

Supporting high school students' self-directed learning experiences through documentation tool design

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ABSTRACT

This paper offers a case study of the co-design and evaluation of learning support tools resulting from a design-based research engagement with facilitators of a year-long high school self-directed learning (SDL) experience. As a co-design team, we developed an integrated set of physical and digital documentation tools - the SDL documentation kit - to support student reflection on their learning and articulation of their skills while building an evidence base that they could use to apply for competency-based micro-credentials. The documentation kit consisted of a QR-linked manipulable poster, an evidence upload form, a structured cloud folder, and a timeline visualization function. The kit was made available to over 60 students, with 14 students and two educators (also co-authors) taking part in an exploratory study of tool deployment. Mixed methods findings suggest that the kit was successful in supporting key documentation-related learning processes of reflection and articulation, and that students linked the documentation kit affordances of organization, tracking progress, and making their thinking visible to their confidence in completing their SDL experience and applying for selected micro-credentials. We discuss implications for the design of documentation technology for learning, including the importance of centering pedagogical values and practices.

CCS CONCEPTS

• **Applied computing** → **Education**; • **Human-centered computing** → **Participatory design**; **Empirical studies in interaction design**.



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KEYWORDS

self-directed learning, competency-based education, co-design, design research, educational technology, documentation and learning, reflection

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1 INTRODUCTION

Open-ended and self-directed work is a hallmark of creative learning environments such as makerspaces, arts and computing studios, and project-based educational experiences. Documentation – the tools and practices that record and make the processes and products of student learning visible – plays a crucial role in these environments. This design-based research case explores how technology-enhanced tools were intentionally developed to foster documentation activity and practices associated with self-directed learning (SDL) in a high school setting in the United States. Specifically, we report on the results of an extended co-design process with educators to design and deploy a “documentation kit” to support student learning.

2 BACKGROUND

Disciplined and habitual use of documentation routines and tools in creative practice are known to support the cultivation of domain-relevant skills and competencies [13, 24, 39]. Documentation practices are recognized as expansive learning tools in creative learning environments such as makerspaces and design studios [12, 32, 41, 46]. Digital capture, organization, and communication have been much explored as support for demonstrating learning [15, 22, 47, 48]. While it's feasible to automate, nudge, and structure documentation tasks, user motivation, organizational effort, and intuitive mechanisms for capture, management, and sharing remain elusive [12, 18].

Current trends in U.S. K-12 formal schooling emphasize greater student choice, autonomy, and self-directed learning [7]. This has

led to renewed interest in educational approaches that center inquiry-based learning [3] and project-based learning [33]. These approaches build upon and extend the principles of experiential education theorized by John Dewey [20] and his intellectual successors, emphasizing hands-on engagement and connected to real-life experiences as the context for learning. It follows that these approaches are closely linked to frameworks such as competency-based education [11, 35, 49] which emphasize growth and mastery of targeted skills in ways that center students' personal interests and bring real-world relevance to their work.

Demand for authentic, hands-on student experiences that accompany a competency-based ethos has necessitated the development of accessible yet systematic tools and routines which enable students to mindfully capture, store, organize, curate, and synthesize the processes and products of learning experiences. Performance assessments [30], learning portfolios [10, 12], badging [1, 31], micro-credentials [21], and mastery transcripts [38] are all examples of attempts to reimagine how individualized learning is motivated, demonstrated, and evaluated. These formats center demonstrations of learning and descriptions of skills acquired or improved in place of grades. Yet despite shifts towards more holistic, open-ended, and self-directed approaches to learning, documentation is still typically used for assessment purposes. Like studio and makerspace educators, classroom teachers struggle to cultivate practices that move documentation from a compliance exercise to an intrinsic, valued practice that encourages open-ended inquiry and reinforces ownership over the pace and direction of one's learning.

2.1 Mediating Processes Found in Documentation

For this design research project, we organized our work around two key behaviors, or mediating processes, which research suggests are important to learning and to creative practice. Specifically, we intentionally designed the documentation kit to facilitate: *reflecting* and *articulating*.

2.1.1 Reflecting. Reflecting refers to the act of reviewing, assessing, and using what one has experienced, observed, or produced, to constructively move work forward. In learning, slowing down to notice and consider one's process and performance supports internal, reflective dialogue [14, 19]. Documentation activities like logging or taking a picture to coax a learner to contemplate their process, product, and learning experience. Schön [44], Brereton & McGarry [8], and Sengers et al [45] similarly highlight how design and hands-on inquiry-based learning embody forms of reflective practice. In learning settings, it is important to form a shared language to define the modes and purposes of reflection and the conditions in which it takes place [4, 23]. In our co-design project, reflection is the building block of self-regulated learning in which one is able to monitor and maintain progress toward one's learning goals [50].

2.1.2 Articulating. Articulating refers to the socially situated process in which students synthesize, give language, voice, and meaning to their creative intent, process, and experiences. In tandem with reflection, articulation is crucial to managing one's learning and supports sensemaking in complex or unstructured inquiry processes that aim for integrated understandings [37]. Articulation

involves translating what one has noticed and/or reflected on into spoken, written, or visual language proximal to what is happening in the learning environment [42]. Articulation can focus on demonstrating knowledge of skills and concepts or be used to illustrate problem-solving, externalizing, and clarifying the learner's thinking processes and performance [14]. For our purposes, the main value of articulation is that it reinforces and synthesizes learning that may have occurred during a creative process and in conversation with others [43].

3 CONTEXT

3.1 Quaker Valley Self-Directed Experiential Learning

Quaker Valley High School (QV) is a public, suburban high school in western Pennsylvania. The school served 623 students during the 2020-21 school year, approximately 17% of whom were eligible for the federal free or reduced-price lunch program. Demographic data reports racial/ethnic identification as 87% White, 5% Black, 5% "two or more races," and less than 5% as American Indian/Alaska Native, Asian, or Hispanic combined.

Beginning in 2017, our practice partners and co-authors, Linda Conlon and Amy Keller, designed a career counseling curriculum that aspires to empower Quaker Valley High School students to navigate and thrive in their endeavors upon graduation. Influenced by John Dewey's views on experiential learning [20], Art Costa's work on habits of mind [17], and the Next Generation Learning Challenges' MyWays project [34], the Quaker Valley Wayfinding Framework focuses on student engagement in three overlapping dimensions: individual interests, strengths, and skills; the world of work; and experiential learning opportunities. In 2018, the QV School District adopted an innovative element of the wayfinding curriculum as a graduation requirement: a year-long independent study experience entitled Self-Directed Experiential Learning (referred to by educators and students as "SDL experience" or simply, "the SDL").

For this endeavor, each student identifies an SDL experience aligned with their interests and the skills they would like to develop or improve. As their SDL unfolds, they are guided to collect evidence of learning and skill growth, which they then use to apply for micro-credentials across three domains: Habits of Success, Creative Know-How, and Wayfinding Abilities. The three domains and corresponding micro-credentials are visualized in Figure 1 and adapted from [6].

The educators encourage students to go for depth over breadth by selecting 2-4 (out of 14) micro-credentials that are most relevant to their SDL. Students do not need to commit to specific micro-credentials at the outset; while the co-authors encourage students to identify focal micro-credentials early as part of SDL planning, they also communicate that it is common for these to change as some skills prove to be less salient or compelling, while others emerge as better-aligned and more strongly evident. Recognizing these shifts and responding with intention is an essential SDL feature.

To support SDL development, the educators guide students through a curriculum that includes self-discovery assessments, brainstorming, goal setting, learning about different types of evidence, and

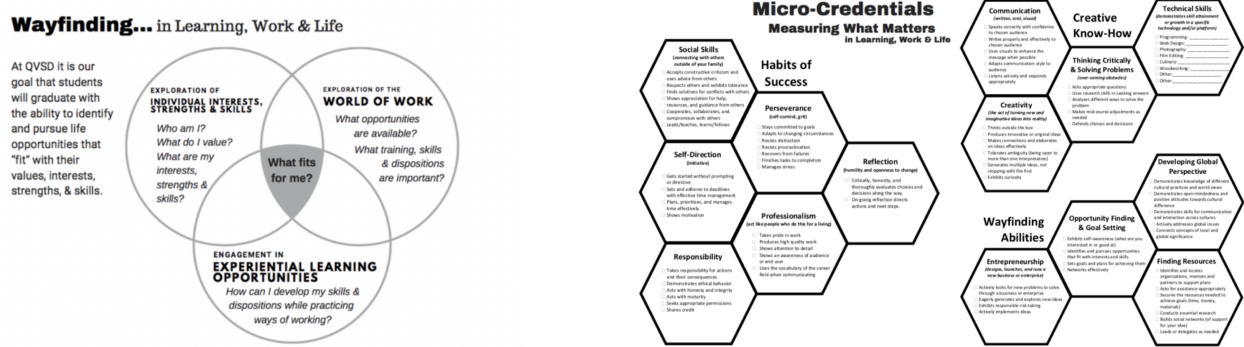


Figure 1: Left: The SDL Wayfinding Framework. Right: SDL Micro-Credentials

sharing emerging plans with themselves and peers. A student typically begins their SDL in the fall of their third year of high school and fulfills the requirements by the following June although time can be extended if needed. When students approach the conclusion of their SDL, they complete an application in which they formally indicate the micro-credentials for which they are applying, accompanied by a brief written rationale. The final step is a “press conference” presentation attended by the educators as well as any faculty, administrators, community members or peers the student invites. During the press conference, students tell their SDL story and highlight evidence of learning and skill development to justify the micro-credentials they wish to earn. After the press conference, the Conlon and Keller review students’ applications and presentations, and notify them of the micro-credentials they have earned to fulfill their SDL graduation requirement. The micro-credentials a student earns appear on their transcript and are contextualized in letters of recommendation which are included in college application packages.

3.2 Co-design Partnership

Prior to the SDL collaboration, co-authors, Stol, Louw and Byrne had engaged with Quaker Valley educators in exploring how documentation technologies can facilitate student learning in creative environments. They facilitated a series of generative workshops involving preliminary design research activities that would help the team better understand the contexts of learning, emphasize valued practices, and explore technological and design possibilities [9]. The SDL collaboration grew out of this larger project and prioritized a close research-practice relationship in which co-design was conceptualized as an act of co-creation [40] between design researchers and education practitioners. For the remainder of this paper, “co-design team” refers to all five co-authors (three university-based learning researchers and two school-based educators).

The SDL co-design team’s design goals were framed at the intersection of the researcher co-authors’ interest in mediating processes of documentation and the educator co-authors’ SDL values. Much of the team’s ongoing discussion centered on pedagogical aspirations for the SDL experience, namely, to develop students’ self-efficacy (the belief that they can do what they set out to do); to reinforce a sense of ownership of their own learning (that they have autonomy

and agency in their SDL), and to cultivate a process-over-product orientation towards learning outcomes. The educator co-authors put emphasis on the ongoing collection of evidence related to skill growth as it is a crucial mechanism for realizing goals. This often runs counter to traditional grading systems which condition students to think of their learning as valuable and demonstrable only in summative terms (e.g., a final grade). The co-design team’s mutually agreed upon problem, therefore, was the challenge of facilitating students’ awareness of their skill development during the SDL process, rather than retrospectively. Thus the co-design team decided to focus on designing tools that would catalyze those reflective moments and enable students to strengthen the evidence base on which they could articulate their learning.

3.3 The SDL Documentation Kit as Design Response

The SDL documentation kit included a printed take-home poster set linked via a QR code to a form-based digital system utilizing the Google suite of cloud-based tools to upload, tag, review, and curate evidence of learning (Left, Figure 2). Though components of the kit were designed to complement each other, students could choose which physical and digital tools they used.

The poster included a set of hexagonal cards describing each of the fourteen SDL micro-credential competencies a student could earn (right, Figure 2). Selected micro-credential cards can be slotted into the poster allowing students to personalize its focus, layout and composition. Color-coded stickers representing the four evidence types – anecdote, document, visual, feedback – emphasized in the SDL curriculum. The stickers could be placed on a micro-credential card to highlight evidence collection and make visible progress towards achieving a micro-credential.

To enable convenient and consistent digital capture of evidence with a mobile device, the poster set contained a printed QR code that linked to a Google-based evidence upload form. The form prompted the student to name and describe the nature of evidence, identify it by evidence types, label it with the micro-credentials skill they believe apply, and explain how the evidence demonstrated growth or competence for the corresponding micro-credential(s). Students could also attach a media file or document to the upload form before submitting. This process was intended to catalyze reflection, remind

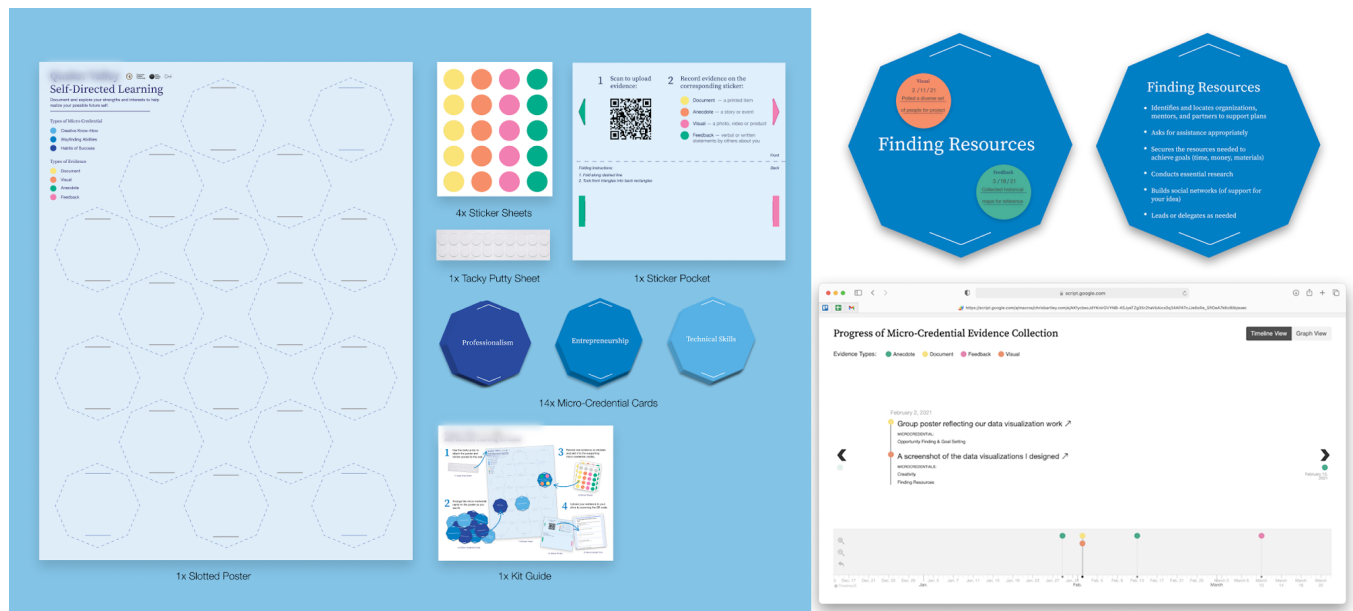


Figure 2: Left: SDL Documentation Kit; Right Top: SDL Micro-Credential Card with Color-Coded Stickers; Right Bottom Timeline Visualization

students of the range of types of documentation that could be used as evidence of learning, and tag the evidence with appropriate metadata for later review. A custom automated script processed a student's uploaded evidence and copied uploads into one or more cloud folders corresponding to the fourteen micro-credentials. Each student had their own set of folders, which they could use to access and review and share with others, namely, SDL peers and educators.

Finally, an interactive timeline visualization (see bottom right Figure 2) offered students a way to review accumulated evidence and select individual examples for use in micro-credential applications and final press conference. The visualization had two modes: one view displayed the history of evidence collection by evidence type, and the other view enabled students to see the accumulation of evidence towards specific micro-credentials. The timeline was intended to support students in reviewing evidence and reflecting on their SDL progression.

4 METHODS

Deployment of the SDL documentation kit took place from January 2021 through June 2021. The educators facilitated monthly group check-ins with students via Zoom due to the COVID-19 pandemic. The poster, evidence upload form, and Google folder structure were introduced to students during their February check-in session. The timeline viewer feature was introduced to students during March. Two research questions guided research design and data analysis:

RQ 1: What is students' level of engagement with the documentation kit in terms of frequency and characteristics of use?

RQ 2: In what ways, if at all, is the documentation kit valuable as a tool to facilitate reflection on learning and the articulation of micro-credential-related skills?

4.1 Data Sources

Sixty students worked on their SDL during the deployment period, and all had access to the documentation kit. Within this cohort, 15 students were consented to participate in the research component of the co-design partnership. Fourteen of these students, whom we refer to hereafter as "participating students," subsequently engaged in data collection activities. They represented approximately 23% of the total 2020-21 SDL cohort. Data sources utilized for the research aspect of the co-design project are listed below:

Student Pre-Survey (14 student responses): Survey items explored students' experiences with creative learning projects, attitudes towards documentation, and use of documentation technologies.

Student Post-Survey (12 student responses): The post-survey contained repeated items from the pre-survey as well as a new bank of items querying students' use of the documentation kit, perceptions of its value to their SDL, and usability feedback.

SDL Check-in Sessions (8 observations): Co-authors Conlon and Keller observed the monthly Zoom check-in sessions facilitated by co-authors Stol and Louw in February, March, April, and May 2021. During the March and May sessions, time was also used to elicit formative feedback on documentation kit features via Zoom's chat function.

Evidence Upload Form Analytics (60 student users total, 14 participating student users): The evidence upload form provided usage data in terms of volume, frequency, and timing of upload form

use, the categories of evidence uploaded (anecdote, feedback, document, visual), and the micro-credentials tags students applied to each piece of uploaded evidence. Anonymized analytics were made available to the researcher co-authors, while a subset of data from participating students was identified using unique alphanumeric markers linked to student pseudonyms. The team could also access the actual uploaded artifacts from this subset of participating students only.

Focus groups (4 focus groups, 12 students total): After completing their press conferences, participating students were invited to take part in a one-hour focus group. We facilitated four groups total. The semi-structured focus group protocol included open-ended questions and using Jamboard, to elicit feedback about the kit's value (or lack thereof) at three major points in the SDL process.

Educator interviews: Researchers formally interviewed each educator three times – once before the documentation kit launch, once mid-deployment, and once after the 2020-21 SDL cycle had ended. These interviews focused on their goals for the SDL experience and for the documentation kit and their perspective on the value and challenges of using the documentation kit.

Co-design meeting recordings: We recorded the conversations among the five co-authors which occurred at four co-design meetings. This enabled us to chart the evolution of the SDL documentation kit co-design, including the formalization of design goals, the marking of conceptual and logistical challenges, and in-the-moment reflections on deployment.

4.2 Data Analysis

Descriptive statistics were run on the evidence upload form analytics (organized in spreadsheet form), from which we drew findings related to upload frequency, volume, and the application of micro-credential and evidence tags. We further examined these analytics against upload dates to build a picture of different dimensions of upload form usage over time.

We used an iterative, constant comparative approach [25] to analyze the qualitative focus group, interview, and co-design meeting data. This involved multiple rounds of coding to explore not only emergent themes, but the strength and integrity of themes relative to each other, as well as possible relationships between them. Transcripts were first segmented into “meaning units” [5], which we defined as an exchange, segment of conversation, or standalone quote in which a central topic could be identified, and for which a beginning and end could be demarcated. This process resulted in 75 meaning units within the focus group data and 74 meaning units within the combined corpus of interview and co-design meeting data. We next engaged in an initial round of open coding to identify meaning units containing content relevant to the purposes of the SDL experience and to the documentation kit design goals. During subsequent rounds of focused coding [5] and axial coding [16], we augmented, revised, and/or collapsed thematic categories by attending to code frequency, co-occurrence, significance, conceptual similarity, and the dialectic between categories. We also used SDL check-in session observation notes and usability feedback, and post-survey items related to SDL documentation kit use and value. This helped to triangulate analytic conclusions from our qualitative data to strengthen, nuance, and/or disconfirm thematic findings.

Documentation kit deployment and related data collection was conducted within the context of the 2020-21 academic year, during which QV was either fully remote or hybrid due to the COVID-19 pandemic. As such, students' SDL experiences, documentation behaviors, and utilization of the documentation kit were likely different than might otherwise occur. The atypical school year also posed a challenge for recruiting students. Many were navigating the shifts to new instructional formats and were reluctant to add what may have been perceived as additional work. This resulted in a relatively low participant count (14 out of 60 possible) and consequently, a greater reliance on qualitative data. Self-selection bias must also be taken into account, as participating students likely had higher initial interest in using the documentation kit than their peers. Additionally, a glitch prevented use of the evidence upload form and no data was collected during the second week of deployment. This may have had a small effect on findings related to usage.

5 FINDINGS

We organize our findings by the two research questions documented in the above Methods section.

5.1 Documentation Kit Usage

5.1.1 The participating student group used the evidence upload form to a greater extent than their SDL cohort peers. Sixty students interacted with the digital evidence upload form at least once, logging a total of 180 uploads. Within this dataset, participating students uploaded 97 evidentiary artifacts, accounting for 54% of their SDL cohort's upload form usage overall. Furthermore, the upload form was used with medium to high frequency by more than half of the participating students, with eight of the ten highest frequency users (five or more uploads) found within the participating student group. This pattern offers insight into the relationship between research study participation and documentation kit usage. In addition to the self-selected nature of participating students that may reflect greater interest and investment in using the kit, participating students were intentionally grouped together for their check-in sessions (see data sources above). During these sessions, educator co-authors tended to make more explicit connections between the SDL curriculum and documentation kit features, and researcher co-authors were able to solicit formative feedback on the kit. Both served to focus participating students' attention on the documentation kit as a resource. The combination of these activities suggests the importance of deliberate facilitation and integration of documentation kit usage into instructional activities.

Table 1 offers a brief, high-level description of each participating student's SDL alongside the total number of evidence uploads, in ascending order (pseudonyms have been applied). In keeping with the intentionally open-ended and student-directed nature of the SDL, participating students' SDLs varied greatly. These data break down to an average of 6.86 evidence uploads per participating student (min=1, max=18), with high variability across the group (std = 5.43). As Table 1 shows, eight participants (57%) uploaded more than five pieces of evidence, and five of these uploaded more than ten (35%). The remaining 42% (6 students) can be classified as “low” users, with fewer than 5 uploads. It is notable that two students in

this latter group did not complete data collection activities beyond the pre-survey, indicating possible disengagement with the study and/or lack of interest in using the kit. It is also important to note that the number of evidence uploads does not necessarily represent the only evidence students collected and drew upon over the course of their SDL, but rather the evidence that they utilized a specific feature of documentation kit to capture.

5.1.2 Upload tags reveal student use aligned with the pedagogical emphases of the SDL and highlight ways in which digital documentation data could be leveraged to inform the guidance and differentiated support offered to students. The evidence upload form allowed students to associate each piece of evidence with up to three of the 14 possible micro-credentials. The fourteen participating students applied 192 micro-credential labels to 97 evidence uploads, which demonstrates that students commonly saw their evidence as speaking to more than one micro-credential. Self-Direction (27 tags), Reflection (20 tags), and Perseverance (23 tags) were the highest frequency micro-credential tags in absolute terms, with Social Skills and Technical Skills (21 tags each) close behind. For the most part, these corresponded to the highest proportions of participating students who used these tags, too: Self-Direction and Reflection each with 9 unique students; Perseverance and Social Skills each with 8 unique students. This is unsurprising given the emphasis on self-directedness inherent to the experience (the “SD” in SDL), the emphasis on reflection built into the SDL process by educators, and the fact that challenges through which one must persist are an expected and even desired aspect of the SDL. These tags suggest students absorbed these messages and were consequently more likely to focus on and recognize the manifestation of these skills.

A snapshot of micro-credential tags by individual student offers another angle on this data. In the heat map (left, Figure 3) we see that Sarah (A09) and Emily (A13) collected evidence across almost all micro-credential categories, though we see more densely applied tags within each band. In contrast, Kelly (A03) honed in on just four micro-credentials. Taken together, these group trends and individual profiles offer insights into how SDL projects may shape the collection of evidence, and how broadly or narrowly students are thinking about the skill sets they are developing. It also provides a window into how these data could be used to strategically group students for check-ins and peer-based support.

Our analysis of upload tags by evidence type offers another window into how students approached substantiating their micro-credentials. Participating students favored documents (38 uploads), followed by visual evidence (34 uploads) and anecdotes (20 uploads); feedback was only tagged in 5 uploads. As with the micro-credential heat map (left, Figure 3), the individual profiles of uploads by evidence type highlight different behaviors and approaches to documenting progress and skill development (right, Figure 3). There was no quota set for any evidence type, but the reliance on documents is consistent with a narrow view of documentation perpetuated by formal schooling.

5.2 Supporting Student Learning

In this section we present findings on the extent to which the documentation kit facilitated student reflection on learning and the articulation of micro-credential-related skills.

5.2.1 SDL evidence organization features were foundational in realizing the design goal of engaging students in the mediating processes of reflection and articulation. A straightforward but important finding involved students’ unanimous identification of organization as a primary benefit of the documentation kit to their SDL experience. They called out the categorization function of the poster and upload form, the centralized storage function of the Google Drive folders, and the aggregation function of the timeline views as useful aids for managing and keeping their SDL “on track.” Ten of the twelve focus group participants expressed appreciation for how one or more of the kit’s features provided an organizational structure which made their SDL progress visible and accessible. Others who used it less also reported that the visual nature of the documentation kit features provided the kind of “reassurance” she mentioned:

“I was able to just look back at all the evidence and all that I completed. And once I did, then I was able to see how far I had left to go and... that caused me to stay organized and get my project done on time...” -Penny
 “Having the visual representation of how much evidence I had was extremely helpful. It made me feel like I was making the progress that I aimed for.” -Kara

These reports suggest a practical valuing of kit features to keep track of evidence over the course of a months-long experience.

The visual nature of these features offered both motivational and functional benefits. Physical and/or digital representation of their collected evidence showed students the skills they had substantiated and how much they had accomplished, as well as helping them plan accordingly in order to complete their SDL. Students’ use of words like “pride” and “reassurance” to describe how it felt to see indicators of their progress over time, suggesting that this aspect of the kit contributed to a sense of self-efficacy and accomplishment (an SDL objective). Triangulation of these focus group data with post-survey data and educator interviews strengthened our finding that the intentional scaffolding of organization for students instrumentally encouraged reflection and made articulation of their learning easier.

5.2.2 Visual features also supported reflection on SDL next steps. One throughline that emerged within the general theme of tracking and planning was the efficacy of having a visual reference of accumulated evidence that could inform decisions about which micro-credentials to pursue. Those who used the poster reviewed their Google Drive folders, or activated the timeline viewer could quickly observe which micro-credentials were amassing evidence and which were still lacking. One student, Sarah, provided the most explicit example of this:

“...at first, I was overwhelmed [by the poster] because there were so many micro-credentials...I originally thought ‘Okay, I need to come up with these micro-credentials and I need to fill them out’, but once I started to add more evidence and had different micro-credentials, it allowed me to look back and be like, ‘okay I like these certain micro-credentials, let’s aim for

Student	SDL Description	Uploads
Sawyer	Worked with Brandon to create instructional mountain biking videos	1
Brandon	Worked with Sawyer to create instructional mountain biking videos	1
Jackie*	Focused on developing visual arts skills	1
Isla*	Designed a plan for an entrepreneurial venture	2
Penny	Used an Arduino to program a light show	3
Miriam	Researched the history of tea, created her own blends, and created a website highlighting both	3
Rina	Planned a gap year	6
David	Participated in a business competition to create a client investment portfolio	6
Hannah	Conducted scientific research and presented at a competition	8
Emily	Taught a beginners mountain biking class to a group of upper elementary school-aged girls	10
Kelly	Learned four basic medical procedures	12
Molly	Wrote a psychology research paper and submitted it to a competition	12
Erin	Made "happy squares" and distributed them to local elementary schools	13
Sarah	Learned the fundamentals of American Sign Language (ASL)	18
Total		97

Table 1: Participating Student SDL Description and Total Uploads. * indicates did not complete a post-survey or participate in a focus group.

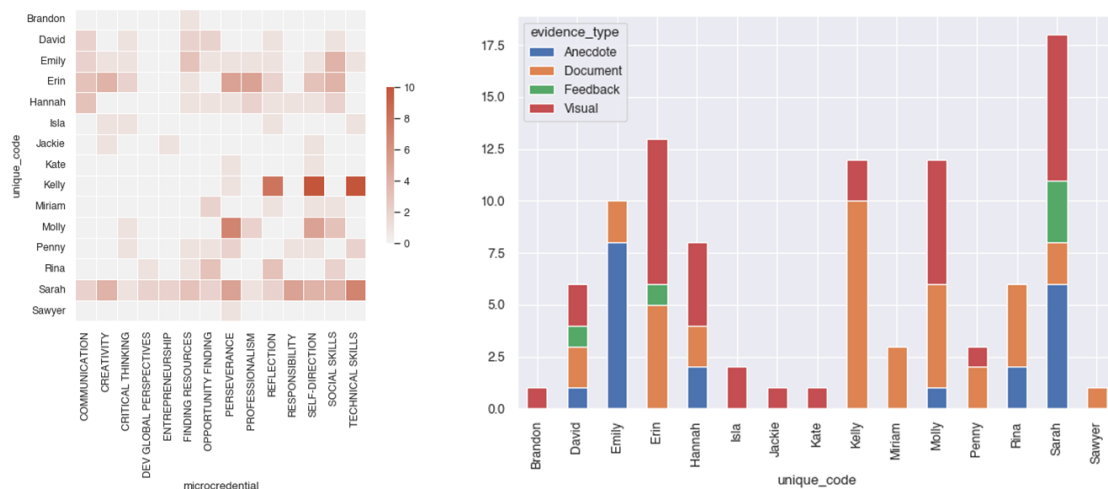


Figure 3: Left: Micro-Credential Tags by Participating Student ; Right: Participating Student Uploads by Evidence Type

these ones', and it allowed me just to see... where I like to lean more towards."

In Sarah's case, the population of micro-credential cards and evidence on the poster triggered reflection on the development of micro-credential-associated skill sets relative to one another. It prompted other students to notice and learn something about themselves (i.e., skills towards which they had a more natural affinity) as well. They corroborated the helpfulness of digital features such as the micro-credential upload timeline in elevating micro-credentials they wanted to pursue, and in subsequently making choices about what should be either further substantiated or dropped. Yet at the same time, the poster had the most mixed results among documentation kit features in terms of use and usability feedback. Some students reflected that they wished they had leveraged the poster kit more as they felt it may have been "easier" to use as tool to

visualize progress and more helpful to use in conjunction with the digital features when preparing for their press conference.

5.2.3 The evidence upload routine facilitated active reflection on learning. Half of the focus group participants (six of the twelve) spoke in depth about how use of the evidence upload form elicited in-the-moment reflection. They attributed this to the structure of the form which prompted them to categorize their evidence by micro-credential and type, and then justify those decisions ("How does this evidence support the chosen micro-credential?"). Specifically, the option of selecting multiple micro-credentials per piece of evidence was an unanticipated reflective moment for students, as illustrated by Rina:

I never really thought of the idea of using [a piece of evidence] for more than one [micro-credential], so I know on the upload form, there

was like ‘what credential would you use?’, but there were three different options. And so, when you were filling it out you do the first one...you look at the second one and think ‘is there another way this could apply?’... [This] happened to me on a few occasions, especially because some of them are kind of similar but then you think ‘oh it works better for this one.’”

Rina’s sentiments here were echoed by peers. They spoke of coming to the prompted realization that one piece of evidence may speak to multiple skills. This suggests the design intention of the evidence upload form – to engage students in a form of coding their own experiences first implicitly (selecting categories) and then explicitly (responding to questions about those categorizations) – catalyzed reflection on why their evidence demonstrated one or more micro-credential-related skills. Qualitative data offered promising evidence that these reflections influenced micro-credential selection in constructive ways. Indeed, in their mid-point and post-deployment interviews, the educator co-authors voiced that they saw the tagging task as possibly the most important and successful component of the documentation kit.

5.2.4 The evidence upload routine made students’ prior thinking accessible for future use in articulating their learning to others. Students described leveraging documented instances of reflection to articulate their learning and skill development when applying for micro-credentials and preparing for their press conference. The categorization and explanatory prompts built into the upload form captured students thinking at an important point in time; a moment of reflection on the significance of selected evidence tied to an SDL experience. This was valuable for learning and also meant they did not have to rely on memory when they reached the end of their SDL. This was illustrated in two excerpts:

“The evidence kit allowed me to understand what my thinking was at the time that I took a certain picture and helped me explain why I should earn that micro-credential.” -Elaine
 “...when I was doing the micro-credential applications, it was really helpful for me to just remember what I had been thinking when I uploaded the evidence, so my reasoning was consistent across the board...” -Kelly

In other words, reflecting in the moment of upload on why this evidence supported the development of a micro-credential built a corpus of justification along the way, enabling smoother and “consistent” articulation of skill development. The reflective pieces students produced laid a stronger and more direct foundation for articulating their learning journey to others, demonstrating a connection between reflection and articulation in which the two exist on a continuum of internalized to externalized forms of meaning-making. As a practical extension of this finding, students further reported that the documentation kit features also helped focus their final micro-credential selections and curate the most illustrative evidence to articulate their skill development, making preparation for the press conference “easier” and “faster.”

6 DISCUSSION

Our qualitative analysis suggests students made connects between the organizational affordances of the documentation kit and their subsequent ability to reflect upon and articulate evidence which demonstrated skill growth and competency. Across all sorts of learning environments, but especially those oriented towards creative practice, information management skills are increasingly required. Students must wrangle varied content, media assets, platforms, and processes; design solutions for documentation should attend to the complexities of information management needs across digital and non-digital formats. Every participating student across four different focus groups called out to some degree the instrumental and/or motivational value of being able to structure, categorize, and retrieve their evidence of learning using features of the documentation kit, better enabling them to pursue their SDL goals by helping them plan, monitor, control, and reflect upon their learning. These activities are key aspects of self-regulation, the process of self-monitoring progress and performance in pursuit of learning goals [50]. We posit that the visibility of these organizational scaffolds constructively catalyzed the interplay of motivational and metacognitive routines which support making conscious choices about when, where, and how to place effort - learned behaviors which play a central role in self-regulation [29]. The SDL experience also connects to a longstanding dialogue around managing documentation in educational technology and personal information management (PIM) [2, 36]. Documentation – and the archival collection of large volumes of learning process and product information – necessitate the need for strategies to manage, review, and organize the complex information. To this end, we highlight the intentional and creative use of Google Drive to manage documentation content. A widely used platform like the Google Workspace affords data portability, allowing students to easily access and migrate content after their SDL experience is complete. It also allows educators to model organizational structures to students that they can replicate in future creative projects. There is of course a duality: for students who already have already developed robust information management strategies, and/or for schools that rely on a specific learning management system (e.g., Schoology), this approach could pose a barrier rather than a support (i.e., fragmentation of where information is stored) if not approached from a mindset of integration and accessibility.

Our approach acknowledges that documentation as a learning practice is not uniform; it adapts to the nature, context, and subject of the project as well as to the user’s learning needs. The SDL documentation kit was intentionally organized as a series of related components: a poster, an evidence upload form, online cloud folders, and timeline viewers. Students reported preferring and prioritizing different aspects of the kit (e.g., some students appreciated the poster, while others were content with using only the digital features). The extent to which the poster kit was viewed as helpful appears to depend on a student’s preference for physical tools and/or having a visual reference in their learning area. We found that the kit’s ability to respond to individual student needs and preferred practices was an advantage. Moreover, by affording multiple entry points to documentation, the kit helped learners personalize the management and structuring of their learning experiences.

Our findings affirm the importance of designing documentation tools and practices that offer different modes of learning support at different moments and phases.

In many realms of learning interventions and technology design, solutions are defined *a priori* and independent of the specific situations and pedagogical values educators embody in their classrooms. In contrast, educational co-design is a deep and effortful form of engaged design [26, 28] that emphasizes continual participation and collaboration [27] to jointly understand, attend to, and design with and for specific learning contexts with change-oriented goals. For us, this engaged process was integral to translating abstract concepts, instructional language and learning goals into integrated tools and routines. Our collaborative exploration gave us greater insight into the complexity students face in navigating self-directed learning experiences - wrestling with how, when and what to document, shifting mindsets from documentation as a compliance exercise to an activity that can be personally meaningful and learning-oriented, and how to use evidence to demonstrate growth in desired competencies.

7 FUTURE WORK

In this project, we explored how a co-design process between design researchers and educators led to the development of a documentation kit that sought to enhance teacher facilitation and student enactment of documentation practices to support student learning as they pursued competency-based micro-credentials over the course of a self-directed learning experience of their own design and choosing.

Future work will scale future iterations of the documentation kit with larger cohorts to strengthen or complicate findings of this exploratory study regarding the value and challenges of co-designed documentation tools for learning. We also hope to focus future research efforts on closer analysis of students' uploaded artifacts, evidence types used, reflective responses, and tagging patterns to better understand the quality of reflection and articulation fostered through the use of these tools, to better leverage digital usage data to inform instructional support, and to contribute to the knowledge base on the cadences of learning trajectories in creative, self-directed, and competency-focused learning environments.

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