

Is Less Interface More? Evaluating a Minimal Tangible Interface for Gamified Learning

Nick Vasiljevic

English Taught Program in International Business, Shih Chien University, Taipei, Taiwan

profnickv@gmail.com

Abstract: Gamified learning tools are typically delivered through rich graphical interfaces on multi-function devices, where points, avatars and animations compete for attention. Games-based learning research has examined which gamification mechanics work, but often treats the interface as a neutral carrier rather than a pedagogical variable. The Attention Support Apparatus (ASA) makes that variable impossible to ignore: a dedicated physical Pomodoro device whose entire user interface is a monochrome E-ink screen, a red status light and a small set of physical controls. This paper asks whether such radical interface minimalism can be defended on pedagogical grounds, and under what conditions. The review deliberately prioritises synthesis-level evidence over isolated primary studies and design conventions. Rather than reporting a new user study, the paper makes two contributions: first, it reviews meta-analyses and systematic reviews located through OpenAlex, Scopus and ERIC on how interface simplicity and complexity affect learning, spanning seductive details, the coherence principle, emotional design, expertise reversal, and tangible-versus-graphical comparisons; second, it distils this evidence into six design principles and uses them to evaluate the ASA interface, distinguishing between what the interface declines to display and what the device cannot do. The evidence supports a conditional claim: removing extraneous elements reliably benefits retention and transfer, and dedicated tangible devices remove a source of task-switching cost, but appealing design can support motivation and imposed simplicity can backfire for learners who experience structure as controlling. The evaluation finds the interface aligned with four of the six principles — one satisfied by the device’s architecture rather than its display — partially aligned on emotional warmth, and weakest on adaptivity to individual differences; it yields an evidence-derived design agenda for the next iteration. The paper argues that “simple is pedagogic” should be reframed as “aligned is pedagogic”, and offers the audit as a reusable method for evaluating any games-based learning interface.

Keywords: Games-based learning, Tangible user interface, Cognitive load, Gamification, Calm technology, Design evaluation

1. Introduction

Gamification — the use of game design elements in non-game contexts (Deterding et al., 2011) — is normally experienced through screens, where gamification favours abundance: leaderboards, avatars, streaks, animations, badges and notifications. Meta-analytically it produces small but significant benefits for motivational and cognitive outcomes (Sailer and Homner, 2020). Yet these devices also host distractions, and adolescent learners demonstrably switch between them mid-task (Rosen, Carrier and Cheever, 2013). GBL research has focused more on mechanics than their interface, though every rendered element competes for the working memory the task requires.

The Attention Support Apparatus (ASA) is a dedicated physical Pomodoro timer that embeds a deliberately minimal set of gamification mechanics in a monochrome E-ink interface (Lu, Vasiljevic and Cheng, 2025). A preliminary multiple-baseline feasibility study of five senior high school students suggested improved self-reported task focus for four and a negative response from one (Vasiljevic, 2026). That study evaluated the device as a whole, not the interface. This paper asks the question it could not answer: is there evidence for treating an extremely simple user interface as a pedagogical asset rather than a technical limitation?

Two research questions follow, neither requiring new participant data:

RQ1. What does the highest-level published evidence say about how interface simplicity and complexity affect learning, and under what conditions does simplicity help or harm?

RQ2. Evaluated against principles derived from that evidence, which design decisions in the ASA interface are supported, and which are not?

The ASA combines two design philosophies that usually pull apart. Calm technology asks an object to recede from attention; gamification asks it to capture and direct it. Most gamified tools choose the second and pay the attentional cost. The ASA holds both — enough game to encourage interval completion, little enough to remain at the edge of awareness — and this paper tests whether that is coherent. The contribution is a synthesis and reusable evaluation method; its claim is deliberately conditional.

2. Method

The study combines a structured evidence review with a framework-based design evaluation. In Grant and Booth's (2009) typology the review is closest to a rapid umbrella review, prioritising meta-analyses and systematic reviews over primary studies and trading exhaustiveness for level of evidence.

2.1 Evidence Review

Searches were conducted in July 2026 in OpenAlex, with verification in Scopus and ERIC, pairing an interface term — “seductive details”, “coherence principle”, “emotional design”, “tangible user interface”, “expertise reversal effect” — with “meta-analysis” or “systematic review”, expressed in each database's native syntax. Inclusion criteria were: (a) meta-analysis, systematic review, or overview of reviews; (b) outcomes include learning, cognitive load or motivation; (c) English language; (d) published 2007–2026. Canonical sources cited by the included reviews (e.g. Ishii and Ullmer, 1997; Weiser and Brown, 1996) were retained for interpretation. Eight synthesis-level sources met the criteria and anchor Section 4.

2.2 Design Evaluation

From the review findings, six evidence-derived design principles (P1–P6) were formulated. Each element of the ASA interface — screen layout, iconography, status light, physical controls and reward screen — was then audited against each principle, recording alignment, partial alignment or misalignment, with the supporting source noted. This analytic procedure follows the logic of heuristic evaluation, but substitutes evidence-derived principles for generic usability heuristics, since the object of evaluation is pedagogical soundness rather than usability alone. Each notable absence was first classified as an interface omission, an architectural choice or a component constraint (Section 3.2), so that alignment is attributed to the display layer only where that layer made the decision.

3. The ASA Interface

The ASA began as a research prototype and is now a commercial product, manufactured and sold by the company that holds its patent. It was developed by a team of three, of which the author was the second-named inventor (Lu, Vasiljevic and Cheng, 2025). His involvement is academic only: he received no payment, sought none, and holds no equity, royalty or other interest in the patent, the company or the product. The units evaluated are the research build reported in Vasiljevic (2026); the production version differs in enclosure detail, not interface logic. Because the device is in production, the audit in Section 5 addresses its next revision rather than a design still on the bench.

3.1 Interface Elements

The ASA is a standalone battery-powered device implementing Cirillo's (2018) Pomodoro protocol of timed work intervals separated by short breaks. It has three output channels and a small set of physical controls. The E-ink screen is divided into two fixed panels: a state panel showing the current mode (waves for a focus interval, a coffee cup for a break) with two counters (total completed intervals and progress toward the daily goal), and a countdown panel showing the remaining minutes in large type (Figure 1). A row of four tomato icons along the bottom edge fills as the day's Pomodoros are completed. A red light strip along the top edge is lit during focus intervals only, signalling to others that the learner should not be interrupted; it is off during breaks (Figure 2). Completing the daily goal triggers a single reward screen: a trophy with the running totals and a timestamp (Figure 3).



Figure 1: The ASA interface during a focus interval: state panel (left), countdown panel (right), daily-goal tomato row (bottom), red status light (top)

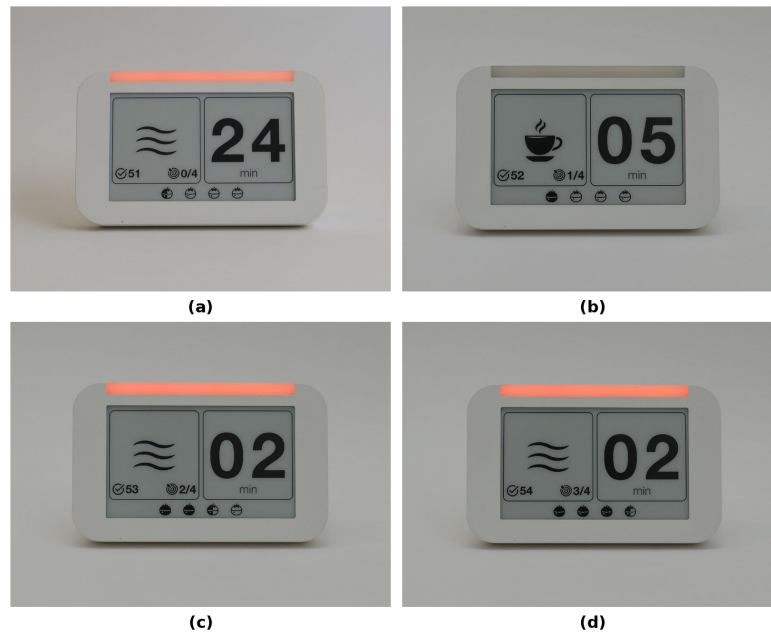


Figure 2: Interface states: (a) session start; (b) break, red light off; (c) later session; (d) daily goal almost reached



Figure 3: The daily-goal reward screen

3.2 Interface Minimalism and Functional Minimalism

What the ASA omits is as important as what it includes. However, not every absence can be attributed to interface design. A feature may be absent because the interface deliberately withholds information that the device could display, because the device architecture excludes the capability altogether, or because the hardware itself cannot support it. Distinguishing these cases is necessary if minimalism is to be evaluated fairly.

Three categories are therefore used in this paper.

Interface omissions occur when the underlying capability exists but the interface deliberately does not expose it. The ASA, for example, measures time to the second but displays only whole minutes. It also records the timing of completed intervals, but represents this information through cumulative counters and a single end-of-day reward screen rather than a browsable session history. In both cases, the information exists and could be presented differently; its simplified representation is therefore properly treated as an interface-design decision.

Architectural choices concern capabilities that were deliberately excluded from the device as a system. The ASA has neither an internet connection nor a general-purpose operating system. It does create a local Wi-Fi access point so that a smartphone can access the firmware for configuration, but this connection does not carry external content. Leaderboards, social comparison and notifications are therefore absent because no cloud service, account system or content-delivery mechanism was built around the device. These omissions contribute to the ASA's functional minimalism, but they should not be credited to the display itself.

Component constraints arise when the selected hardware cannot support a particular form of presentation. The monochrome E-ink panel cannot display colour, and its refresh characteristics make animation impractical. The absence of colour rewards and animated feedback therefore reflects the properties of the chosen display rather than a deliberate decision to withhold capabilities that are otherwise available.

Table 1 classifies the ASA’s main omissions according to these three categories. The distinction matters because the ASA combines interface minimalism with functional minimalism in a single artefact. An evaluation of the device alone cannot determine how much each contributes to the effects reported in Vasiljevic (2026). Accordingly, the audit in Section 5 attributes alignment to the interface only where the relevant decision was actually made at the display or interaction level.

Table 1: Attribution of the ASA’s notable absences

Absent feature	Underlying capability	Attribution
Browsable session history	Present — intervals and times are stored	Interface omission
Seconds in the countdown	Present — timing is to the second	Interface omission
Adjustable level of imposed structure	Partial — length, goal and pause available; effort within an interval not shown	Interface omission
Leaderboards, social comparison	Radio present; no cloud service or account system	Architectural choice
Notifications, third-party alerts	No internet path; no general-purpose OS	Architectural choice
Task-unrelated content on screen	Absent — single-purpose firmware	Architectural choice
Colour rewards	Absent — monochrome E-ink panel	Component constraint
Animated feedback	Absent — E-ink refresh characteristics	Component constraint

4. Review Findings: What the Evidence Says About Simple Interfaces

4.1 Extraneous Elements Reliably Harm Learning

The strongest body of evidence concerns the removal of interesting but irrelevant material. Rey’s (2012) meta-analysis found that seductive details reliably reduced retention and transfer; Sundararajan and Adesope’s (2020) meta-analysis confirmed it. Noetel et al.’s (2022) overview of 29 systematic reviews covering 1,189 studies found robust support for the coherence principle — learning improves when extraneous material is excluded. Cognitive load theory supplies the account: working memory is narrow, and any element consuming it without contributing to schema construction is extraneous load (Sweller, van Merriënboer and Paas, 2019), an argument Skulmowski and Xu (2022) extend to digital environments where visually rich interfaces impose load plainer designs avoid. This literature supports the ASA’s core design bet (Section 5.1).

4.2 The Counter-evidence: Appealing Design can Help

The evidence does not, however, equate austerity with effectiveness. Brom, Stárková and D’Mello’s (2018) meta-analysis of 33 independent samples found that anthropomorphic faces and pleasant colours produced positive effects on intrinsic motivation and affect and also on retention and transfer; Wong and Adesope (2021) replicated and extended this. The apparent contradiction with Section 4.1 resolves on inspection: seductive details add irrelevant *information*, whereas emotional design manipulates the *appearance* of relevant information. Warmth and appeal are therefore not automatically extraneous: a monochrome interface forgoes a documented, if small, motivational resource.

4.3 Simplicity is Learner-dependent

Kalyuga’s (2007) synthesis of the expertise-reversal effect shows that instructional supports benefiting novices can become redundant, even harmful, for more knowledgeable learners, and vice versa. Structure imposed by an interface is such a support. Sailer et al. (2017) found gamification motivates when it satisfies the need for competence; conversely Hanus and Fox (2015) found badges, leaderboards and competition reduced intrinsic motivation over a semester, consistent with reward structures being experienced as controlling. No fixed level of interface simplicity is therefore optimal for all learners: the rigid 25-minute protocol that scaffolds one constrains another — consistent with the one negative participant response in the ASA feasibility study (Vasiljevic, 2026).

4.4 Tangible Interfaces: Real but Qualified Advantages

Comparisons of tangible and graphical interfaces caution against overclaiming. Marshall (2007) found the assumption that tangibility benefits learning largely untested; Li et al.'s (2022) review of 92 TEI publications concluded tangibles can scaffold learning, but urged their effectiveness be viewed “with rational and critical minds”. Tselegkaridis, Sapounidis and Stamovlasis's (2024) meta-analysis of 88 studies comparing physical and graphical circuit-teaching interfaces found no blanket superiority. The defensible claim is therefore not that physical form improves learning as such, but that a single-purpose object removes the multi-function device and with it a documented cost of self-interruption during study (Rosen, Carrier and Cheever, 2013; Mark, Gudith and Klocke, 2008).

4.5 The Periphery: Calm Technology

Finally, Weiser and Brown's (1996) calm technology — informing from the periphery of attention, moving to the centre only when needed — supplies the positive design vocabulary that cognitive load theory supplies negatively: an interface is judged by how little central attention it demands while remaining informative. The ASA's static display and red light are peripheral displays in this sense; Ishii and Ullmer's (1997) tangible bits programme anticipated the coupling of ambient information to physical objects.

5. Design Evaluation of the ASA Interface

Section 4 yields six principles. Each is stated below with the evidence licensing it and applied to the interface elements described in Section 3; Table 2 summarises the judgements and 5.7 draws them together. Throughout, the attribution categories of Section 3.2 apply: a principle may be satisfied by a display decision or by the device's architecture, and the difference governs what the evaluation can claim.

Table 2: Evaluation of ASA interface elements against evidence-derived principles (✓ aligned; ~ partial; ✗ misaligned; — not applicable)

Interface element	P1	P2	P3	P4	P5	P6
Two-panel E-ink layout (state + countdown)	✓	✓	✓	✓	~	~
Pomodoro progress row (daily goal)	✓	✓	✓	—	✓	~
Cumulative counters (total, trophies)	✓	✓	✓	—	~	~
Red status light (focus signal)	✓	~	✓	✓	—	~
Reward screen (trophy, timestamp)	✓	✓	✓	—	✓	~
Physical controls; no notifications	✓	—	✓	✓	—	~

Table 2 records alignment at the level of the artefact; Section 5 attributes each alignment to the display or to the device.

5.1 P1: Exclude Elements That Convey Task-Irrelevant Information

The principle. Exclude elements conveying task-irrelevant information (Section 4.1; Rey, 2012; Sundararajan and Adesope, 2020; Noetel et al., 2022). *The elements.* Everything rendered encodes task state, progress or protocol — mode in the state panel, time remaining in the countdown, attainment in the tomato row and counters, completion on the reward screen. Nothing is decorative; the seductive-details category is empty by construction. *The judgement.* Aligned across all six elements, with credit qualified: the display cannot host task-unrelated content at all, a property of single-purpose firmware rather than restraint by the layout. What the layout shows is that no area was spent on decoration — the state panel could have carried an avatar and does not.

5.2 P2: Make goal Progress and Competence Visible

The principle. Make progress and competence visible, the condition Section 4.3 identifies as the reliable route to gamified motivation (Sailer et al., 2017; Sailer and Homner, 2020). *The elements.* The tomato row renders the daily goal as positions to be filled, so the gap between current and target state is legible without counting; the counters place the session in a longer record of attainment; and the reward screen marks completion as an event. *The judgement.* Aligned for the layout, tomato row, counters and reward screen. The red light is partial

— it communicates state to others rather than attainment to the learner, serving P4 more than P2. The controls do not bear on this principle.

5.3 P3: Minimise the Attentional Cost of Consulting the Interface

The principle. Inform peripherally, at minimal attentional cost (Section 4.5; Weiser and Brown, 1996; Ishii and Ullmer, 1997). *The elements.* The E-ink display is static between state changes, so it never competes for attention through motion or refresh; the countdown is legible from any side of the device and readable in peripheral vision; the red light, an evenly diffused band rather than visible points of light, carries the single most important item of state — in focus, or not — without the learner looking at the screen, and carries it to others at the same time. *The judgement.* Aligned across the interface. This is the principle the ASA serves best, and the one case where medium and design decision coincide, E-ink having been chosen for it.

5.4 P4: Remove Access to Competing Tasks Rather Than Relying on Self-control

The principle. Where possible, learning tools should reduce access to competing tasks rather than depend entirely on the learner resisting them (Section 4.4; Rosen, Carrier and Cheever, 2013; Mark, Gudith and Klocke, 2008).

The elements. The ASA is a single-purpose device. It cannot become a browser, display social-media content or deliver incoming messages. Its physical controls keep interaction within the timer itself rather than redirecting the learner to another device. The red status light addresses a second source of interruption by signalling to people nearby that a focus interval is in progress.

The judgement. The ASA is strongly aligned with P4 at the level of the artefact, but most of that alignment comes from its architecture rather than from the interface alone. The absence of browsers, notifications and other competing applications results from the device being single-purpose and having no path to external content. These are system-level choices and should not be presented as achievements of the display.

The interface nevertheless contributes in two ways. First, the physical controls allow the learner to operate the timer without returning to a multi-function device. Second, the red status light extends the principle beyond digital distraction by providing a peripheral signal intended to reduce interruption from other people. P4 is therefore an important strength of the ASA, but it is also the principle that transfers least directly to learning tools implemented on general-purpose devices: much of the advantage belongs to the architecture of the object rather than to the minimal interface displayed on it.

5.5 P5: Preserve Motivational Warmth Where it Adds no Task-irrelevant Information

The principle. Preserve warmth where it adds no task-irrelevant information (Section 4.2; Brom, Stárková and D’Mello, 2018; Wong and Adesope, 2021); austerity is not free. *The elements.* The tomato iconography and trophy screen carry warmth and are informative rather than decorative — the tomato is the progress unit, the trophy the completion marker — but the panel forgoes colour entirely and nothing is anthropomorphised. *The judgement.* Partial, and the clearest evidence-based critique of the design. Section 3.2 sharpens the remedy: colour is a component constraint needing new hardware, whereas anthropomorphism is not — a face works in monochrome line art, and an anthropomorphised tomato on the reward screen is available on the current build. It is the cheaper revision and the better supported.

5.6 P6: Accommodate Individual Differences in Tolerance for Imposed Structure

The principle. Accommodate individual differences in tolerance for imposed structure (Section 4.3; Kalyuga, 2007; Hanus and Fox, 2015). *The elements.* The device is generous in quantity and fixed in kind. Interval length and daily goal are adjustable, a session may be paused, and an hour passes before abandonment is assumed. But the tomato row has three states only: empty, half-filled once an interval begins, and full on completion (Figure 2). The half-fill marks that a session is under way without encoding how far it has run — one minute in and twenty-four minutes in look identical — and an abandoned interval returns to empty. With the countdown showing time remaining rather than time invested, the interface represents distance from the target throughout and accumulated effort nowhere. *The judgement.* Partial, and the interface’s principal gap — narrower and sharper than a general lack of adaptivity. What cannot be varied is the framing: no mode tracks the daily goal without displaying it as a target, and no representation of effort survives non-completion. For a learner who experiences goal framing itself as controlling, adjusting the numbers does not reach the harm. The state a softer mode needs already exists, since pause requires the firmware to track elapsed time; surfacing it, or letting a learner bank an incomplete session, is a display-layer change rather than a new capability. This is

where expertise-reversal logic predicts a fixed minimal interface will fail, and where the one negative response in the feasibility study occurred (Vasiljevic, 2026).

5.7 Summary of the Audit

Across the six principles the audit yields three findings. The interface is genuinely aligned with the exclusionary and peripheral principles (P1, P3) and makes progress and competence visible as the gamification evidence requires (P2). Its compliance with P4 is real but belongs to the device rather than the display, narrowing what this case licenses others to conclude. Its two shortfalls differ in kind: the P5 gap is half component constraint and half available design decision, while the P6 gap is an interface omission the current hardware could support. The agenda that follows — an anthropomorphised reward screen and a way to bank partial effort now, colour at the next hardware revision — is ordered by that distinction rather than by the size of the shortfall.

6. Discussion

On RQ1, the evidence justifies a conditional defence of minimal interfaces, which are supported insofar as they eliminate seductive details, reduce extraneous cognitive load, and remove competing tasks from the learning context. Minimalism is *not* supported as a blanket aesthetic: emotional design evidence shows appeal can aid motivation and even learning, tangibility confers no automatic advantage, and fixed structure interacts with individual differences. The accurate slogan is not “simple is pedagogic” but “aligned is pedagogic”: every element should earn its attentional cost, every omission should be checked against what the evidence says is worth keeping, and both credited to the interface only where the interface made the choice.

On RQ2, the verdict is given in Section 5.7. Its implication for the wider claim is this: the absence of leaderboards and notifications is an architectural commitment rather than an achievement of the interface, while the absence of animation reflects a component constraint. Compliance with the coherence principle is real; who deserves the credit is a separate question, and answering it turns a description of one device into a transferable finding.

For the GBL community the method matters as much as the verdict. Design guidance often accumulates features; the audit used here runs the other way, asking of each element which meta-analytic finding licenses it. It is reusable for any learning interface, and the attribution step of Section 3.2 travels with it: asking whether an absence reflects what the interface withheld or what the system could not do stops an audit of a minimal design from flattering itself. Section 7 sets out how to test its predictions with users.

7. Limitations and Future Work

The review is an umbrella-style synthesis, not an exhaustive PRISMA systematic review, so primary studies contradicting the included syntheses at the margins may exist. The mapped literatures concern multimedia learning materials more often than device interfaces, so transferring effect estimates to a hardware timer involves an inferential step. The evaluation is analytic and was conducted by the designer; it identifies alignment with evidence, not proven efficacy, and an independent audit could score elements differently. A further limitation is structural: as a single artefact the ASA confounds interface with functional minimalism (Section 3.2), so neither this evaluation nor the feasibility study can establish that the display decisions rather than the architecture produced the reported effects. Hence the paper claims consistency rather than confirmation. The planned next step is a controlled trial (ASA versus a non-gamified physical timer versus a phone application with equivalent mechanics) into which the variants identified in Section 5.7 can be embedded as evidence-derived conditions; a richer-display ASA on identical hardware would form a further arm isolating interface from device.

8. Conclusion

A very simple interface can carry a substantive design argument precisely because its simplicity is a position in an evidential debate, not an absence of design. The evidence supports the ASA’s exclusions, qualifies its austerity, and localises its risk in the learners for whom imposed structure backfires. Minimal interfaces should be designed, and defended, element by element against that evidence.

Ethics Declaration: This study involved no human participants; it is a synthesis of published literature and an analytic evaluation of a device interface, so formal ethical clearance was not required. The feasibility study cited (Vasiljevic, 2026) reports its own ethics statement. The author’s role in developing the device and his co-inventorship of the associated patent are stated in Section 3; his involvement is purely academic and he holds

no financial or commercial interest in the patent, the company holding it, or the sale of the device, and the analytic limitations arising from that involvement are discussed in Section 7.

AI Declaration: A large language model was used as a drafting and editing aid, including assistance in locating candidate sources. All included sources were verified against the original publications by the author, and all arguments, evaluations and interpretations are the author's own.

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