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An Empathy-to-Testing Workshop to Strengthen Human Factors Evaluation in Design Education

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ABSTRACT

This paper reports an experiential workshop intervention embedded in an undergraduate human factors (HF) course for industrial design. The intervention followed an empathy-to-testing sequence. Before the workshop, students completed an empathy-oriented preparation activity by imitating age-related and disability-related constraints to sensitize them to embodied interaction barriers and everyday usability issues. During the workshop, students engaged in hands-on tasks that deliberately exposed usability and ergonomic failures, followed by guided reflection and rapid redesign. The workshop explicitly emphasized the "test phase" of the design process: students defined simple evaluation goals, selected observable criteria, and conducted basic tests of early concepts and discussion of core principles (affordances, feedback, mapping, constraints, and error prevention) to connect observations to theory. Effectiveness was evaluated using a mixed-methods approach focused on three indicators: a pre–post motivation questionnaire (learning motivation and self-efficacy), a post-workshop questionnaire on perceived usefulness and transfer intention, and a course exam assessing core HF knowledge. Results indicated increased motivation toward HF learning and strong perceived value of embodied simulation and testing-oriented practice for making abstract principles observable and actionable. Students reported greater confidence in identifying HF issues and justifying design decisions with evidence, while exam outcomes indicate that an experiential emphasis can coexist with theoretical consolidation. The study offers practical evidence for integrating feasible HF evaluation into early-stage design education.

Keywords: Human factors education, Design education, Experiential learning, Design workshop

INTRODUCTION

Human factors (HF) and ergonomics provide a knowledge-intensive foundation for industrial design, informing how designers anticipate user capabilities, constraints, and interaction problems. Yet in studio-based programs, novice designers often underemphasize testing and evaluation during project development. Instead, students may rely on intuition, aesthetic iteration, or informal feedback, resulting in design decisions that are weakly supported by user evidence. This gap is especially consequential in early-stage concept development, where feasible evaluation and iterative testing can substantially reduce subsequent usability and ergonomic failures.

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A central pedagogical challenge is that students often understand HF principles declaratively yet struggle to operationalize them as evaluative criteria in design decisions. Concepts such as affordances, mapping, feedback, constraints, and error prevention may be understood conceptually but remain difficult to operationalize in concrete design decisions. The Design of Everyday Things argues that well-designed artifacts communicate action possibilities through signifiers and feedback, and that many "human errors" are predictable outcomes of design choices rather than user shortcomings (Norman, 2013). Bridging this gap requires learning experiences that make HF principles observable, measurable, and directly usable in iteration.

Empathy has long been recognized as critical to user-centred design for understanding users' lived experiences and constraints. A key insight from empathic design study is that empathy is not merely an attitude or a set of interview skills; it is an experiential process in which designers "step into" the user's world and "step out" again to translate understanding into design decisions (Kouprie & Visser, 2009). However, students often struggle to convert empathy into evaluation practice: they may produce sympathetic narratives yet still struggle to translate empathetic insights into explicit test criteria or evidence-based justification.

Embodied and experience-centred perspectives reinforce why empathy-oriented learning can be powerful in HF education. Embodied cognition accounts emphasize that cognition is situated and action-oriented, with bodily interactions shaping understanding (Wilson, 2002). Experience-centred design perspectives likewise highlight empathy as a methodological construct for engaging with lived experience and meaning-making (Wright & McCarthy, 2008). The remaining challenge is to support students in translating embodied experiences into explicit, observable test criteria for iterative improvement.

A further consideration is temporal structure. Design courses often distribute project work across an academic term, which supports reflection but may dilute urgency and weaken students' perception of usability problems that necessitate testing. Condensed workshops, in contrast, concentrate observation, prototyping, testing, and redesign into a bounded time window. Learning science suggests that appropriately designed challenge can strengthen learning and transfer: "desirable difficulties" can yield more durable performance (Bjork & Bjork, 2011) and "productive failure" can enhance learning when struggle is followed by consolidation and instruction (Kapur, 2008). A time-bounded workshop can highlight usability issues and support rapid linkage between observed failures, evaluation criteria, and redesign.

This paper reports an empathy-to-testing workshop intervention embedded within a third-year industrial design HF course. The workshop was designed to (1) cultivate embodied empathy through constraint experiences and (2) strengthen students' HF testing mindset by emphasizing feasible evaluation practices in early-stage design. Accordingly, this study addresses:

(1) How do students' HF learning motivation and self-efficacy change from pre to post?
(2) How do students perceive the workshop's learning value and transfer potential?

METHOD

Before the workshop, 19 third-year industrial design students (12 female, 7 male) completed an embodied constraint activity intended to sensitize them to interaction barriers associated with aging and disability. Students imitated constraints such as reduced vision, limited dexterity, restricted reach, and mobility limitations. The activity was not intended to represent lived disability experience, but to provide a shared reference for noticing interaction difficulties and translating them into testable criteria.

The workshop was designed as a time-bounded cycle of problem-identifying, rapid prototyping, basic testing, and redesign. Activities were sequenced to make failures visible, discussable, and actionable:

- Problem-identifying: students interacted with everyday artifacts and micro-scenarios under constraints to surface usability and ergonomic failures.
- Rapid prototyping: teams produced quick modifications or concept variants (e.g., paper/foam prototypes, taped modifications, interface sketches).
- Peer testing: teams defined 2–4 observable measures (e.g., errors, time/steps, reach/grasp issues, comprehension/interpretation, safety risk indicators) and tested with peers.
- Reflection and justification: teams documented what failed, what changed, and how evidence supported design decisions; instructors linked observations to HF principles.

Following the workshop, targeted discussion connected interaction problems to theory. Discussion prompts emphasized affordances and signifiers, feedback, mapping, constraints, and error prevention (Norman, 2013), and reinforced how these concepts become measurable through basic usability and ergonomic criteria. This consolidation step was intended to prevent the workshop from being a stand-alone experience and to improve transfer into later project work.

Three course-embedded indicators were used to evaluate the course and the intervention:

1) Pre–post learning motivation questionnaire: the motivation section of the Motivated Strategies for Learning Questionnaire (MSLQ) was adapted for the course context to capture constructs including intrinsic/extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning/performance, and test anxiety (Pintrich, 1991). Item selection and the Chinese wording followed an established course-appropriate adaptation reported in prior work(吳靜吉 & 程炳林, 1993). Items were rated on a 7-point Likert scale. Pre–post differences for each MSLQ motivation item were examined using two-tailed paired-samples t-tests ($\alpha = .05$).
2) Post-workshop questionnaire: immediately after the workshop, students completed a brief questionnaire assessing perceived usefulness, engagement, and transfer intentions and one open-ended reflection prompt to capture perceived mechanisms and learning takeaways.
3) Course exam: a 20-item exam assessed students' understanding of foundational HF concepts emphasized across the course.

RESULTS

Pre–Post Learning Motivation Questionnaire

The pre–post results from the adapted MSLQ (n = 19; see Table 1) suggest an overall strengthening of students' motivation and self-efficacy toward HF. Across the 31 questions, 16 showed statistically significant increases from pre to post ($p < .05$). The most pronounced gains clustered around (a) self-efficacy for learning and performance—especially confidence in performing well despite course difficulty and confidence in learning via effective strategies—and (b) task value and interest—greater liking of the course content and stronger beliefs about its usefulness and importance. Where effect sizes were calculated, improvements in confidence-related items fell in the medium-to-large range ($dz \approx 0.62–0.91$), consistent with the intervention goal of making HF principles feel actionable through testing-oriented practice.

Table 1: MSLQ pre–post item results (means, SD, p).

	Short Label	Pre M	Pre SD	Post M	Post SD	p
1	Prefer challenging content	4.37	1.3	5.32	1.2	0.02
2	Learn with right strategies	5.21	0.85	5.95	1.03	<.001
3	Feel inferior presenting	4.37	1.77	4.32	1.95	0.927
4	Apply learning to others	5.26	0.87	5.74	0.87	0.035
5	Expect excellent grades	4.89	1.1	5.42	1.12	0.037
6	Understand hardest parts	4.05	0.97	5.11	1.41	0.001
7	Good grades satisfy me	4.84	1.07	5.47	1.12	0.135
8	Think of unknowns answering	4.79	1.32	5.37	1.64	0.03
9	Blame self if not learn	4.53	1.17	5.11	1.37	0.065
10	Learning content important	5.21	1.08	5.79	1.27	0.037
11	Focus on course grades	4.95	1.13	5.11	1.52	0.635
12	Learn basic concepts	5.05	0.85	5.63	0.9	0.083
13	Want higher than most	3.47	1.39	3.74	1.57	0.464
14	Worry about poor work	4.79	1.03	5.11	1.56	0.454
15	Understand complex teaching	4.37	0.96	5.16	1.21	0.007
16	Prefer curiosity topics	4.53	0.77	4.89	1.2	0.036
17	Interested in content	4.53	0.84	5.32	1.25	0.001
18	Effort leads to understanding	4.74	1.15	5.63	1.07	0.015
19	Uncomfortable presenting	4.68	1.6	4.74	1.88	0.893
20	Confident n tasks/present	4.37	1.01	5.32	1.38	0.007
21	Expect to do well	4.89	0.88	5.42	1.07	0.037
22	Thorough understanding satisfies	5.32	0.95	5.95	0.97	0.029
23	Content useful	5.26	1.1	5.89	0.81	0.014
24	Choose learning-focused tasks	4.53	0.91	5.11	1.41	0.087
25	Not enough effort if fail	4.68	0.95	5	1.2	0.38
26	Like course content	4.53	0.61	5.42	1.07	<.001
27	Understanding important	4.95	1.03	5.74	1.1	0.001
28	Heart races presenting	5.11	1.14	5.53	1.51	0.119

(Continued)

Table 1: Continued.

	Short label	Pre M	Pre SD	Post M	Post SD	p
29	Master skills/techniques	4.32	0.82	5.11	1.24	0.002
30	Do well to show ability	4.47	1.02	5.11	1.37	0.087
31	Perform well given conditions	4.53	1.02	5.53	1.22	<.001

Item wording was translated from the Chinese survey; full wording can be provided upon request.

By comparison, items associated with presentation-related discomfort and negative social comparison showed little change. This suggests that the intervention mainly influenced HF-specific motivation and evaluation mindset, rather than generalized classroom anxiety. One pattern that increased was heightened awareness of uncertainty while answering difficult questions, which is interpreted here as emerging metacognitive sensitivity to knowledge limits—a potentially beneficial disposition for evidence-driven testing.

Post-Workshop Questionnaire

Workshop feedback was strongly positive across all seven learning dimensions. Students rated the highest perceived gains in practical (making) ability ($M = 4.45$, $SD = 0.69$) and overall benefit ($M = 4.36$, $SD = 0.67$), with over 90% of responses at the upper end of the scale for these two dimensions. Ratings for professional competence, active learning, innovation/creativity, responsibility, and social concern were also high overall ($M \approx 4.00$–4.18). Taken together, the profile indicates that the condensed cycle of problem-identifying, rapid redesign, and practical testing was perceived as particularly effective for turning abstract HF concepts into concrete design moves. This aligns with learning science accounts suggesting that appropriately designed challenge can function as a desirable difficulty that supports durable learning and transfer (Bjork & Bjork, 2011).

Students' open-ended reflections further clarified how the workshop experience supported learning transfer. Three themes were consistently articulated across responses.

1. Idea validation through making and testing. Students emphasized that rapid prototyping and immediate testing revealed feasibility constraints and usability issues that were invisible during discussion-only ideation. This helped them move from "having an idea" to "having evidence" for what should change.
2. Comparative reflection through peer contrast. Students highlighted how seeing other teams' approaches and receiving peer critique created productive friction ("collision") that expanded their solution space and prompted reflection on their own assumptions. Rather than converging too early, teams reported learning from contrasting strategies and justification styles.
3. High cognitive intensity, interpreted as high benefit. Students described the workshop as mentally demanding due to time pressure and the need to repeatedly decide, build, test, and revise. Importantly, they framed this intensity as beneficial—an experience of productive difficulty—because

failures were immediately observable and could be addressed through redesign. This reflection pattern is consistent with accounts of productive struggle and "productive failure," in which challenge becomes learning when paired with guided reflection and consolidation.

Course Exam

Exam performance indicates that emphasizing experiential testing did not reduce theoretical consolidation. The result suggests robust understanding of foundational usability concepts, particularly those related to intuitive use, universal design framing, and reducing memory load in interface design. However, students showed weaker performance on questions requiring conceptual discrimination (e.g., differentiating slips from mistakes) and on anthropometric reasoning (e.g., selecting work-surface heights for precision tasks, and choosing inclusive strategies for large body-size variation such as adjustable design rather than "designing for the average").

This profile suggests that the workshop and associated consolidation effectively supported broad usability principles, while percentile-based and taxonomy-driven reasoning remains a candidate area for additional scaffolding (e.g., more worked examples, short calculation drills tied to design cases, or follow-up micro-tests using anthropometric tables).

DISCUSSION

To clarify evidentiary scope across data sources, we distinguish three outcome layers. The pre–post questionnaire reflects the overall course impact (including lectures, readings, assignments, and the workshop) on motivation and self-efficacy, and thus should not be interpreted as workshop-specific. The post-workshop survey captures immediate perceptions of the time-bounded workshop and transfer intentions, providing more direct evidence of perceived workshop value. The exam primarily reflects theoretical understanding of HF concepts; while it cannot be uniquely attributed to the workshop, it supports the claim that an experiential, empathy-to-testing emphasis can coexist with conceptual rigor.

This study provides evidence that how an empathy-to-testing sequence can bridge a common gap in design education: the gap between recognizing HF principles and applying them as evaluative practice. Rather than treating empathy as an end, the intervention required students to translate embodied observations into explicit and observable test criteria (e.g., errors, time/steps, reach/grasp issues, comprehension). This translation step is the mechanism by which empathy becomes operationalized as evidence-driven evaluation.

A second contribution is the use of a condensed workshop to highlight the difficulty and strengthen the necessity of testing. The pre–post shifts in motivation and self-efficacy, combined with strong workshop ratings, suggest that the intensive format supported engagement without sacrificing conceptual rigor. The results are consistent with the idea that appropriately designed challenge can be desirable and productive when paired with reflection and consolidation (Bjork & Bjork, 2011; Kapur, 2008).

The exam pattern provides a nuanced instructional implication: experiential emphasis appears compatible with strong consolidation of foundational usability principles, but additional support is likely needed for anthropometric reasoning and for taxonomic distinctions in human error concepts. In future iterations, instructors could integrate short "micro-labs" after the workshop focused specifically on percentile reasoning and error-type classification, using small, concrete design decisions (e.g., choosing control heights, reach envelopes, or error-proofing strategies) to reinforce conceptual precision.

Limitations and Future Work

One important limitation is the reliance on self-report instruments to assess perceived learning and motivation. While the triangulation of multiple indicators strengthens internal consistency, responses may be subject to social desirability bias, particularly in a course where student-instructor interaction is high. Future iterations could integrate external measures, such as rubric-based assessments of students' usability testing in real-world projects, or longitudinal tracking of testing behaviours in later studio courses.

Additionally, while constraint-based empathy activities proved effective for surfacing design issues, it is critical to avoid overgeneralization of disability experiences. Simulating impairments can risk misrepresenting the lived realities of users with disabilities (Ladner, 2015). To mitigate this, future designs should incorporate explicit guidance framing simulation as a noticing tool—not a proxy for lived experience—and ideally integrate co-design or participatory input from users themselves.

Finally, generalizability is limited by context: results derive from a single institution, instructor, and course structure. While the approach appears robust, replication in other educational environments with diverse learners is needed to evaluate its broader applicability.

CONCLUSION

This paper reported an empathy-to-testing workshop intervention embedded within an industrial design HF course. By combining embodied constraint experiences with a condensed cycle of problem-identifying, rapid prototyping, and practical testing, the intervention aimed to make HF principles concrete and actionable. Across the three indicators: pre–post motivation, post-workshop perceived learning, and exam performance; over 90% results support a workshop-centred pedagogy that strengthens students' confidence in identifying HF issues and justifying design decisions with observable evidence, while maintaining conceptual rigor. The approach offers a practical model for integrating HF evaluation into early-stage design education with feasible resources.

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