we can better support student practice by modeling specific subroutines that train

students to enact ideal learning strategies that leverage available planning supports in the subsystem of practice. In this way, we can increasingly help students and mentors recognize the ways in which students can improve their metacognitive practice, and guide them in the actionable next steps they can take to improve their practice, as they practice.

Future work can explore the role of such process management frameworks in supporting students to build and *maintain* a practice. For example, our empirical findings suggest that both senior and novice students showed improvements in their process execution the weeks they used Compass, and saw less effective process the weeks the framework was removed. This suggests that, irrespective of the level of expertise, students may benefit from process scaffolds that help them set up and build the routines of their practice, and even as they work to maintain a practice through the moments of dysregulation, i.e. when their surrounding contexts shift.

In learning ecosystems with socio-technical supports that scaffold these other metacognitive skills, future work can similarly aim to guide metacognitive practice across these supports, at opportune moments. For instance, process management frameworks can guide particular helpseeking interactions throughout the week, such as routing someone to an expert when they encounter an obstacle in their work, or guiding someone in framing help requests for upcoming feedback and practice venues. Similarly, recent work begins to explore how process management frameworks can guide the practice of reflection strategies at particular moments [32]. For example, capturing both project feedback (e.g. "Work on defining measurable outcomes for your user testing this week") and metacognitive feedback (e.g. "You planned an ambitious user test and likely don't have the hours to execute it. Rather than overcrank, consider focusing your user test on the core functionality you want to test") in a feedback venue, and attempting to adapt and practice new ways of working in response. In this way, process management frameworks can enrich existing metacognitive practice environments, guiding learners in a deeper, more authentic practice of their skills.

8 Conclusion

In this paper, we introduce Compass, a system that guides design-research students to recognize and act on replanning moments as they work in an ecosystem of planning supports. There exist many socio-technical scaffolds that train component skills of planning (e.g. visualizing the design problem, diagnosing risks, focusing plans on key risks), or weave socio-technical supports together (i.e. tools, processes, feedback venues) into learning ecosystems to train skills like planning. However, few works consider how to guide students to flexibly adapt their plans at opportune moments, such as after one receives planning feedback in a feedback venue, or replanning prior to a venue to better leverage available support. Further, needfinding demonstrated that students failed to recognize such replanning moments, and to strategically adapt their plans in response. To overcome these challenges, Compass uses a combination of in-action cues to prompt students at desired replanning moments before and after feedback venues, and an on-action dashboard that scaffolds students to adapt and re-align the structure of their plans in ways that implement planning feedback. Our 8-week deployment study demonstrates that design-research students using Compass adapted their plans more before and after feedback venues, and executed plans that were more structurally aligned and better integrated feedback. Our findings demonstrate a need to advance the design of learning ecosystems with process management frameworks like Compass. Such frameworks can guide students in enacting desired learning interactions across ecosystem supports, enabling learners to build an authentic practice of metacognitive skills like planning.

9 Acknowledgments

We thank the members of Design, Technology, and Research program and Delta Lab at Northwestern University for their continuous feedback. Funding for this research was provided by the National Science Foundation under Grant No. 250633.

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