
Design is (A)live: An Environment Integrating Ideation and Assessment

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Abstract

Design coursework is iterative and continuously-evolving. Separation of digital tools used in design courses disaffects instructors' and students' iterative process experiences.

We present a system that integrates support for design ideation with a learning analytics dashboard. A preliminary study deployed the system in two courses, each with ~15 students and 1 instructor, for three months. We conducted semi-structured interviews to understand user experiences.

Findings indicate benefits when systems *contextualize creative work with assessment* by integrating support for ideation with a learning analytics dashboard. Instructors are better able to track students and their work. Students are supported in reflecting on relationships among deliverables. We derive implications for contextualizing design with feedback to support creativity, learning, and teaching.

Author Keywords

Design education; Iterative Design; Design Ideation; Creativity; Design Assessment; Learning Analytics Dashboard.

CCS Concepts

•Human-centered computing → Interactive systems and tools;

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Figure 1 (cont'd).

Students used *LiveMâché*, a collaborative, multiscale, and free-form system for performing design curation [9].

We integrated submission mechanisms into *LiveMâché*. Once students join a course, the 'Submissions' affordance becomes available (top right: highlighted with dashed orange oval). On press, students see a dialog where they can select new deliverables to submit to and see previous submissions (See Figure 2).

Note: Our IRB protocol enables participants to choose attribution for their creative work, using their preferred name.

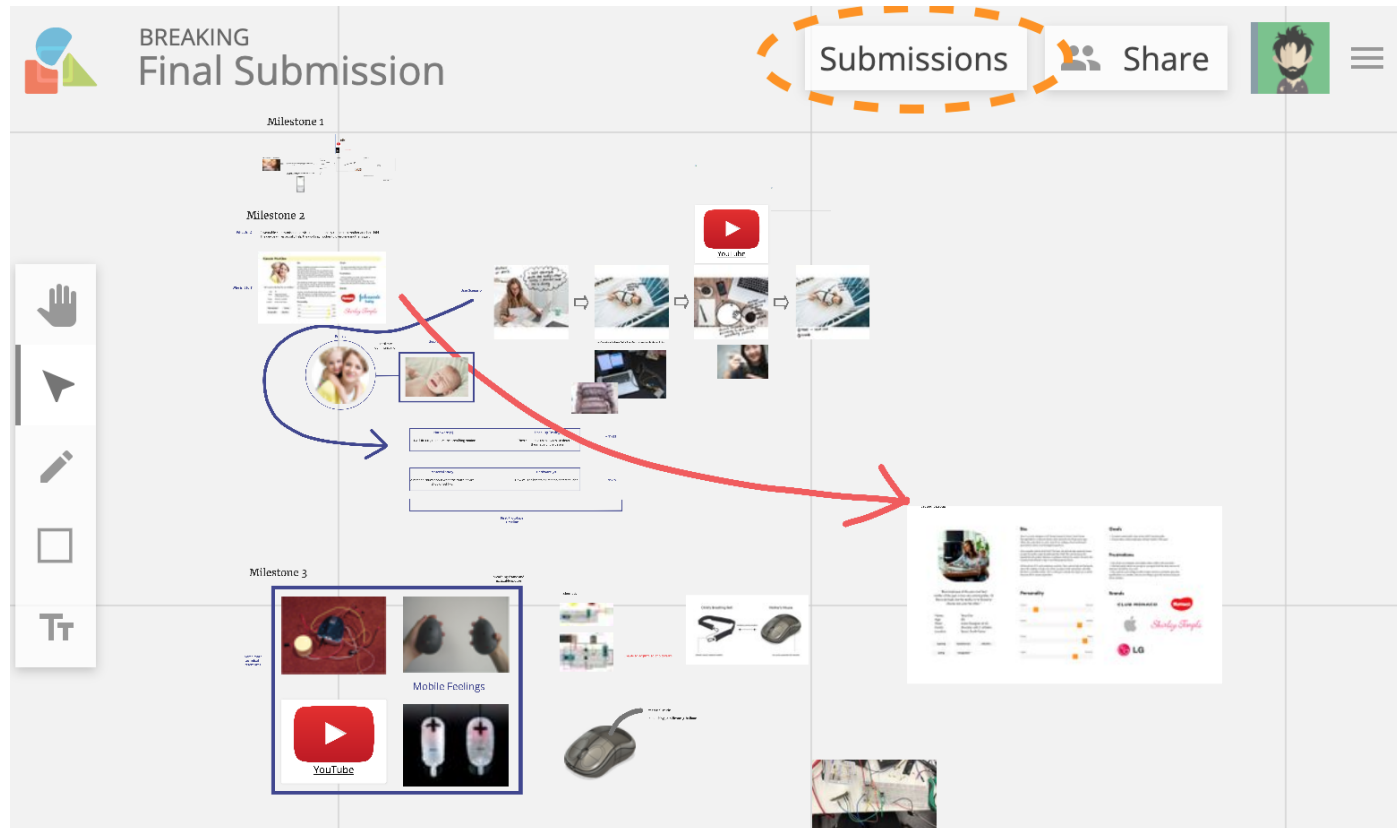


Figure 1: Jinjae Kim created and submitted this work in KAIST design studio course, using *LiveMâché*. Continued on the left.

Introduction

We develop an integrated design ideation and assessment system and evaluate it in two course contexts. The open-ended, creative nature of design coursework requires students to take risks, sometimes fail, and reflect on how to improve [19]. Design has been identified as an iterative and creative process. A problem and ideas for solution evolve

simultaneously: as designers progressively develop and evaluate solutions, their understanding of the problem improves, which stimulates refining and reframing [5]. This constantly changing nature of design makes it a "living" process, with feedback and reflection at its core. In design courses, feedback from instructors guides students towards their next iteration [6], and helps students recognize how

Research Questions

1. How does integrating ideation and assessment affect students' iterative design processes?
2. How does integrating ideation and assessment affect instructors' insights into students' creative design processes?

others perceive their work [15]. As technology becomes increasingly integrated into design and design education due to growing demand, instructors rely more on digital solutions. However, digital submission and assessment systems are often external to the environments in which students perform design. These systems fall short in accounting for the living nature of design, as they only assess a narrow, static aspect of the broader process.

Learning analytics dashboards have proven effective in providing insights into students' work and guiding it [21, 2]. Prior dashboards do not focus on design learning. We develop computationally derived design learning analytics and present those in a dashboard. Instructors can view design work in the same environment in which students create it. This allows them to provide assessment and feedback in-context. Through our investigation, we aim to address two research questions (see left sidebar).

As part of ongoing investigation into design creativity, we defined *design curation*, as processes in which designers collect and organize design artifacts to think about, represent, reflect on, perform, and present design processes [17]. One form is *free-form curation*, which has been shown to support ideation, as students perform creative strategies of collect, assemble, sketch, write, shift perspective, and exhibit [13]. *Multiscale design curation* emphasizes the contribution of levels of visual scale in these creative processes [17]. We continue developing *LiveMâché* [10, 9], as a collaborative system for free-form, multiscale design curation.

The present research integrates submission and assessment mechanisms in this design curation environment (Figure 1). Two design courses used the integrated system for a semester: one at KAIST in South Korea; another at Illinois State University in the U.S. Each course consisted of approximately fifteen students led by one instructor.

Figure 2: Submissions dialog: the student selects a deliverable to submit their curation to. They choose whether instructors will see a subarea—i.e., the current view—or the whole curation when they open it from the dashboard.

Related Work

Previous work has investigated assignment submission, versioning, feedback, and learning analytics dashboards.

Digital Submission, Versioning, and Feedback Systems

Digital submission systems in programming courses support instructors in collecting assignments and automatically assessing both correctness and open-ended characteristics such as style [12]. Design work—like any open-ended task—relies on feedback, whether through human or automatic evaluation. Brusasco et al. demonstrated how collecting assignments and providing instructor feedback on students' design work in-context through redlining and commenting is valuable to students [3]. They also allowed stu-

Figure 3 (cont'd).

For a single deliverable, for each student or team, instructors see name input, the submitter's *LiveMâché* username, the timestamp of the latest submission (snapshot), Fluency analytics—the number of elements, words, and images—derived from the latest submission, and links for the instructor to view the latest submission and live work.

Student/Team Name	Submitted By	Submitted	Elements	Words	Images	Latest Snapshot	Submission Link (Live)
Student 1 (Anonymized)	Username 1 (Anonymized)	Nov 07 11:57	24	88	8	Milestone 1	Nov 08 21:12
Student 2 (Anonymized)	Username 2 (Anonymized)	Nov 07 20:07	178	1659	50	Blood LINK	Dec 23 16:44

Figure 3: Instructor Dashboard: view of one deliverable across students (see caption left).



Assignment	Submission Open?	Submitted By	Student/Team Name	Latest Snapshot	Submission Link (Live)
Milestone 1		Username 1 (Anonymized)	Student 1 (Anonymized)	Nov 7 11:57	Milestone 1
Milestone 2		Username 1 (Anonymized)	Student 1 (Anonymized)	Nov 17 23:20	Milestone 1

Figure 4: Student Dashboard: view submitted works across deliverables (see caption left).

Figure 4 (cont'd).

Students access all their submissions, for a course, through this view. Submission metadata includes the deliverable name, whether the deliverable is open or closed for submission, the latest submission (snapshot) and its timestamp, submitter's username, the student or team name input by the submitter, and the original curation from which the latest submission, i.e., the snapshot was created.

dents to create snapshots of their work, which instructors could view to observe students' progress. However, their work does not incorporate computational insights.

Learning Analytics Dashboards

As more students interact with digital tools, new opportunities arise for using data to give instructors and students insights on learning. Arnold et al. show learning analytics dashboards' ability to increase student retention, by enabling instructors to construct student action plans [2]. Their study further showed that dashboards increased student and instructor satisfaction, and even prompted students to take initiative in improving their own course performance. Prior dashboards do not focus on design learning.

Further, there is limited prior work in deriving computational insights from design work. CritiqueKit aims to support peer assessment by providing feedback recommendations to design students, based on real-time analysis of students' review comments [7]. Their study found students were hes-

itant to use suggestions. It highlights the need for generating contextually relevant insights on students' design work.

Integrated Ideation + Assessment System

We created mechanisms for students to submit and review deliverables inside the *LiveMâché* design curation system.

Design Deliverable Submission

When ready for feedback on their creative work, the student, in *LiveMâché*, selects a deliverable to submit to (Figure 1). They also choose the view of their curation the instructor will first see, upon accessing the submission: either a global overview, or a zoomed subarea (Figure 2). After deliverable submission, student teammates are notified via email. They can view the submitted curation through the submission dialog (Figure 2) or dashboard (Figure 4).

Learning Assessment Dashboard

Fluency, i.e., number of ideas, is a key analytic for assessing creative designs [20]. Prior work assesses both text and

Instructor Interview Questions

Q1: How does the *LiveMâché* course dashboard compare with other dashboards and LMSs?

Q2: Has using the dashboard to follow and track student design processes changed how you interact with students? If yes, how?

Q3: Has the dashboard shown you anything new or unexpected about your students or class or learning? If yes, what?

Q4: How do you understand and utilize the numbers presented on the dashboard with submissions?

Q5: Do the numbers presented on the dashboard support your evaluation and feedback processes? If yes, how?

Q6: What are your suggestions for tailoring the dashboard more to your instruction practices, or design education in general?

image fluency [14], as these represent complementary cognitive processes, whose combination promotes formation of mental models [8, 18]. For each deliverable, we present instructors with three fluency analytics: word count, image count, and element count, in addition to links to the live design and the latest submission snapshot (Figure 3).

Preliminary Study: Findings

As users interacted with the system over the course of the semester, we logged their interactions. We derived usage metrics from the logs to evaluate the integrated environment. In total, 29 different design curations were created using *LiveMâché*, which, in turn, were submitted 43 times. Five design curations were re-used across multiple deliverables (10 submissions), attesting to the "living" nature of design. Twenty-six snapshots were created over the semester. As the snapshot feature was rolled out later, there were fewer snapshots than submissions.

In order to understand how integrating the dashboard with curation affects design instruction and learning, we conducted 4 semi-structured interviews: 2 with instructors (D1 and D2) of the 2 courses and 2 with students (S1 and S2). Two authors analyzed the qualitative data, using a grounded theory approach [4], resulting in these categories.

Integrating Design with Dashboard Supports Iterative Process
Compared to prior learning management systems (LMS) experiences, instructors and students found that the integrated system helps them see the current deliverable in the context of ongoing work, rather than in isolation. D1 felt as though they were part of the students' ideation process and progress, "*kind of like building ideas together*".

D1: *As the name of the program tells, you're live...it's not a fixed and frozen document, it's still a living thing.*

D1: *I felt more engaged with the students' whole process rather than checking certain points. As classes are becoming larger and larger, it becomes difficult to know every student's work from beginning to end.*

S1: *[Previous LMS was] only for uploading the files I made in...other software. LiveMâché is literally live, I could [perform creative work] and submit it.*

Students reported that the system supported their iterative design processes by enabling them to easily reuse material across deliverables, and reflect on their previous work.

S1: *Firstly, I cannot memorize every statement or special terms...so I visited my [previous submissions] to check it. Secondly, for uniformity of my [design].*

S2: *[LiveMâché]...refreshes my memory on how I design: why I designed this, and how I designed this, and what my deliverables were, all in one image...I guess [LiveMâché] is [useful] for a designer to reflect upon what worked, what didn't work, what was hard, and what their process was.*

At the same time, both instructors and students felt that traditional LMSs offered more features for managing administrative functions of the class. For example, D2 suggested that "*it would help [if the system] supports keeping track of deadlines.*" Students echoed this need.

Instructors' Assessment and Feedback to Students

Instructors report that automatic access to student work, on submission, streamlines design assessment and feedback.

Previously, students often forgot to grant instructors access rights to submissions—despite instructions—delaying feedback. Instructors want students to submit work early, in advance of deadlines, and then continue to iterate, enabling

Student Interview Questions

Q1: How does *LiveMâché*'s submission system compare with electronic submission systems you have used in the past?

Q2: Do you think anything could be improved about the submission confirmation or the dashboard? If yes, what?

Q3: How does the integration of submissions and the course dashboard compare to making things in an external design tool and then submitting?

Q5: Did you choose to send your current view to your instructor, rather than the whole design work? Why?

Q6: Have you used the course dashboard to revisit what you submitted for an assignment via the dashboard? If so, why?

Q7: How did you use your previous submissions, if at all? How did you use the snapshots that are automatically-created?

more feedback. Submitting creative work early for contextual feedback represents a new user model for design.

D2: *Being able to see how their processes evolve has been helpful for me...in seeing how much they actually learned.*

D1: *I expected them to submit sooner, so that I could provide feedback before the class.*

D1 suggested that the ability to notify students when feedback is left on their designs—and being notified when students resolve that feedback—would be helpful. D2 subsequently expressed interest.

D1: *[Notifications on feedback] are critical because even though I provided comments...to [designs] submitted earlier, [before] the deadline, [students] had no idea I had provided feedback. I kind of [want] my students to respond to my comments right away [and at] an email notification [when students resolve feedback].*

Computational Derivation of Analytics from Design Work
Instructors report that while the analytics do not indicate the quality of a design, they provide insight into students' effort across certain dimensions. D2 expressed that visualizing changes in analytics over time would be useful.

D1: *I think it showed me this student worked hard, they did a lot of research...[but] it's challenging to see numbers and somehow assess the quality of work.*

Both instructors desire advanced analysis of student design work, in particular, presenting conceptual ideas present in students' design.

D1: *Numbers are nice, but things like a word cloud would be helpful.*

D2: *I would like to see how we can analyze the images... Though whatever the computer reads is different from the designer's aspect.*

Implications for Design

Systems that integrate ideation and assessment, by contextualizing deliverables, mutually support instructors and students in design education. Their understanding of design processes and progress becomes enhanced. As S1 articulated, *"what worked, what didn't work, what was hard, and what their process was."*

Design is alive: as a process. The dashboard keeps a link to the live submission available to instructors, facilitating ongoing feedback. In support of design's living nature, students and instructors benefit from integrated systems that contextualize creative design work with assessment. As part of this, build systems that enable instructors to leave feedback on designs and notify students. Close the loop by notifying instructors when students address the feedback.

Design education will benefit from extending AI-based content recognition techniques [1, 16] to perform computational analysis of design work [11]. Instructors said design analytics provide insights into student work, across dimensions.

Future research needs to investigate, in-depth, how instructors evaluate student work, to guide computational modeling of their approaches. As D2 expressed, *"whatever the computer reads is different from the designer's aspect."*

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REFERENCES

- [1] Martín Abadi, Ashish Agarwal, Paul Barham, Eugene Brevdo, Zhifeng Chen, Craig Citro, Greg S Corrado, Andy Davis, Jeffrey Dean, Matthieu Devin, and others. 2016. Tensorflow: Large-scale machine learning on heterogeneous distributed systems. *arXiv preprint arXiv:1603.04467* (2016).
- [2] Kimberly Arnold and Matthew Pistilli. 2012. Course signals at Purdue: Using learning analytics to increase student success. *ACM International Conference Proceeding Series* (04 2012). DOI : <http://dx.doi.org/10.1145/2330601.2330666>
- [3] Pio Luigi Brusasco, Luca Caneparo, Gianfranco Carrara, Antonio Fioravanti, Gabriele Novembri, and Anna Maria Zorgno. 2000. Computer Supported Design Studio. *Automation in Construction* 9, 4 (2000), 393 – 408. DOI : [http://dx.doi.org/https://doi.org/10.1016/S0926-5805\(99\)00024-2](http://dx.doi.org/https://doi.org/10.1016/S0926-5805(99)00024-2)
- [4] Kathy Charmaz. 2006. *Constructing grounded theory: A practical guide through qualitative analysis*. Sage.
- [5] Kees Dorst and Nigel Cross. 2001. Creativity in the design process: co-evolution of problem–solution. *Design Studies* 22, 5 (2001), 425 – 437. DOI : [http://dx.doi.org/https://doi.org/10.1016/S0142-694X\(01\)00009-6](http://dx.doi.org/https://doi.org/10.1016/S0142-694X(01)00009-6)
- [6] Steven P. Dow, Kate Heddleston, and Scott R. Klemmer. 2009. The Efficacy of Prototyping Under Time Constraints. In *Proceedings of the Seventh ACM Conference on Creativity and Cognition (C&C '09)*. ACM, New York, NY, USA, 165–174. DOI : <http://dx.doi.org/10.1145/1640233.1640260>
- [7] C. Ailie Fraser, Tricia J. Ngoon, Ariel S. Weingarten, Mira Dontcheva, and Scott Klemmer. 2017. CritiqueKit: A Mixed-Initiative, Real-Time Interface For Improving Feedback. In *Adjunct Publication of the 30th Annual ACM Symposium on User Interface Software and Technology (UIST '17)*. Association for Computing Machinery, New York, NY, USA, 7–9. DOI : <http://dx.doi.org/10.1145/3131785.3131791>
- [8] Arthur M Glenberg and William E Langston. 1992. Comprehension of illustrated text: Pictures help to build mental models. *Journal of memory and language* 31, 2 (1992), 129–151.
- [9] William A. Hamilton, Nic Lupfer, Nicolas Botello, Tyler Tesch, Alex Stacy, Jeremy Merrill, Blake Williford, Frank R. Bentley, and Android Kerne. 2018. Collaborative Live Media Curation: Shared Context for Participation in Online Learning. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article Paper 555, 14 pages. DOI : <http://dx.doi.org/10.1145/3173574.3174129>
- [10] Interface Ecology Lab. 2020. LiveMâché. <http://livemache.ecologylab.net/>. (2020).
- [11] Ajit Jain. 2017. Measuring Creativity: Multi-Scale Visual and Conceptual Design Analysis. In *Proceedings of the 2017 ACM SIGCHI Conference on Creativity and Cognition*. 490–495.
- [12] Mike Joy, Nathan Griffiths, and Russell Boyatt. 2005. The boss online submission and assessment system. *Journal on Educational Resources in Computing (JERIC)* 5, 3 (2005), 2.

- [13] Andruid Kerne, Nic Lupfer, Rhema Linder, Yin Qu, Alyssa Valdez, Ajit Jain, Kade Keith, Matthew Carrasco, Jorge Vanegas, and Andrew Billingsley. 2017. Strategies of Free-Form Web Curation: Processes of Creative Engagement with Prior Work. In *Proceedings of the 2017 ACM SIGCHI Conference on Creativity and Cognition*. ACM, 380–392.
- [14] Andruid Kerne, Andrew M Webb, Steven M Smith, Rhema Linder, Nic Lupfer, Yin Qu, Jon Moeller, and Sashikanth Damaraju. 2014. Using metrics of curation to evaluate information-based ideation. *ACM Transactions on Computer-Human Interaction (TOCHI)* 21, 3 (2014), 14.
- [15] Scott R. Klemmer, Björn Hartmann, and Leila Takayama. 2006. How bodies matter : five themes for interaction design. *Designing Interactive systems* (2006), 140.
- [16] Siming Li, Girish Kulkarni, Tamara L Berg, Alexander C Berg, and Yejin Choi. 2011. Composing simple image descriptions using web-scale n-grams. In *Proceedings of the Fifteenth Conference on Computational Natural Language Learning*. Association for Computational Linguistics, 220–228.
- [17] Nic Lupfer, Andruid Kerne, Rhema Linder, Hannah Fowler, Vijay Rajanna, Matthew Carrasco, and Alyssa Valdez. 2019. Multiscale Design Curation: Supporting Computer Science Students' Iterative and Reflective Creative Processes. In *Proceedings of the 2019 on Creativity and Cognition (C&C '19)*. ACM, New York, NY, USA, 233–245. DOI : <http://dx.doi.org/10.1145/3325480.3325483>
- [18] Richard E Mayer and Roxana Moreno. 2003. Nine ways to reduce cognitive load in multimedia learning. *Educational psychologist* 38, 1 (2003), 43–52.
- [19] R. Keith Sawyer. 2018. Teaching and Learning How to Create in Schools of Art and Design. *Journal of the Learning Sciences* 27, 1 (2018), 137 – 181.
- [20] Jami J Shah, Steve M Smith, and Noe Vargas-Hernandez. 2003. Metrics for measuring ideation effectiveness. *Design studies* 24, 2 (2003), 111–134.
- [21] Katrien Verbert, Erik Duval, Joris Klerkx, Sten Govaerts, and José Santos. 2013. Learning Analytics Dashboard Applications. *American Behavioral Scientist* 57 (09 2013). DOI : <http://dx.doi.org/10.1177/0002764213479363>