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MSc. Design & Technology Futures

**FROM COMPLIANCE TO CONVERSATION:
REDESIGNING DOCUMENTATION
INFRASTRUCTURE FOR ESTONIAN HOME
EDUCATION**

**ARUANDLUSELT DIALOGILE: EESTI KODUÕPPE
DOKUMENTEERIMISE ÜMBERKUJUNDAMINE**

MASTER THESIS

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THESIS TASK

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1. Identify the systemic frictions in Estonian home education documentation through qualitative fieldwork with families, school coordinators, and policy stakeholders, attending to how institutional trust, control, and legal obligations interact around the documentary record.
2. Translate the findings into a design framework that specifies what a documentation infrastructure for home education should do.
3. Design and prototype a system grounded in this framework, redistributing documentation across family members, supporting the family-coordinator relationship, preserving human agency over AI-generated suggestions, and positioning the child as an active participant in self-documentation.

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SUMMARY

Decentralised and hybrid schooling is expanding, but the infrastructure for documenting learning and assessment still assumes a classroom presence. In Estonia, this mismatch falls hard on home education. Families must evidence their children's progress against the national curriculum (RÕK) using tools built for schools, while coordinators receive scattered evidence that requires extra time to analyze. Meanwhile, children play minimal part in a documentation process that is entirely about them.

This thesis investigates how this documentation infrastructure can be redesigned to reduce administrative burden, build trust between families and schools, and give the child an active role in their own learning record. Following a Research for Design approach, the empirical work draws on ten semi-structured interviews with parents, school coordinators, a Ministry representative, and an educational psychology expert. It also includes a retrospective digital observation in an online home education community and a visual audit of existing documentation artefacts. Four structural failures emerge from the fieldwork: a documentation tax, a trust-control tension, systemic tool fragmentation, and the underuse of the learner's voice.

In response to these findings, the thesis presents *Ekko*, a four-component reflective documentation system for home education. *Ekko* splits the process into immediate, low-friction capture of the learning moment and later parental curation through four distinct touchpoints: (1) the *Ekko Device*, a screen-free physical companion for child-led voice and photo capture; (2) the *Ekko App*, a mobile interface for parent review and curriculum mapping; (3) the *Ekko Portfolio*, a web dashboard for coordinators; and (4) the *Ekko Community*, a curriculum-anchored knowledge-sharing layer. Within this system, multimodal AI works strictly as an advisory layer under human control. It suggests reflection questions for the child and drafts curriculum tags for the parent, but final decisions remain with the user.

The system was developed and validated through two iterations of a hybrid prototype combining physical form and digital interaction, refining onboarding and interaction flows. The final contribution is a working specification for a trust-based learning documentation infrastructure. It shows that what home-educating families need today will become relevant tomorrow for mainstream flexible learners as well.

Keywords: home education, documentation, human-centred AI, Research for Design, digital portfolio, master thesis

KOKKUVÕTE

Detsentraliseeritud ja hübriidõpe on levimas, kuid õpitu dokumenteerimise ja hindamise süsteem eeldab endiselt klassiruumis viibimist. Eestis mõjutab see ebakõla eriti valusalt koduõpet. Pered peavad tõestama oma laste edasijõudmist riikliku õppekava (RÕK) põhjal, kasutades koolide jaoks loodud tööriistu. Samal ajal saavad koordinaatorid killustatud tõendusmaterjali, mille analüüsimine nõuab lisaaega. Lapsed ise osalevad neid puudutavas protsessis minimaalselt.

Käesolev magistritöö uurib, kuidas seda dokumenteerimistaristut ümber kujundada nii, et vähendada halduskoormust, luua usaldus perede ja koolide vahel ning anda lapsele aktiivne roll oma õpiteekonna jäädvustamisel. Lähtudes disainipõhise uurimistöö (Research for Design) lähenemisviisist, tugineb uuring kümnele poolstruktureeritud intervjuule lapsevanemate, õppekoordinaatorite, ministeeriumi esindaja ja hariduspsühholoogia eksperdiga. Samuti viidi läbi tagasivaatv digitaalne vaatlus ühes veebipõhises koduõppe kogukonnas ning olemasolevate dokumenteerimisvahendite visuaalne analüüs. Empiirilise uurimistöö tulemusena ilmneseid neli süsteemset puudujääki: dokumenteerimiseks, usalduse ja kontrolli vaheline pingeline, tööriistade killustatus ning õppija hääle alakasutus.

Nendest tulemustest lähtuvalt on loodud *Ekko* – neljaosaline refleksiooni toetav dokumenteerimise süsteem koduõppe jaoks. *Ekko* jagab protsessi kaheks: vahetuks õpihetke jäädvustamiseks ja hilisemaks vanemapoolseks kureerimiseks, mis toimub läbi nelja erineva puutepunkti: (1) *Ekko seade* – ekraanivaba füüsiline kaaslane lapse juhitud heli- ja fotosalvestuseks; (2) *Ekko rakendus* – mobiilne liides vanemale ülevaatamiseks ja õppekavaga sidumiseks; (3) *Ekko portfoolio* – veebipõhine töölaud koordinaatoritele; ning (4) *Ekko kogukond* – õppekavale tuginev teadmiste jagamise kiht. Süsteemis toimib multimodaalne tehisintellekt üksnes nõuandva kihina inimese kontrolli all. See pakub lapsele refleksiooniküsimusi ja koostab vanemale õppekava märksõnade mustandeid, kuid lõplikud otsused jäävad kasutajale.

Süsteemi arendati ja valideeriti kahe iteratsiooni jooksul hübriidprototüübiga, mis ühendas füüsilise vormi ja digitaalse interaktsiooni, et parandada kasutuselevõttu ja interaktsiooni voogusid. Töö lõpptulemuseks on toimiv spetsifikatsioon usalduspõhisele õppimise dokumenteerimise infrastruktuurile. See näitab, et koduõppeperede tänased vajadused saavad tulevikus aktuaalseks ka peavoolu paindlike õppijate jaoks.

Märksõnad: koduõpe, dokumenteerimine, inimkeskne tehisintellekt, Research for Design, digitaalne portfoolio, magistritöö

LIST OF ABBREVIATIONS AND TERMS

BPS — British Psychological Society

DR — Design Requirement (DR1–DR8)

EHIS — Eesti Hariduse Infosüsteem (Estonian Education Information System)

EU AI Act — Regulation (EU) 2024/1689 laying down harmonised rules on artificial intelligence

F — Finding (F1–F4)

GDPR — General Data Protection Regulation

HCAI — Human-Centred Artificial Intelligence

HTM — Haridus- ja Teadusministeerium (Estonian Ministry of Education and Research)

IÕK — Individuaalne õppekava (Individual Learning Plan / Individual Curriculum)

RÕK — Riiklik õppekava (Estonian National Curriculum)

RfD — Research for Design

SDT — Self-Determination Theory

1. INTRODUCTION

Over the past decade, remote and hybrid work have steadily loosened the link between professional life and fixed locations, quietly reshaping family routines and expectations around schooling. Recent research finds that when parents gain the right to work from home, their children's educational outcomes improve measurably (Achard, Belot & Chevalier, 2025), suggesting that flexible work arrangements have direct consequences for how families manage education. International policy frameworks anticipate the same direction: OECD scenarios for the future of schooling outline a gradual shift away from building-centric institutions toward models where homes, communities, and digital platforms together form a distributed learning infrastructure (OECD, 2020). In this context, arrangements such as homeschooling, temporary home education, and part-time attendance no longer appear as fringe choices but as early signals of broader systemic change.

COVID-19 accelerated a shift that was already underway. In the United States, homeschooling grew from around 2.8% of K–12 students before the pandemic to approximately 6% by 2024–2025, nearly triple the pre-pandemic growth rate, with 36% of reporting states recording their highest-ever homeschool enrolment (Watson, 2025). The reasons families give are varied, including concerns about school safety, desire for individualised pacing, neurodiversity, and lifestyle flexibility, but the common thread is that conventional schooling no longer fits the way many families live and work.

In Estonia, these global shifts intersect with a flexible education framework governed by the Basic Schools and Upper Secondary Schools Act (Põhikooli- ja gümnaasiumiseadus, 2010), which permits home education both on parental request and for health reasons. Official EHIS data show that parent-initiated home education grew from 289 students in 2015 to 858 in 2025, with an additional 159 studying at home for health reasons: a combined total of 1,017 students, representing approximately 0.6% of Estonia's school population (Raag, 2026). The pace has accelerated: HTM's own analysis identifies mental health problems as an increasingly common reason for the choice (Raag, 2026). Unlike in many countries, Estonian home-educated children remain formally enrolled in a school, which retains legal responsibility for verifying curriculum outcomes. This school-bound model creates the documentation challenge this thesis addresses.

1.1 The visibility-surveillance paradox

There is a tension at the heart of this problem that is worth naming at the outset. Learning must be made visible: coordinators, schools, and the state have a legitimate duty of care that they cannot discharge if they cannot see what is happening. The difficulty is that the instruments most readily available for creating that visibility tend to drift toward something else. When documentation is driven primarily by compliance requirements, it transforms learning into performative evidence. Families reconstruct activities retroactively into institutional formats, coordinators scan documents for coverage signals rather than reading them for insight, and the child's role is underused in the documenting process. Williamson (2017) and Selwyn (2019) analyse this as the datafication of education: a mode of oversight in which visibility becomes equated with monitoring rather than support. If pursued uncritically, the result is a home that comes to resemble a data-tracked classroom, where compliance signals displace genuine learning.

The design proposal developed in this thesis is a direct response to this paradox. Rather than adding another layer of mandatory reporting, it attempts to make learning legible to institutions as a by-product of practices that are already educationally useful: child-led capture, parental contextualisation, and AI-assisted curriculum mapping that remains under human control at every step.

1.2 Problem statement

The literature reviewed in Chapter 2 and the Estonian policy context together identify a problem space rather than a discrete defect. Where learning is life-integrated and institutionally supervised from a distance, four pressures act on the actors involved at once. Administrative burden falls on families who must translate organic activity into institutionally legible evidence under uncertain criteria (Daigneault, 2024; Moynihan et al., 2015). Trust between families and schools must be negotiated through documentation rather than through co-presence, with each side carrying its own form of vulnerability (Adams & Christenson, 2000). The tools available for this negotiation were designed for classroom use, not for home education, and do not connect to one another. And the child, who is the subject of the assessment, has no structural place in producing the record that represents them – a gap visible across the assessment, metacognition, and human-centred AI literatures (Boud, 2000; Flavell, 1979; Shneiderman, 2020). Two of these pressures are infrastructural, they describe what the system fails to provide, and two are relational, describing what happens between actors as a consequence. Chapter 4 returns to this distinction.

1.3 Research aim, questions, and objectives

This thesis has two aims. The first is to investigate how documentation and assessment practices in home education can be redesigned to reduce administrative burden and build trust-based visibility. The second is to turn that investigation into a working design proposal that can be evaluated with Estonian families.

The research is guided by two questions:

RQ1: What systemic frictions do Estonian home-educating families and school coordinators experience in current documentation and assessment practices?

RQ2: How might a designed documentation infrastructure address these frictions?

These questions lead to three research objectives:

1. Identify the systemic frictions in Estonian home education documentation through qualitative fieldwork with families, school coordinators, and policy stakeholders, attending to how institutional trust, control, and legal obligations interact around the documentary record.
2. Translate the findings into a design framework that specifies what a documentation infrastructure for home education should do.
3. Design and prototype a system grounded in this framework, redistributing documentation across family members, supporting the family-coordinator relationship, preserving human agency over AI-generated suggestions, and positioning the child as an active participant in self-documentation.

1.4 Target group and scope

The design proposal targets families with children in grades 1–3 (school stage I, roughly ages 6 to 10). Three considerations justify this focus. First, children in these years engage in a great deal of experiential and hands-on learning, exactly the kinds of activity that are hardest to map onto subject-based curriculum frameworks without deliberate translation work, and where the documentation burden is therefore heaviest. Second, parents of children at this stage carry most of the articulation load. Third, this is the developmental window in which children are beginning to develop reflective capacity but have not yet been trained into formal note-taking habits, making it the right stage to position the child as an active participant in their own documentation (Boud, 2000; Vygotsky, 1978). The thesis does not address upper secondary home education, which involves much greater learner autonomy.

The scope is narrower than it might initially appear. This thesis examines only the documentation and assessment layer of home education: the practices, tools, and relationships through which learning becomes visible to people outside the family. It does not propose a curriculum, evaluate pedagogical approaches, or make claims about learning outcomes. The empirical work is grounded in Estonia, but the analytical framework engages a wider literature, and the design is intended to remain legible beyond its immediate context.

1.5 Significance

This thesis makes three kinds of contribution. Empirically, it provides a structured account of how documentation and assessment actually function in Estonian home education, drawing on ten interviews, retrospective digital observation of approximately one year of posts in an online home education community, and a visual audit of existing documentation artefacts. Theoretically, it brings together administrative burden research (Daigneault, 2024), systems-oriented design (Sevaldson, 2017), human-centred AI (Shneiderman, 2020), and tangible interaction (Ishii & Ullmer, 1997) around a problem that has not previously been framed in design research terms. By design, it produces a working prototype that translates the empirical findings and theoretical framework into a concrete proposal, and is intended to be evaluated with home-educating families.

The timing is significant. The September 2025 regulatory changes moved home education oversight from the school council to the director and required monthly rather than twice-yearly monitoring. They were driven by documented cases of home-educated children disappearing from school contact for years (Rakaselg, cited in Raag, 2026). Journalistic coverage in *Õpetajate Leht* (Raag, 2026) and the *Eesti inimarengu aruanne 2026* (Kindsiko, 2026) indicate that the structural problems this thesis investigates are recognised at policy level: the friction between families and schools, the limited place of the child in the documentary record, and the underuse of Estonia's e-governance infrastructure in education because of data protection barriers and poor information system interoperability.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 The global shift toward decentralised learning

OECD scenario analyses include futures in which schools function as coordinating hubs for networks of community-based and home-based learning rather than concentrating instruction within a single building (Figure 1; OECD, 2020). The "Schools as learning hubs" scenario re-purposes schools as coordinating nodes in networks of community and home-based learning, while "Education outsourced" sees the schooling system give way to a market of diverse private and community arrangements. Teacher shortages and rising demand for personalised pathways are already straining building-centric models in many OECD countries.

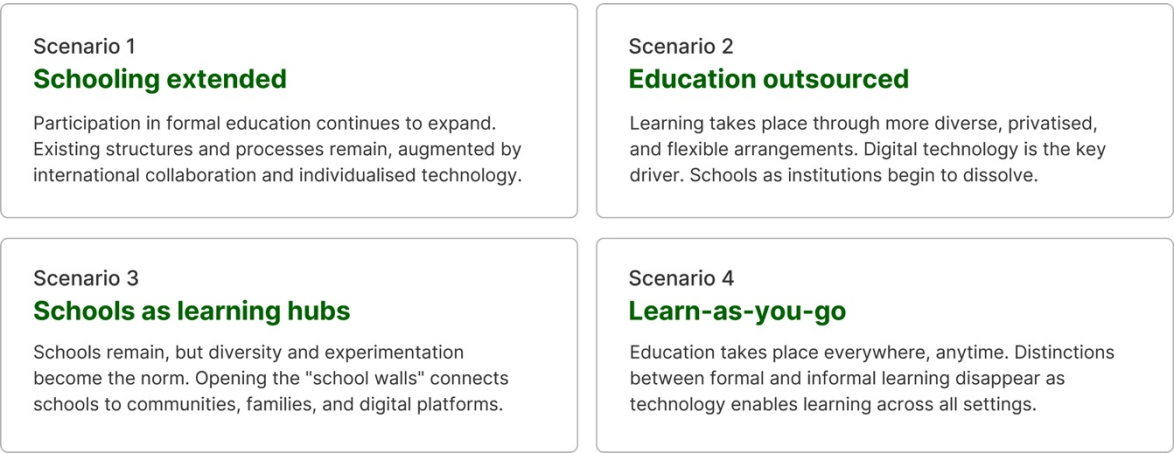


Figure 1 The four OECD scenarios for the future of schooling. Made by the author, adapted from OECD (2020).

Within this context, homeschooling functions as an early indicator of where mainstream education is heading. Tilhou (2020) documents the diversity of contemporary homeschool arrangements, from traditional home instruction to co-ops, hybrid schools, and home-based charter models. The movement has grown beyond its religious origins to encompass a wide range of pedagogical and family motivations. Watson (2024) shows that US homeschooling participation has persisted and continued to grow in the years following the pandemic, with state-reported data putting current participation at roughly twice pre-pandemic levels and defying earlier predictions that families would return to traditional schools. Morris and Pannone (2024) argue that digital technologies in homeschooling are most valuable not as content-delivery systems but as tools that help children cultivate self-directed, lifelong learning habits, a framing this thesis extends to

documentation infrastructure. What drives families to home education varies, but the structural experience of documenting learning for institutions without shared infrastructure is consistent. A one-size-fits-all reporting system fails families whose learning looks radically different from classroom norms.

2.2 Assessment in flexible learning contexts

Contemporary assessment theory has moved away from assessment as institutional sorting and toward assessment that builds the learner's own capacity. Boud's (2000) sustainable assessment, Clark's (2012) account of assessment as the driver of self-regulated learning, and Hattie's (2012) visible-learning synthesis on feedback loops converge on a learner-centred orientation: assessment is most useful when it is specific, timely, and oriented to the learner's next steps rather than to ranking.

The spread of generative AI sharpens the urgency of rethinking what counts as credible evidence. UNESCO (2025a) argues that AI in education must reduce educator workload rather than increase it, a principle this thesis extends to the documentation burden on home-educating families. A parallel UNESCO paper on assessment in the AI age argues that authentic, process-rich evidence of learning should take precedence over outputs that generative AI can produce on demand (UNESCO, 2025c). Broadfoot and Rockey (2025) warn that generative AI risks operating as a form of corporate surveillance in assessment contexts. Both point to the same design challenge: AI in educational assessment must be transparent and subordinate to human judgment, not a substitute for it.

Portfolios offer one practical response to this assessment problem. Barrett (2007) argues that portfolio practice should shift from institution-centred to learner-centred, with students owning the curation of their own work. A more recent and practical extension of this principle comes from the QAA Framework for Flexible Assessment (Firth, 2025). Although written for UK universities, its core ideas fit the home education context well. The framework is built on four principles: Choice in how learning is demonstrated, Clarity about what is being assessed and why, Co-Design with learners in shaping assessment, and Consistency in standards across different evidence formats. Equity sits alongside pedagogy and feasibility as one of three strategic lenses. The framework's most useful contribution for this thesis is the idea that different forms of evidence can demonstrate the same learning, as long as the standards are transparent. This helps close the gap between families who already know how to "speak school" and those who do not.

2.3 Datafication, surveillance, and human-centred AI

The easiest tools for making learning visible are also the ones that take the most data from learners. Critical scholars warn that the datafication of education risks turning learning spaces into systems of automated surveillance, rewarding activity and compliance over reflection and understanding (Selwyn, 2019; Williamson, 2017). For home education the stakes are high: data-heavy tools adopted without care can turn the home into a tracked classroom and remove the very freedom families left conventional schooling to find.

The useful question is how AI-assisted systems can be designed to support visibility without enabling control. Shneiderman's (2020) human-centred AI framework offers one answer (Figure 2): in the high-control, high-automation quadrant, AI makes suggestions and humans make decisions.

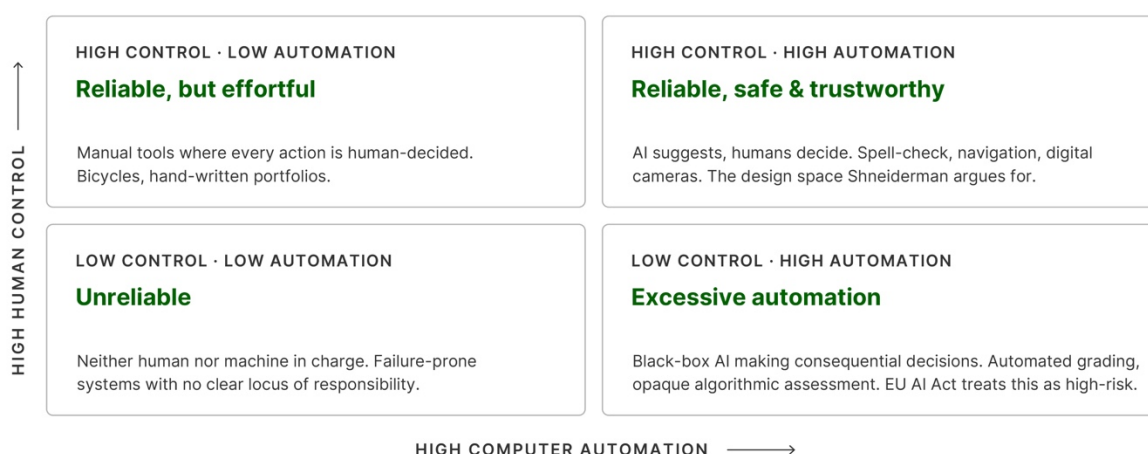


Figure 2 Two-dimensional human-centred AI framework, with quadrant labels and examples added by the author. Adapted from Shneiderman (2020).

Recent reviews suggest this balance is the central unresolved problem in educational AI. Deepshikha's (2025) review of AI-driven assessment tools finds that the main design challenges are ethical rather than technical: data privacy, algorithmic transparency, and the balance between efficiency and human oversight. Alfredo et al. (2024) add that HCAI principles are increasingly invoked in system design, but end-user involvement, particularly of learners themselves, remains limited. Kurian (2025) argues that AI tools intended for use by children should be aligned with developmental science from the start, treating cognitive, emotional, and social development as design constraints rather than after-the-fact considerations. The OECD (2026) takes a similar position at the policy level in its Digital Education Outlook, arguing that GenAI tools used in education should be co-created with teachers and learners, grounded in learning science, and bounded by clear expectations around privacy, transparency, and age-appropriateness.

As Kindsiko et al. (2026) render the Global Human Development Report 2025, AI in education should serve "as an extension of curiosity, not a substitute for the human" (*uudishimu pikendusena, mitte inimese aseainena*; my translation of Kindsiko et al.). The same chapter argues that digital learning and administrative systems should reduce, not multiply, the documentation work that falls on teachers. This offers a policy-level parallel in the Estonian setting: AI-generated suggestions in any documentation tool should be designed to lift administrative load while keeping pedagogical authority with named human actors.

This thesis takes these challenges as design requirements, not background risks. UNESCO (2025b) frames the same concerns through the lens of learner rights, calling for AI systems in education that protect children's privacy, agency, and developmental interests. Any AI component in a trust-based documentation system must therefore work as a suggestion layer, not a decision layer. Curriculum mapping, reflection prompts, and coverage indicators may be generated by AI, but they must be confirmed, edited, or dismissed by a human before they have consequences for the child. This is what makes such a system defensible under current EU AI regulation, and what makes it educationally sound. Design principles such as privacy by design (Cavoukian, 2009; GDPR Article 25) and meaningful user consent over data flows follow directly: sensitive learning data should travel only as far as the agreed assessment purposes require, and families should keep control over what leaves the home. Chapter 5 turns these requirements into specific design decisions.

2.4 Trust, equity, and the documentation burden

Educational relationships are built on trust. Research on home-school partnerships shows that mutual trust and shared responsibility are essential to positive outcomes for children (Adams & Christenson, 2000). In decentralised contexts, trust must be negotiated not only between parents and schools but also between families and the state, which retains a legal duty to protect children's right to education and to intervene if that right is not met (Põhikooli- ja gümnaasiumiseadus, 2010; Monk, 2003; Gerrard et al., 2025). Documentation is one of the main sites where this negotiation plays out in practice.

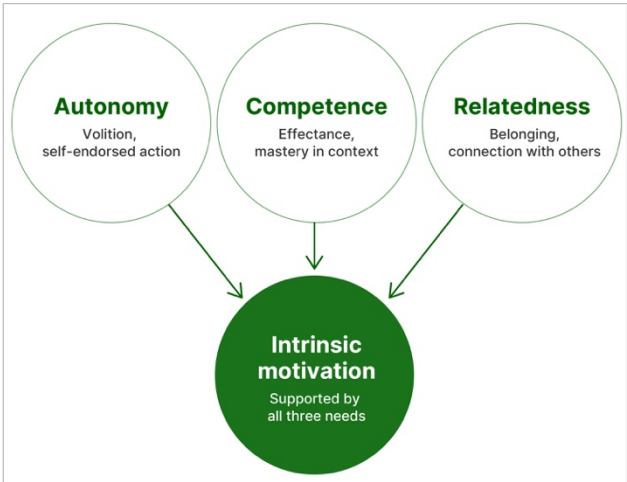
Administrative burden theory provides a useful analytical lens. Moynihan et al. (2015) define administrative burden as the learning, compliance, and psychological costs citizens incur when interacting with public institutions, and Daigneault (2024) sharpens

this into four cost dimensions: time, money, effort, and psychological costs. The documentation tax facing home-educating families is not mainly a time problem but an effortful translation task compounded by uncertainty, fear of non-compliance, and the affective weight of feeling permanently under evaluation.

Burden also does not fall evenly. Kunzman and Gaither (2013) observe that the ability to opt out of conventional schooling and document learning credibly is distributed unequally across families with different levels of academic capital, institutional literacy, and time resources. Watson (2024) shows that since the pandemic, families with fewer resources are entering home education in greater numbers, often without the peer networks and templates established homeschoolers rely on. Scaffolded, accessible documentation infrastructure is therefore an equity issue, not only a usability one.

2.5 Psychological foundations

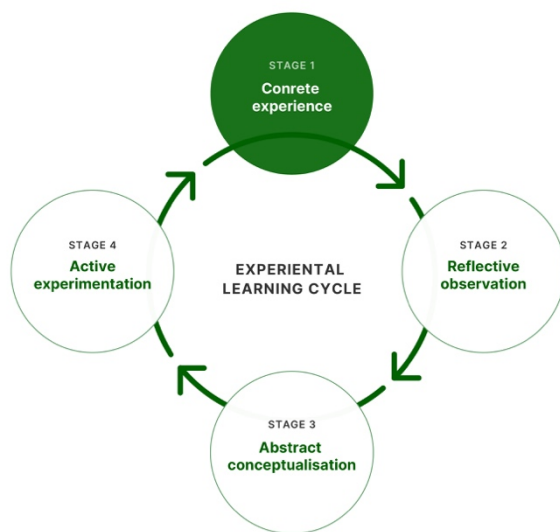
The psychological case for decentralised learning draws primarily on self-determination theory (SDT), which holds that intrinsic motivation depends on satisfying three basic needs: autonomy, competence, and relatedness (Deci & Ryan, 2000). Home-educating families frequently cite autonomy and psychological safety as central reasons for leaving conventional schools (Neuman & Guterman, 2017). A recent meta-analysis by Wang et al. (2024) confirms that SDT-based educational interventions produce significant gains



in intrinsic motivation, particularly through autonomy and competence support, strengthening the empirical case for autonomy-supportive design. High-friction, compliance-oriented evidence production tends to shift motivation toward external control, while trust-based portfolio practices can preserve autonomy and still produce credible evidence for institutional assurance.

Figure 3 Self-determination theory: intrinsic motivation depends on the satisfaction of all three basic psychological needs. Created by the author, adapted from Deci and Ryan (2000).

A second foundation concerns when reflection happens. The developmental case for in-moment capture, rather than retrospective documentation, rests on the distinction between metacognitive experience and metacognitive knowledge (Flavell, 1979). Metacognitive experience is the conscious awareness that arises during a cognitive event, the moment a child notices they have learned something, recognised a pattern, or solved a problem. It is temporally bound. Metacognitive knowledge, by contrast, is stable and retrospective: it is what a person knows about their own cognition in general terms. Documentation systems that rely on retrospective reconstruction capture metacognitive knowledge at best, not the metacognitive experience that occurred in the moment of learning.



Kolb's (1984) experiential learning cycle frames the move from concrete experience to reflective observation as foundational, and reflection includes the emotions present in the moment, excitement, curiosity, frustration, which are audible in the child's voice at capture but absent from a parent's retrospective account (Boud, Keogh & Walker, 1985). These foundations point to the value of capturing learning in the moment rather than reconstructing it afterwards.

Figure 4 Kolb's four-stage experiential learning cycle. Created by the author, adapted from Kolb (1984).

A third foundation comes from policy. The OECD and European Commission's draft AI literacy framework for primary and secondary education (OECD, 2025) treats critical engagement with AI, the ability to understand what it does, judge its outputs, and decide when to trust it, as a foundational competence that should be built from the early school years. This matters directly for a system in which children interact with AI-generated reflection prompts directly, even where other AI suggestions remain with the parent.

2.6 The Estonian educational context

Estonia's national education strategy, the *Haridusvaldkonna arengukava 2021–2035*, frames lifelong learning, learner agency, and flexible, individualised learning pathways as central policy commitments (Haridus- ja Teadusministeerium, 2021a). Estonian home education sits inside this broader framing, and inside a specific legal, regulatory, and digital infrastructure that shapes what documentation can and cannot do. This section sets out that context in four parts: the school-bound oversight model, the recent growth in enrolment and the September 2025 regulatory changes, the strengths and limits of Estonia's digital education infrastructure, and the support initiatives that have grown up alongside it.

2.6.1 Home education oversight as a school-bound workflow

Under the Basic Schools and Upper Secondary Schools Act (*Põhikooli- ja gümnaasiumiseadus*, 2010), every home-educated child in Estonia must be enrolled in a specific school, which retains legal responsibility for monitoring progress and verifying that national curriculum outcomes are met. Parents apply for home education, sign a cooperation agreement, and are expected to prepare or adapt an individual curriculum (*Individuaalne õppekava*, IÕK) aligned with national standards.

The implementing regulation *Koduõppe ja haiglaõppe tingimused ja kord* (Haridus- ja teadusminister, 2018) puts §23 of the Act into practice. It sets out two pathways: home education on health grounds, organised by the school, and home education at parental request, organised and financed by the parent (§§5–8). A separate provision (§9) covers children of Estonian diplomats and long-term overseas civil servants. This is the only category in which mobility itself is recognised as a legitimate basis for home education, a narrow framing that does not extend to the wider population of remote-working families. Administratively, the home-educated child is recorded in the Estonian Education Information System (EHIS) under the special-needs tag *Koduõppe lapsevanema soovil* together with the support measure *Üldine tugi* (Haridus- ja Noorteamet, n.d.). EHIS registers the fact of home education but contains no field for learning evidence, no curriculum-coverage view, and no record of the periodic assessments themselves. The actual record exists only in the documents the family and coordinator exchange privately.

Verification occurs through periodic check-ins, which may take the form of written tests, oral demonstrations, or portfolio-style evidence reviews depending on the school and coordinator. In practice, expectations vary widely between schools: coordinators report

discretion in what they accept as sufficient evidence, and documentation requirements are not standardised across institutions. This variability is itself a structural problem; it produces uncertainty about what constitutes sufficient evidence and fuels the defensive over-documentation documented in the research literature (Daigneault, 2024).

2.6.2 Recent growth and regulatory tightening

Parent-initiated home education in Estonia grew from 105 students in 2013 to 858 in 2025, an eight-fold increase (HTM, 2021b; Raag, 2026). A further 159 students were on home education for health reasons in 2025 (Raag, 2026). The combined total of 1,017 represents approximately 0.6% of the 171,436 students in compulsory education (Statistikaamet, 2025).

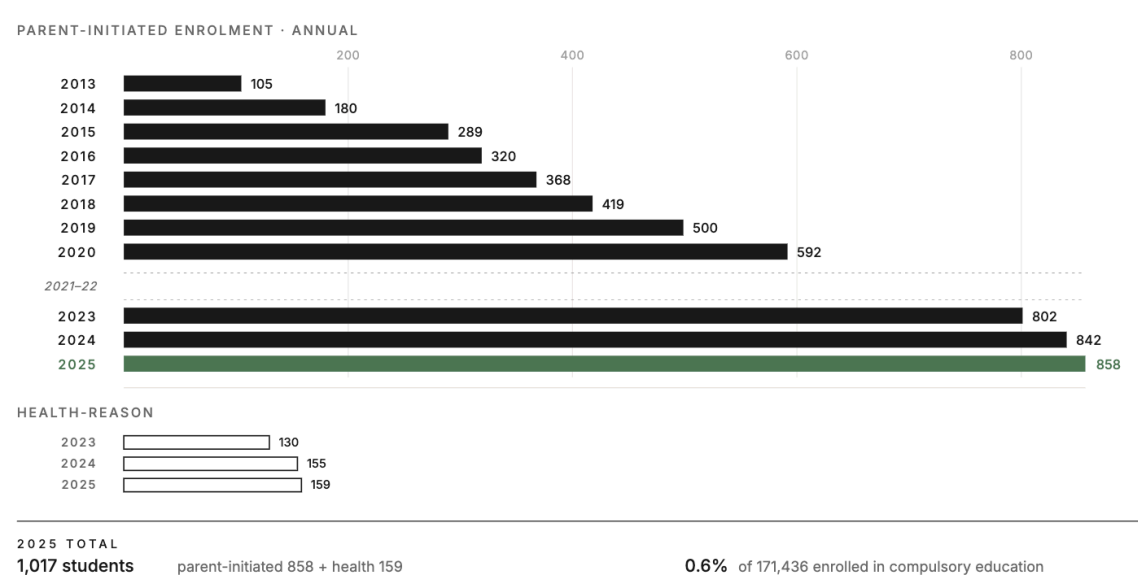


Figure 5 Parent-initiated home education enrolment in Estonia, 2013–2025. Made by the author; data from HTM (2021b), Raag (2026), and Statistikaamet (2025). No published data for 2021–2022.

Two HTM voices set out the reasons for tightening. The Ministry's head of inclusive education, Jürgen Rakaselg, notes that inspection has documented cases where schools had not seen a home-educated child for multiple years (Raag, 2026). Regulatory amendments that took effect in September 2025 responded directly to these failures: the oversight decision moved from the school council to the director, monitoring frequency changed from twice-yearly to monthly, and schools gained clearer grounds to terminate home education where outcomes cannot be verified (Haridus- ja teadusminister, 2025).

The shift also reflected a data protection argument. Sharing detailed personal information about a child's living situation with the full teaching council was inconsistent with basic data minimisation principles, and locating the decision with a single named director was framed as both more flexible and more privacy-preserving (Rakaselg, cited in Raag, 2026). Rakaselg characterised the regulatory aim not as restricting parental choice but as bringing the content of home education and the frequency of evidence verification into closer alignment with the national curriculum that legally applies to every child. Read in those terms, the September 2025 amendments are best understood as a tightening of the evidence regime rather than of access, precisely the design space this thesis enters.

2.6.3 Digital infrastructure and its limits for home education

Estonia's schooling infrastructure is highly digitised: 95% of schools use e-diaries such as eKool or Stuudium, providing real-time visibility of attendance and grades for enrolled students (e-Estonia, n.d.). The *Eesti inimarengu aruanne 2026* (Kindsiko, 2026) goes further. It observes that Estonia underuses its e-governance infrastructure in education. The data needed to identify children at risk and to track learning gaps are often already in registries. What blocks their use for early intervention or personalised support is data protection barriers, poor system interoperability, and weak data literacy.

The report goes as far as to argue that Estonia has built data-protection walls in education so high that it has lost sight of who and what those walls were meant to protect, leaving the e-state's educational potential under-realised in exactly the cases that need it most (Kindsiko, 2026). The same logic applies asymmetrically to home education. Enrolled students are continuously visible to the state through eKool or Stuudium, and their data flow into EHIS as attendance, grades, and individual learning plans. The home-educated child, by contrast, appears in EHIS only as a single tag and a support-measure code, with no field for the learning itself (Haridus- ja Noorteamet, n.d.).

2.6.4 Support initiatives and the remaining visibility gap

Several Estonian initiatives have sought to fill the pedagogical and procedural void that state infrastructure leaves behind. The non-governmental MTÜ Eesti Koduõppe Keskus, founded in 2006, runs a national network of seasonal *koduõppepäevad* (home-education days) in Tallinn, Tartu, and Hiiumaa, maintains a directory of home-education-friendly schools and a links registry of courses, mentors, and peer networks, and publishes a plain-language *Koduõppe ABC* (a "Home Education ABC" guide) explaining application

timing, IÕK construction, mid-year transitions, and the rhythm of school-side assessment (MTÜ Eesti Koduõppe Keskus, n.d.-a, n.d.-b).

Several Estonian schools have built dedicated home-education departments around this practice (MTÜ Eesti Koduõppe Keskus, n.d.-a). Two of these models, at Tartu Luterlik Peetri Kool (TLPK) and Gaia Kool, anticipate the design direction of this thesis particularly closely. TLPK operates the largest home-education department in the country, with coordinators Kadi Künnapuu and Irja Toots arguing in *Õpetajate Leht* that home-education-friendly schools value the self-directed effort of the learner because that effort prepares the child for life beyond schooling (Künnapuu & Toots, 2021). TLPK also runs Künnapuu's VÕK (*veebipõhine õppeprogramm koduõppijale*) online programme, which structures weekly support around three-phase learning cycles (planning, working, reflecting), maps tasks to RÕK outcomes, and treats the workplan as a living attachment to the family's IÕK (Künnapuu, 2023). Gaia Kool offers parallel parent-led and school-guided tracks with downloadable per-grade outcome tables and twice-yearly developmental conversations on Opiq (Gaia Kool, n.d.). Within the monthly monitoring cadence now required by law (Haridus- ja teadusminister, 2025), Gaia uses written study maps alongside subject tests, and its coordinators identify "red flags" as family conflict, persistent learning gaps, and absence of social contact rather than as failures of documentation format (Raag, 2026). Both schools demonstrate that trust-based oversight is practically achievable when clear agreements, a named contact person, flexible assessment formats, and constructive feedback are in place.

What is missing is shared digital infrastructure that would make these practices scalable and portable across all schools with home-educated children enrolled. Each working adaptation currently lives inside a single institution's procedures, templates, and informal know-how. A family changing schools, leaving Estonia, or returning to mainstream education have difficulties carrying the documentary record with them. The pedagogical knowledge exists. The infrastructure to circulate it does not.

2.7 International approaches to home education oversight

International comparisons reveal a wide spectrum of regulatory choices, each carrying distinct trade-offs between family autonomy and institutional accountability. Germany's near-total ban on home education forecloses flexible arrangements entirely, reflecting a constitutional commitment to the school as the primary site of socialisation (Gerrard et al., 2025). The United Kingdom takes an opposite approach: local authorities have limited powers to investigate home education, and families face minimal documentation requirements. The resulting light touch has been criticised for enabling what child protection inquiries have called the "invisible child" problem, in which children fall outside any systematic safeguarding oversight (Gerrard et al., 2025).

Sweden offers a third position: following the 2010 Education Act (Skollag 2010:800), home education is permitted only in exceptional circumstances, such that the practice has effectively ceased. Estonia sits in a different position again: home education is legally permitted and relatively accessible, but the child remains enrolled in a specific school that retains assessment responsibility. This school-bound oversight model is the structural feature that distinguishes the Estonian context from both light-touch and prohibitive regimes, and it is the structural feature that determines what documentation infrastructure has to do.

What these comparisons illuminate is that documentation is not a fixed technical requirement but a design space shaped by policy choices about the appropriate balance between autonomy and accountability.

2.8 Existing documentation tools and their limitations

The documentation ecosystem in which home-educating families currently operate relies on tools designed for other purposes. To the author's knowledge, no purpose-built digital infrastructure for home education documentation exists in Estonia or internationally.

Estonian school systems. eKool and Stuudium are Estonia's dominant school management platforms, used by approximately 95% of schools for attendance tracking, grade entry, and parent-teacher communication (Education Estonia, n.d.). Both assume a teacher entering grades for a defined class, attendance at scheduled lessons, and communication structured around the school calendar. Home-educated children have none of these. Coordinators repurpose the platforms by entering a single summary

grade per subject at term end. Opiq, Estonia's main digital learning materials platform, provides RÕK-aligned content but is a content delivery tool, not a documentation tool.

General-purpose tools. Fieldwork (Chapter 4) confirmed that Google Drive and email form the de facto documentation infrastructure for most Estonian home-educating families. Their strengths are familiarity and zero cost. Their limitations are substantial: assembling evidence into a form coordinators can interpret demands significant manual effort, and the tools offer little structural support for doing so. Facebook groups serve as a parallel shadow infrastructure where families share documents, advice, and experience, but content disappears into the feed.

International portfolio platforms. Several commercial platforms (Seesaw, FreshGrade, Bulb) offer multimedia capture, student-initiated documentation, and standards-linked portfolios. None is designed for the structural conditions of home education: a child learning outside school, a parent documenting without institutional scaffolding, and a coordinator assessing evidence from a distance. All assume a teacher is the primary curator of evidence, none supports the Estonian national curriculum, and none addresses the family–coordinator relationship.

Table 1 evaluates the main tools currently used in Estonian home education against five structural needs.

Table 1 Existing documentation tools evaluated against five structural needs.

Tool / Platform	Reduces effort	Supports trust	Coherent infrastructure	Child's voice	Home-ed designed
eKool / Stuudium	No	No	Partial	No	No
Opiq	No	No	Partial	No	No
Google Drive + email	No	No	No	No	No
Facebook groups	Partial	No	Partial	No	No
International portfolio platforms	Partial	No	Partial	Partial	No

The gap is clear. No existing tool meets all five needs, integrates with the Estonian national curriculum, or positions the child as an active participant in documentation.

2.9 Conceptual framework and research gap

Several tensions run across this literature. Decentralisation and individualisation create demand for flexible, life-integrated learning pathways (OECD, 2020), while assessment theory calls for sustainable and learner-centred evaluation (Boud, 2000). Critical EdTech scholarship warns that data-driven visibility slides easily into surveillance (Selwyn, 2019; Williamson, 2017). The administrative burden literature shows that documentation costs land unevenly across families (Daigneault, 2024; Moynihan et al., 2015; Kunzman & Gaither, 2013), and work in educational psychology emphasises the need to protect autonomy and support metacognition in any intervention (Deci & Ryan, 2000; Wang et al., 2024).

The EU AI Act gives the surveillance concern legal form. Under Annex III of Regulation 2024/1689, AI systems that evaluate learning outcomes or determine access to education count as high-risk. The substantive obligations attached to that classification (human oversight, transparency, data governance, post-market monitoring) become enforceable on 2 August 2026 (EU AI Act, 2024). For any AI-assisted documentation system used in Estonian schools, this is not a future problem but a near-term constraint that has to be designed in from the start.

Despite growing attention to home education and hybrid models, little work treats documentation infrastructure itself as a design problem, especially in the Estonian context. The most current research focuses on growth trends and regulatory questions (Gerrard et al., 2025; Watson, 2024) but stops short of proposing infrastructural responses. On the AI side, the dominant discourse addresses AI for automated grading and feedback in institutional settings (Broadfoot & Rockey, 2025; Deepshikha, 2025) rather than AI for low-friction, family-controlled documentation in decentralised learning. The gap this thesis addresses sits between these two conversations.

3. METHODOLOGY

3.1 Research for Design

Given that the thesis aims not only to describe existing problems but to propose a new infrastructural concept grounded in empirical evidence, it adopts Research for Design (RfD) as its primary methodological framework. Frayling (1993) distinguishes three forms of design research: research *into* design (historical and theoretical study), research *through* design (in which the design process and its artefacts are themselves the site of inquiry), and research *for* design (in which prior research informs and shapes a design outcome). The work presented here belongs to the third category, extended by later HCI methodology work, notably Zimmerman, Forlizzi, and Evenson (2007), who set out the conditions under which design artefacts can themselves count as research contributions. The design is the response to the research, not the vehicle through which the research is conducted.

Research for Design is appropriate here because the visibility–surveillance paradox introduced in Section 1.1 is, through fieldwork, well-defined enough to specify what a solution must do, while the solution space itself remains open. The sequence is linear by intent: empirical findings produce a design framework (Chapter 5), the framework produces a design brief, and the design proposal answers that brief. Prototyping within the proposal is iterative, but operates inside an already-settled brief rather than as a means of producing it. Figure 6 sets out this sequence, from fieldwork through framework and brief to the design proposal.

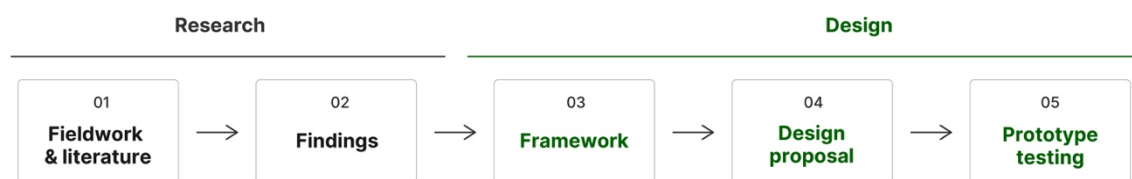


Figure 6 Research for Design: from fieldwork to design proposal. Made by the author, based on Frayling (1993).

3.2 Systems-oriented approach

The research approach began with a systems-mapping exercise in the Sevaldson (2017) tradition, developing a wide view of the population of children learning outside conventional classrooms (Figure 7). The map identified the distant-learner space across five domains: choice and philosophy, health and wellbeing, socio-economic and situational, institutional and structural, and geographic and infrastructural. It also traced relations between the learner, the home, the school, support and community structures, legal and institutional actors, and tools and infrastructure. The figure is reproduced here at a scale that does not invite reading of individual nodes; its purpose is to evidence the breadth of the space considered before the narrowing, not to function as a reference diagram.

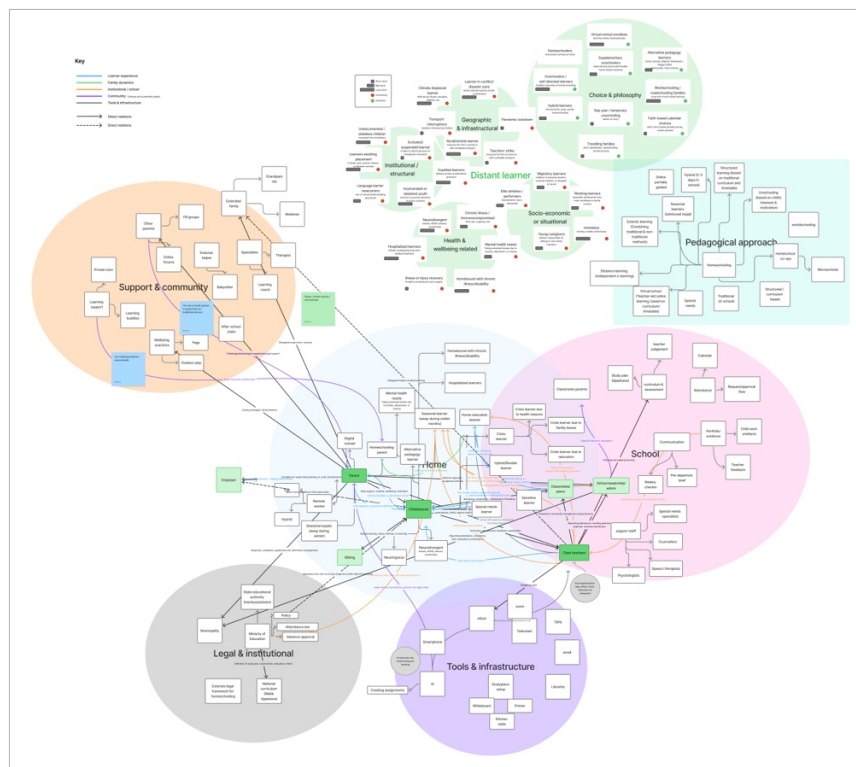


Figure 7 Systems map of the distant-learner space, produced early in the research as a Sevaldson (2017) Gigamap to develop wide-angle systemic literacy of the problem. Made by the author.

The wide-angle map narrowed into a focused systems view of the Estonian home education case. Drawing on systems-oriented design (Sevaldson, 2017), the study maps the relationships, dependencies, and tensions among families, schools, the state, and the surrounding community of resources (Jones, 2014; Meadows, 2008). Figure 8 presents this narrower view as a synthesis diagram distilled from the gigamap, isolating the core actors, relationships and tensions that sustain the documentation burden.

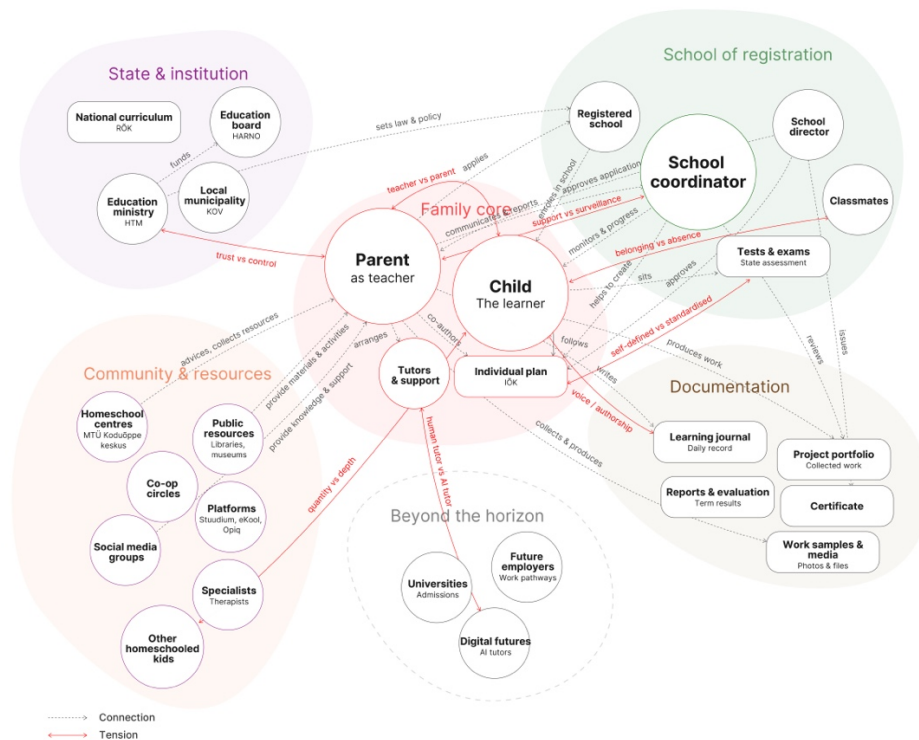


Figure 8 Stakeholder ecosystem of Estonian home education, a synthesis distilled from the map in Figure 7. Made by the author, after Sevaldson (2017).

3.3 Case selection: home education as an extreme case and lead-user group

Home-educating families in Estonia are treated in this study as both an extreme case and a lead-user population. As an extreme case, home education intensifies the documentation and trust-control tensions present in all flexible learning. Families lack the default classroom visibility mechanisms of attendance and direct observation, and must deliberately construct evidence for institutional validators. Problems that stay hidden in conventional schooling become concentrated and unavoidable here, revealing weaknesses in assessment infrastructure that classroom-bound arrangements tend to obscure (Kunzman & Gaither, 2013).

Home-educating families also function as lead users in von Hippel's (1986) sense: people who meet emerging needs earlier and more intensely than the broader population. As hybrid and mobile schooling expands, mainstream schools are likely to face the same documentation burdens that home-educating families navigate today. Studying this group therefore generates design requirements with broader relevance, even though the families are not numerically representative.

3.4 Qualitative field research

To ground the design process in lived experience, the study uses a multi-method qualitative approach combining semi-structured interviews, digital observation, and a visual audit of documentation artefacts. Triangulation across these three sources supports a richer understanding of the problem space and increases analytic credibility by bringing together multiple perspectives and forms of evidence.

3.4.1 Semi-structured interviews

The interview component comprised ten semi-structured interviews with stakeholders in the Estonian home education ecosystem: home-educating parents, school coordinators and teachers responsible for assessing home-educated students, a policymaker, and an educational psychology expert. Participants were recruited through home-education networks and professional connections, using purposive sampling to reflect a range of experiences, including long-term and interim home education, families with special educational needs, and both urban and non-urban contexts.

Interviews were conducted online in Estonian and lasted between 30 and 90 minutes. They were not audio-recorded. Detailed notes were taken in real time and expanded immediately after each conversation. Several participants discussed experiences they found emotionally difficult, including fear of non-compliance and anxiety about assessment outcomes, and the researcher judged that a recording device would limit the candour on which the findings depend. The trade-off this decision involves is acknowledged as a methodological limitation later in this chapter. All participants were anonymised. Interview questions were developed iteratively, with early conversations informing the focus of later ones. A shared core anchored every interview around how learning is evidenced, where the family–school–state system is most strained, and what better infrastructure might look like; role-specific questions then opened onto each participant's wider experience of home education, from daily practice and its origins to oversight, assessment, and the learner's own voice. Full guide is given in Appendix A.

3.4.2 Digital observation

To complement interview accounts with naturally occurring discourse, the study employed digital observation in a closed social media community used by Estonian home-educating families over approximately twelve months from January to December 2025. The researcher is a long-standing member of the community, and the observation was conducted as non-participatory thematic observation of publicly visible posts within

the group. Discussion threads relevant to documentation, IÖKs, assessment encounters, school coordination, and tool use were identified for systematic analysis.

Posts and comment threads were not copied verbatim but summarised into anonymised field notes. Identifying details, including names, locations, school references, and any direct quotations that could identify a poster, were removed or generalised. The ethical considerations of observing a closed community as an existing member, without seeking individual consent for each observed thread, are discussed later in this chapter. This method situates individual interview accounts within the broader social context in which families collectively manage documentation.

3.4.3 Visual audit of documentation artefacts

A third empirical component was a visual audit of documentation artefacts shared by two participating families who consented to provide materials for analysis. With all personal and identifying information removed, these materials included screenshots of a Google Drive folder structure, a personal diary, and examples of evidence assembled for assessment. They were analysed for how documentation requirements translate into file structures and interfaces, where friction accumulates, and how information flows between actors. The audit was not intended as a representative sample but as corroborative grounding: a check on whether patterns described verbally in interviews were also visible in material artefacts. Of the two families, one consented to have their materials reproduced in this thesis; these are presented in Appendix F.

3.5 Participant overview

Two groups of participants are involved in the empirical work. The first is ten interview participants, selected using purposive sampling to capture diversity within a small qualitative sample. The second is one prototype testing participant, a child in the target age band of the design proposal, who took part in the Round 2 testing session described in Chapter 6. Table 2 summarises both groups.

Table 2 Overview of research participants (interview and prototype testing). All participants are anonymised.

Interview participants			
P1	Parent	Interim homeschooling	Professional mobility; learning on the move
P2	Parent	Long-term homeschooling	Special Educational Needs; accessibility
P3	Parent	Self-directed learning	High pedagogical autonomy vs. state standards
P4	Parent	Interim homeschooling	Reintegration; interim documentation
P5	Parent	Hybrid / distance learning	Documentation tax; daily log management
P6	Teacher / Coordinator	Private partner school	Validating non-formal evidence; trust-building
P7	Coordinator	Private partner school	Administrative compliance; coordinator workload
P8	Policymaker	Ministry of Education	Assurance of care; national legal mandates
P9	Educator / Mentor	External mentoring role	Portfolio-based assessment; learner agency
P10	Expert	Educational psychology	Learner agency vs. parent-led compliance
Prototype testing participant			
C1	Child (prototype testing)	Age 6	Prototype testing session (Round 2)

3.6 Data analysis

Data from interviews, digital observation, and the visual audit were analysed using thematic analysis (Braun & Clarke, 2006), producing three sequential artefacts: an open coding matrix, an axial coding consolidation, and a nine-theme synthesis (Appendix E).

In open coding, field notes were read repeatedly and coded for practices, emotions, and perceived problems or successes, with codes tagged by colour to distinguish pain points,

successful practices worth preserving, and latent aspirations. Each interview was synthesised into its own set of coloured cards. Through axial coding, codes were consolidated into higher-order categories such as documentation routines, assessment encounters, trust, and emotional load, then aggregated into nine cross-cutting themes and compared across participant types and data sources. Finally, the themes were grouped by the systemic failure they pointed to. Four named structural failures requiring a design intervention and were carried forward as the findings of Chapter 4; the rest pointed not to failures but to opportunities, and informed the design from Chapter 5 onwards.

3.7 Ethics, positionality, and limitations

The study follows established ethical principles for qualitative research with human participants and digital communities. Personal identifiers were removed from all field notes, pseudonyms are used throughout, and data are stored securely in line with GDPR requirements with access limited to the researcher. The child participant is the researcher's own child. As the parent, the researcher consented to participation, and the child gave verbal assent at the start of the session. The child was free to stop at any point and was reminded of this before the captures began.

For the digital observation, the researcher adopted a non-participatory stance and followed BPS (2021) guidance for internet-mediated research, treating the closed community as a semi-private space. Content was summarised into anonymised field notes rather than copied verbatim, and no verbatim quotations appear in this thesis. Separate consent was not sought from individual community members, on the judgement that intervening to obtain consent would have compromised the naturally occurring discourse the observation set out to study. Full protocol is in Appendix B.

This research is shaped by the researcher's position as a design practitioner and as a parent considering future education options. This closeness supported empathy with home-educating families but also carried a risk of leaning too far toward the parental perspective. To offset this, the sample deliberately included coordinator, policy, and expert voices, and the analysis returned to the raw notes repeatedly to check whether the themes held across different participant types.

Several limitations apply. The sample is small and Estonian, intended to support analytic rather than statistical generalisation, and because home-educating families are so varied, the proposal is deliberately modular. The study addresses only the

documentation and assessment layer, not learning outcomes or the pedagogical effectiveness of home education. Interviews were not audio-recorded, which limits exact quotation; this was offset by expanding the notes within an hour of each interview. No member checking or second-coder reliability checks were carried out; triangulation across participant types and data sources was used instead. Limitations specific to prototype testing are discussed in Chapter 7.

3.8 Use of AI tools

Generative AI tools were used instrumentally throughout this thesis, under the author's direction and judgement. Claude (Anthropic) supported drafting, restructuring, and refining text, translation between Estonian and English, and reasoning as a sounding board. All findings, arguments, frameworks, and design decisions are the author's own, and all citations were checked against the original sources. Some figures were drafted with the help of Gemini and Claude under the author's direction and then refined in design software. No AI tool was used to generate or fabricate research data.

Generative AI is also a working component of the prototype developed in Chapter 6, where it produces the reflection questions. The design is not tied to a particular model, and in all cases the AI operates as an advisory layer under full parental control, consistent with the human-centred AI position in Section 2.3.

4. FINDINGS

Four core themes emerged from the fieldwork: the documentation tax, the trust-control tension, systemic fragmentation, and the underuse of learner voice from the documentary record.

4.1 The regulatory reality

Fieldwork confirmed that home education in Estonia operates as described in Section 2.6: every child is enrolled in a specific school, parents prepare an IÕK aligned with the national curriculum, and monitoring occurs through periodic check-ins. The variation that mattered for design was in implementation. Participants reported that expectations vary widely between schools and coordinators. Some conduct informal conversations about the child's development; others require extensive documentation packages before each meeting. This variability is itself a structural problem. It produces persistent uncertainty about what counts as sufficient evidence and drives families toward defensive over-documentation as a precaution. The regulatory tightening of September 2025, described in Section 2.6, made this pressure stronger. Parents felt they had to produce more convincing evidence without getting any clearer guidance on what convincing means (Postimees, 2025).

4.2 Stakeholder perspectives

4.2.1 Parents: the documentation tax and pedagogical translation gap

Home-educating parents across all interviews described documentation as the single most burdensome aspect of their practice, more demanding than the teaching itself. The burden showed up across three dimensions: cognitive, temporal, and emotional.

The cognitive load centred on translation. Parents struggled to convert organic, everyday learning into the curriculum-aligned, institutionally legible evidence schools expect. One parent described being faced with the curriculum outcome "understands principles of healthy eating" and not knowing whether a photograph of cooking cabbage with their child would count as adequate proof. Without clear guidance on what counts as valid evidence for abstract curriculum language, families defaulted to photographing and logging almost everything. The IÕK emerged as a particular friction point, repeatedly described by parents as the first bureaucratic obstacle they faced. With no official templates available, families turned to peer networks and Facebook groups to

learn what an acceptable IÖK looks like, acquiring compliance knowledge horizontally rather than through institutional scaffolding.

The temporal burden was concentrated outside active learning time. Documentation work took place mainly late at night after children were asleep. Parents described weekly cycles of last-minute documentation panic, and assessment deadlines that cast a shadow over the preceding weeks.

Emotionally, parents described feeling overburdened, judged, and afraid of being found deficient. Several connected this to a broader social stigma around home education that requires constant defensive justification to relatives and institutions. Parents of children with special educational needs faced compounded difficulties: standard assessment formats failed to capture the slow, non-linear progress typical of neurodiverse learners. The burden did not fall evenly. Parents with strong academic literacy or institutional experience performed documentation confidently. Those without such capital felt overwhelmed and dependent on peer communities, an equity dimension consistent with the administrative-burden literature reviewed in Section 2.4.

4.2.2 School coordinators and teachers: accountability without capacity

School coordinators described themselves as legally responsible for certifying learning outcomes and fulfilling duty-of-care obligations, yet lacking the time, training, and tools to evaluate non-traditional evidence effectively. Several described being caught between competing demands from school leadership and municipal authorities.

Coordinators reported receiving documentation in highly variable formats. One coordinator described receiving a Google Drive link with around 200 photographs and having roughly 40 minutes to determine whether the child was making progress, with no clear criteria for what to look for.

A second driver of coordinator behaviour was legal anxiety. One coordinator described feeling that families perceived them as judgmental, when in fact they were primarily concerned with protecting themselves legally and ensuring proper documentation in case something went wrong. Several coordinators expressed a genuine wish for better tools, including infrastructure that could demonstrate oversight without requiring families to assemble thick evidence packs.

4.2.3 Ministry and policy perspective: duty of care without sustainable systems

The ministry representative articulated the oversight challenge from a system-level view: insufficient visibility risks educational neglect or undetected welfare concerns, yet heavy-handed control undermines the flexibility that gives home education its value. The representative acknowledged operating at a distance from schools' daily reality and noted that the absence of standardised tools makes it difficult to understand how home education functions at a system level, or to distinguish effective arrangements from problematic ones.

The representative noted that Estonia's strong digital infrastructure makes a balanced system possible in principle but requires investment specifically aimed at the home education context, which currently has no dedicated digital tools.

4.2.4 Educational psychology expert: the missing developmental dimension

The educational psychology expert offered a perspective largely absent from policy and coordinator accounts: the developmental cost of excluding children from their own documentation. The expert argued that adolescents need to practise self-assessment and evaluative judgment, and that documentation systems which remain parent-driven and externally imposed deprive children of the chance to develop that metacognitive capacity. Current documentation arrangements are therefore not only administratively burdensome but pedagogically counterproductive: systems designed for adult accountability miss the developmental opportunity to help learners articulate and reflect on their own growth.

The expert also challenged the value of fragmented photo evidence, noting that real learning manifests as lasting understanding applied in new contexts, a standard rarely captured by a single photograph or completed worksheet. The expert supported the use of AI tools to assist documentation but cautioned that AI prompts cannot substitute for thinking, and that the design goal must be to foster autonomy and evaluative judgment rather than to automate assessment.

4.2.5 Digital observation: online communities as informal infrastructure

Digital observation in the closed online community reinforced interview findings and added a community-level dimension. Four patterns were especially salient.

The community functioned as a **bureaucratic translation service**: new families repeatedly sought clarification on what counts as an acceptable IÖK and how closely it must mirror the national curriculum. Compliance knowledge is learned horizontally rather than scaffolded institutionally, which disadvantages families without language fluency, digital confidence, or connections to established networks.

The second pattern was **geographic coordination**. A significant share of threads involved families searching for other home-educating households nearby, or announcing shared learning days, joint field trips, and informal co-teaching arrangements. Co-study arrangements did form, but fragility was inherent. Announcements disappeared into the feed within days, recurring events required constant re-posting, and families without existing connections had no reliable way to discover what was happening near them.

The third pattern was **peer support**, encouragement, and debate about educational philosophy, the social fabric that sustains long-term home education. Taken together, the community's existence as shadow infrastructure signals that the formal system meets neither families' documentation needs nor their social and coordination needs.

4.3 Cross-cutting findings

Four themes cut across all stakeholder accounts and data sources, each pointing toward a structural failure rather than an individual shortcoming. As Figure 9 shows, these are not parallel problems but a connected system failure: two infrastructure failures (the documentation tax and systemic fragmentation) produce two relational consequences (the trust-control tension and the absent learner voice).

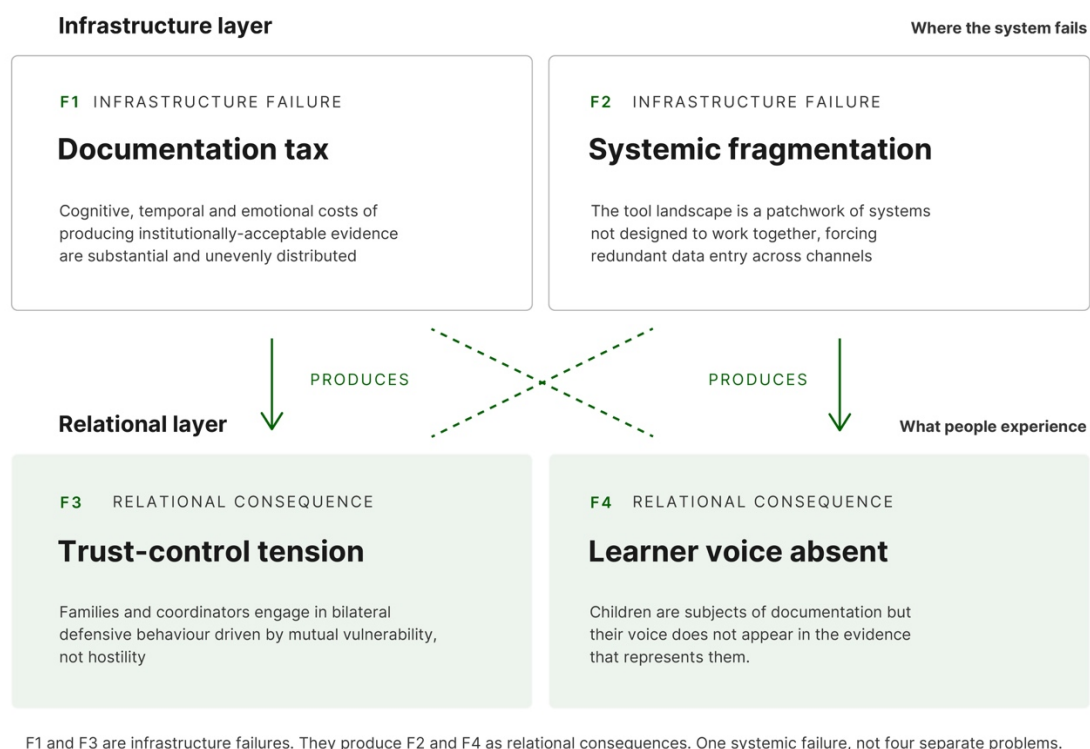


Figure 9 Four structural findings: a connected system failure. Made by the author.

Finding 1: **Documentation tax.** The cognitive, temporal, and emotional costs of producing institutionally acceptable evidence are substantial and unevenly distributed. The translation problem, converting organic learning into curriculum-aligned proof under uncertain criteria, is at the centre of the burden and is not addressed by any current tool or official resource. This maps directly onto Daigneault's (2024) framework of onerous experiences across time, effort, and psychological cost dimensions.

Finding 2: **Trust-control tension.** Both families and coordinators engage in bilateral defensive behaviour driven by mutual vulnerability rather than mutual hostility. Parents fear judgment and over-document to signal effort, coordinators fear liability and policymakers fear welfare gaps and tighten regulations. Several participants mentioned the absence of shared infrastructure: without transparent documentation norms, both sides resort to self-protection. One coordinator argued that better tools could shift the focus from compliance toward growth and dialogue.

Finding 3: **Systemic fragmentation.** The set of tools is a patchwork of systems not designed to work together: eKool and Stuudium for official grades and communication, Opiq for learning materials, Google Drive for evidence storage, email for coordination, and Facebook groups for peer support. Each serves a purpose, but none connects to the

others, forcing redundant data entry and producing evidence that arrives at coordinators in incompatible formats. The fragmentation reflects the absence of any infrastructure designed with home education in mind.

Finding 4: **Learner voice gap.** Children do participate in assessment conversations themselves, since many coordinators structure these as discussions rather than tests. The structural gap is earlier, in the documentary record that precedes and frames the meeting. Parents produce documentation about learning; coordinators assess it; policymakers regulate it. The child is the subject of this activity but their voice is minimal in the evidence. The educational psychologist noted this as a missed opportunity: children who are not asked to articulate what they know and where they struggled, in the moment it happened, lose both the metacognitive benefit of reflection and the chance to contribute their own perspective to the record that represents them.

4.4 Visual audit: material evidence of friction

The visual audit gave concrete, material grounding to the patterns described above. One participating family shared a term-long planning and learning diary they had created independently, without any request from the school: a weekly table covering fifteen weeks of first-grade home education and documenting dozens of learning activities across natural science, mathematics, Estonian language, arts, physical education, music, and cross-curricular projects. Screenshots from the same family's Google Drive showed the parallel digital layer: photographs from nature walks, museum visits, cooking sessions, and art projects, organised into weekly folders but with no mechanism for mapping any of them to curriculum outcomes. A coordinator receiving this family's submission would encounter both the richness and the opacity of this material: impressive evidence of learning that still requires substantial interpretive effort to read as such. Appendix F reproduces the family's weekly diary alongside two of the items they did submit, a photograph of an outdoor learning moment and a page of arithmetic exercises, to show the contrast between the rich private record and the fragmented submitted evidence.

The diary was never submitted to the school. It was the parent's own tracking tool, a way of maintaining continuity across weeks and monitoring where the family stood in relation to the national curriculum. This single observation encapsulates the central design opportunity of this thesis: the parent had independently built the kind of tool this thesis proposes, a coverage-tracking, weekly-planning, reflective record. The information stayed private not from choice but from the absence of infrastructure to

carry it. Over weeks, the diary's observations (that the child preferred conversation to video, read independently beyond what was planned, and struggled with certain mathematical concepts) accumulated into a developmental portrait of real precision.

The same pattern appears beyond the families interviewed. The MTÜ Eesti Koduõppe Keskus website publishes exemplar parent-written evaluations (*hinnangud*) under anonymised initials, intended as a guide for families writing their own reports (MTÜ Eesti Koduõppe Keskus, n.d.-c). These exemplars are for the third school stage rather than the early grades this thesis targets, but they show the same structural features the audit found in participants' private documents: long-form prose, no mapping to curriculum codes, no shared schema for evidence, and no consistent link between described activities and outcome attainment. That a community-published reference reproduces these features suggests the friction is not a property of any one family's practice but of the documentary genre itself.

4.5 Synthesis: a design problem, not a compliance problem

Four of the themes surfaced through analysis describe structural failures the design has to address; the remainder describe opportunities the design picks up directly. The findings together portray Estonian home education as a high-friction system in which families, coordinators, and the ministry each recognise the problem but lack the shared infrastructure to address it collaboratively. The four structural failures are not independent. The documentation tax exists because the tools are fragmented; the trust-control tension persists because neither side can see enough to feel secure; and the learner's voice stays minimal in the documentary record because no mechanism positions the child as a participant.

The data also highlight moments when visibility functions well: coordinators who accept varied forms of evidence and centre assessment conversations on the child's growth; parents who develop portfolio practices that feel meaningful rather than performative; community-shared templates that reduce cognitive load for newcomers. These are not exceptions that disprove the finding but signals that trust-based visibility is achievable when conditions support it. What is missing is not the will to make it work, on either side of the family-school relationship, but the infrastructure to make it easier. Chapter 5 translates these four failures into design requirements that respond to them as a connected system.

5. DESIGN FRAMEWORK

This chapter bridges the empirical findings and the design proposal by translating the four findings from Chapter 4 into design requirements, a set of governing principles, and a stakeholder interaction model. It does not introduce new empirical material, but establishes the logic that connects what was found to what was built.

5.1 Translating findings into requirements

Each of the four findings points to a design requirement. To move from problem to requirement without assuming a solution in advance, the findings are reframed as How Might We (HMW) questions, a standard design technique for turning a problem into an open design opportunity (IDEO.org, 2015).

The findings are not independent, and this shapes the strategy. As Figure 9 showed, two of them are infrastructure failures, and the other two are their relational consequences. This matters for the brief: if the infrastructure failures are addressed, the relational ones should ease as well. A family that no longer spends Sunday evenings reconstructing evidence has less reason to over-document defensively, and a system that gives the child a capture tool brings the learner's voice into the record without anyone having to require it. The design therefore treats the infrastructure layer as the primary place to intervene, on the assumption that relational change follows from structural change rather than the reverse. This is in line with Meadows' (2008) argument that the strongest leverage points in a system lie in its information flows and structure, not in individual attitudes.

Together, the HMW questions, requirements, and principles in this chapter form the brief that the design proposal answers in Chapter 6.

5.2 System map: where the design intervenes

It is useful to map the full system and identify exactly where the design proposal intervenes. Service blueprinting (Shostack, 1984) provides a method for visualising multi-actor service processes across frontstage (visible to all actors) and backstage (supporting infrastructure) dimensions.

Estonian home education today functions as an information system without a designed substrate. The child learns; the parent reconstructs that learning into evidence after the

fact, in whatever tools the household has, a phone gallery, a Drive folder, a Word document. The coordinator receives the result by email and reads it alone. The child, who is the source of the evidence, is not the author of it. Each connection between actors is mediated by hand, and the assessment meeting is the first point at which all three are in the same conversation.

The system, in other words, is not failing for lack of effort. It is failing because the row that would carry shared infrastructure is empty. The design proposal, presented in Chapter 6, sits on top of that empty row. It does not introduce a new actor or a new ritual. The child still learns, the parent still curates, the coordinator still assesses. What it introduces is a shared substrate underneath the three of them, so the translations each was doing alone become a single flow no one re-enters.

A system map of this kind tends to read as a description of the ideal flow, in which each actor plays their part on time and the connections between them function as drawn. Real use diverges from this in predictable ways: children disengage, parents fall out of routine, infrastructure fails, and tools designed as supports get turned into instruments of pressure. Section 6.9 sets out the anticipated obstacles and the design responses to them, so that the system map is read alongside an explicit account of where the design is expected to hold and where it is not

5.3 Design requirements

Each of the four findings points to a How Might We question, which in turn yields a design requirement. The traceability is direct, and is summarised in Table 3.

Finding 1, the documentation tax, points to the question: **how might we make evidence capture light enough to happen in the flow of learning, rather than as a separate retrospective effort?** The corresponding requirement is that the system must support in-context capture, not retrospective reconstruction. The heavier interpretive work, identifying curriculum links, adding context, preparing a portfolio view, is shifted to a separate, supported moment.

Finding 2, the trust-control tension, points to: **how might we give coordinators the visibility they need to fulfil their duty of care without asking families to produce evidence they experience as surveillance?** The requirement is that the system must present evidence in structured, role-appropriate views that reduce interpretive burden

for coordinators while giving families control over what is shared and when. These are structural requirements, not optional features.

Finding 3, systemic fragmentation, points to: **how might we replace the messy stack of disconnected tools with a coherent infrastructure that serves all three roles?**

The requirement is one database, role-specific views. A single capture event, the child recording a moment, becomes the source from which the parent's review workflow, the coordinator's portfolio view, and the child's own reflection record are all derived. No data is entered twice.

Finding 4, the gap of learner voice from the documentary record, points to: **how might we bring the child's own perspective into the evidence?** The requirement is that the child must have their own entry point to the system, one that captures their voice and reflection in the moment of learning, so the portfolio the coordinator reads contains the child as a narrator, not only as a subject.

Table 3 states the design requirements as numbered criteria. These are referenced in Chapter 7 when evaluating how the prototype addressed each requirement.

Table 3 Design requirements (DR1–DR8) and their source findings.

ID	Design requirement	Source finding
DR1	Producing evidence must be possible within everyday learning, without a separate, burdensome documentation effort.	F1
DR2	The child's own perspective must be present in the record, not only the parent's account of it.	F4
DR3	Any automated or AI-generated suggestion must remain advisory; consequential decisions must rest with a human.	F2
DR4	Families must control what evidence is shared, and with whom; sharing must be an active choice.	F2
DR5	Coordinators must be able to make sense of the evidence without disproportionate interpretive effort.	F2, F3
DR6	Evidence must be relatable to the national curriculum (RÖK) in a way that is understandable to non-specialists.	F1, F3
DR7	Families must be supported in planning against the curriculum, regardless of prior pedagogical expertise.	F1, equity
DR8	The knowledge needed to document and assess well must be available to all families, not only those with peer connections.	F3, equity

5.4 Design principles

Six principles govern the design framework set out in this chapter. Each is grounded in the empirical findings and the theoretical frameworks developed in Chapter 2.

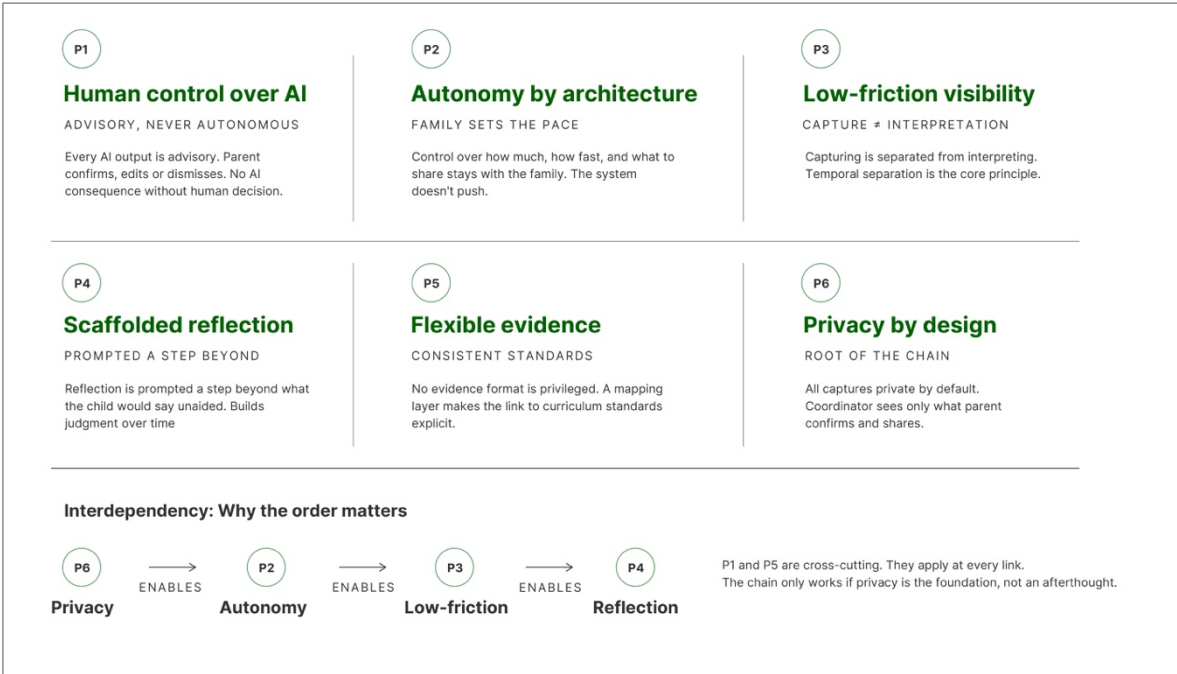


Figure 10 Six design principles: a coherent system. Made by the author.

Human control over AI. Every AI-generated output in the system must be advisory. A human, whether parent or coordinator, confirms, edits, or dismisses it, and no AI output has any consequence for the child without a human decision. This realises Shneiderman's (2020) high-control/high-automation model as a structural constraint, and places the design within the obligations the EU AI Act (2024) attaches to high-risk educational AI.

Autonomy-supportive by architecture. Following self-determination theory (Deci & Ryan, 2000), the system must support autonomy through its structure rather than its tone. Control over how much to document, at what pace, and what to share stays with the family and the child. The system does not push families to produce more than they choose.

Low-friction visibility. The documentation tax arises from converting authentic learning into legible evidence (Daigneault, 2024). The principle that addresses this is to separate the moment of capture from the work of interpretation. Recording something

is light and immediate, while curriculum alignment and portfolio preparation happen later. This temporal separation is the core of the principle.

Scaffolded reflection for the learner. The child's reflection should be drawn out, not merely recorded. Drawing on Vygotsky's (1978) zone of proximal development, reflection is prompted a step beyond what the child would say unaided, calibrated to their developmental level, so that what suits a child in grade 1 grows with a child in grade 3. This builds the habit of reflective self-expression that Boud (2000) identifies as the basis of sustainable assessment. The principle is documentation, not tutoring. The system does not assess or give feedback on what the child says. Pedagogical feedback continues to come from the parent and the coordinator, and the design supports that human loop rather than replacing it.

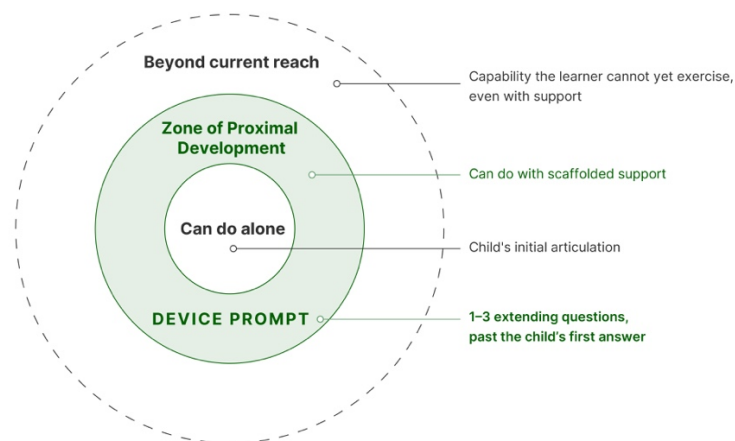


Figure 11 Scaffolded reflection prompts operate inside Vygotsky's (1978) Zone of Proximal Development, extending the child's articulation by a step, without reaching beyond it. Created by the author, adapted from Vygotsky (1978).

Flexible evidence, consistent standards. Following Firth's (2025) Flexible Assessment Framework, no evidence format is privileged over another. A mapping layer makes the relationship between each piece of evidence and the national standards explicit, satisfying the framework's clarity and consistency principles. Families can see which areas are well-documented and which are thin, and coordinators can apply consistent criteria regardless of format.

Privacy by design. Sensitive learning data about children must be processed with minimal mandatory flows, and privacy must be structural rather than rhetorical. This principle implies four design constraints. First, all captures must be private by default; sharing requires an active parental action. Second, coordinators should access only what families have explicitly chosen to include. Third, location data in any community layer should default to coarse precision (municipality level), with greater precision only on

explicit family choice. Fourth, child data must not be used for AI model training or profiling. These are not policy commitments but architectural constraints. A system meeting this principle cannot share what has not been released, because sharing requires an active parental action rather than being the default state.

5.5 Stakeholder ecosystem and interaction model

The findings established that documentation in Estonian home education is not a simple two-party exchange but a multi-stakeholder process involving children, parents, schools, and the state. Each actor has different information needs, a different relationship to the evidence, and different consequences attached to how that evidence is interpreted. Sevaldson's (2017) systems-oriented design approach shapes the framework's response: rather than designing separate tools for each stakeholder, the framework proposes a shared infrastructure with role-specific views derived from a common evidence base.

Learners need an entry point that positions them as contributors, not subjects. Their own evidence, in whichever forms suit the child's age and context, should be the primary source material for the rest of the system.

Parents need a low-effort way to review what the child has captured, add context, and build up a picture of where the term stands, without it becoming a separate documentation session that competes with family life. The work should fit into short, regular moments rather than one demanding sitting.

School coordinators need a structured, readable overview of the evidence that allows efficient and fair assessment, rather than a raw collection of files to interpret from scratch. The child's own voice should be present in what they read, not only the parent's account.

The interaction model shifts the relationship between these roles from one-directional reporting, in which families send evidence and coordinators judge, toward relational dialogue, in which the documentary record becomes a shared resource for conversations about the child's development.

5.6 What was rejected and why

Three directions were considered and set aside. Automated assessment, using AI to score or rate evidence, was rejected on legal, ethical, and pedagogical grounds: the EU AI Act (2024) classifies it as high-risk, families already report feeling surveilled, and automating evaluative judgment undermines the metacognitive capacity the framework is meant to build. Continuous tracking was rejected because it inverts the calm-technology principle (Weiser & Seely Brown, 1996) and reproduces, in digital form, exactly the surveillance dynamic the design seeks to avoid. A single monolithic application was rejected because the three actors have fundamentally different needs and contexts of use; one interface would serve none of them well. The architecture described in Chapter 6 follows from these decisions.

6. DESIGN PROPOSAL: EKKO REFLECTIVE DOCUMENTATION SYSTEM

This chapter presents the Ekko system as it was designed and prototyped. It introduces the system, its four-component architecture, and the workflow change Ekko makes to home education documentation, before describing each component in turn.

6.1 System overview

Ekko is a four-component reflective documentation system designed for Estonian home-educating families and the schools that coordinate their oversight. The system name draws on the Estonian and Nordic word for “echo”: a learning moment caught in the moment echoes forward to become evidence, and echoes back to the child as a record of their growth. The target group is children in grades 1–3 and their families.

The system has four components: the **Ekko Device** (a child-held physical capture tool), the **Ekko App** (a mobile web application for parents), the **Ekko Portfolio** (a desktop view for school coordinators), and the **Ekko Community** (a shared knowledge layer for all families). A capture made by the child flows through the system without any actor re-entering data.

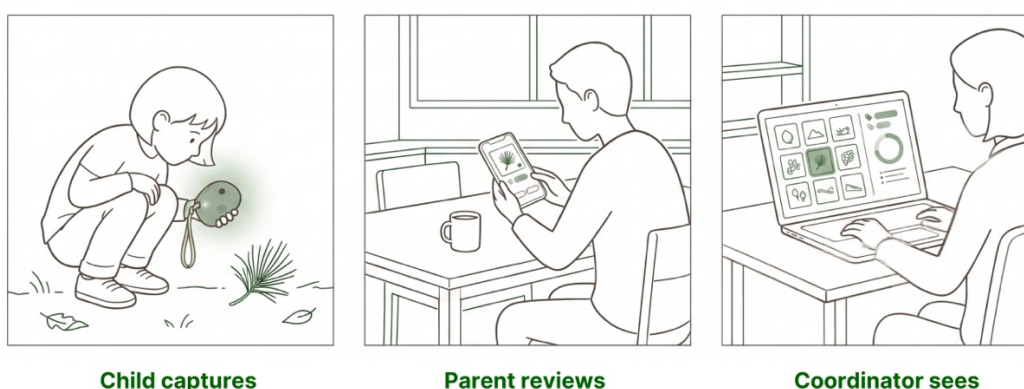


Figure 12 The Ekko system across three actors. Made by the author.

Figure 12 shows the core flow of a single captured moment as it moves through the system. The child captures a moment of learning. The parent reviews the capture later, in a low-effort evening workflow. The coordinator sees the result as part of a structured portfolio. Each actor sees a view appropriate to their role.

6.2 Four-component architecture

The decision to build Ekko as four components rather than a single app follows directly from the design framework set out in Chapter 5. Each actor has different needs, contexts of use, and consequences attached to how they handle the evidence. One interface would serve none of them well. Components linked by a shared database mean that each actor gets a tool tuned to their role, while the data they all rely on stays consistent.

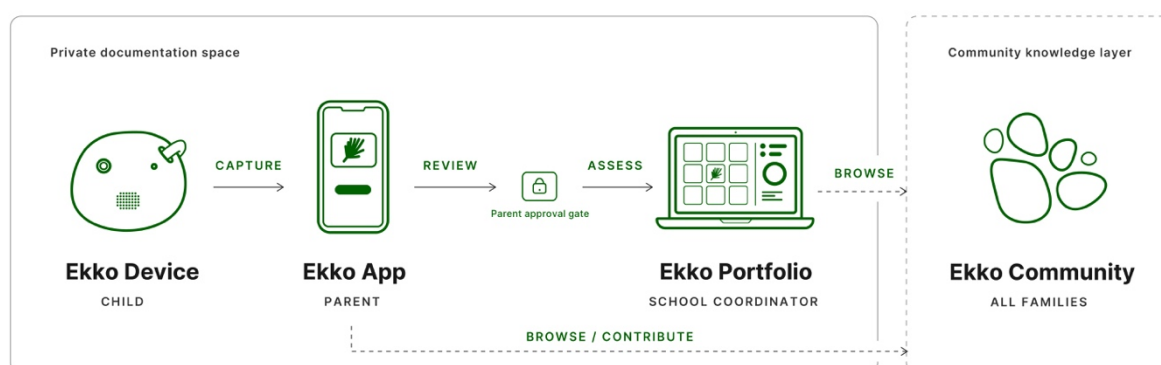


Figure 13 Ekko: four-component architecture. Made by the author.

The architecture is shown in Figure 13. The Device sits at the top left as the entry point, where the child captures a moment of learning. The capture flows through the App, where the parent reviews, adds and curates; into the Portfolio, where the coordinator assesses; and the Community knowledge layer feeds activity ideas, events, templates, and peer guidance back to the family.

6.3 System map and temporal rhythms

A documentation system for home education needs to operate at several different temporal rhythms. A child capturing a moment in the field works in seconds. A parent reviewing captures in the evening works in minutes. A coordinator preparing for an assessment meeting works across weeks. The Community knowledge layer accumulates over months and years. A system that runs at only one rhythm cannot serve all of these.

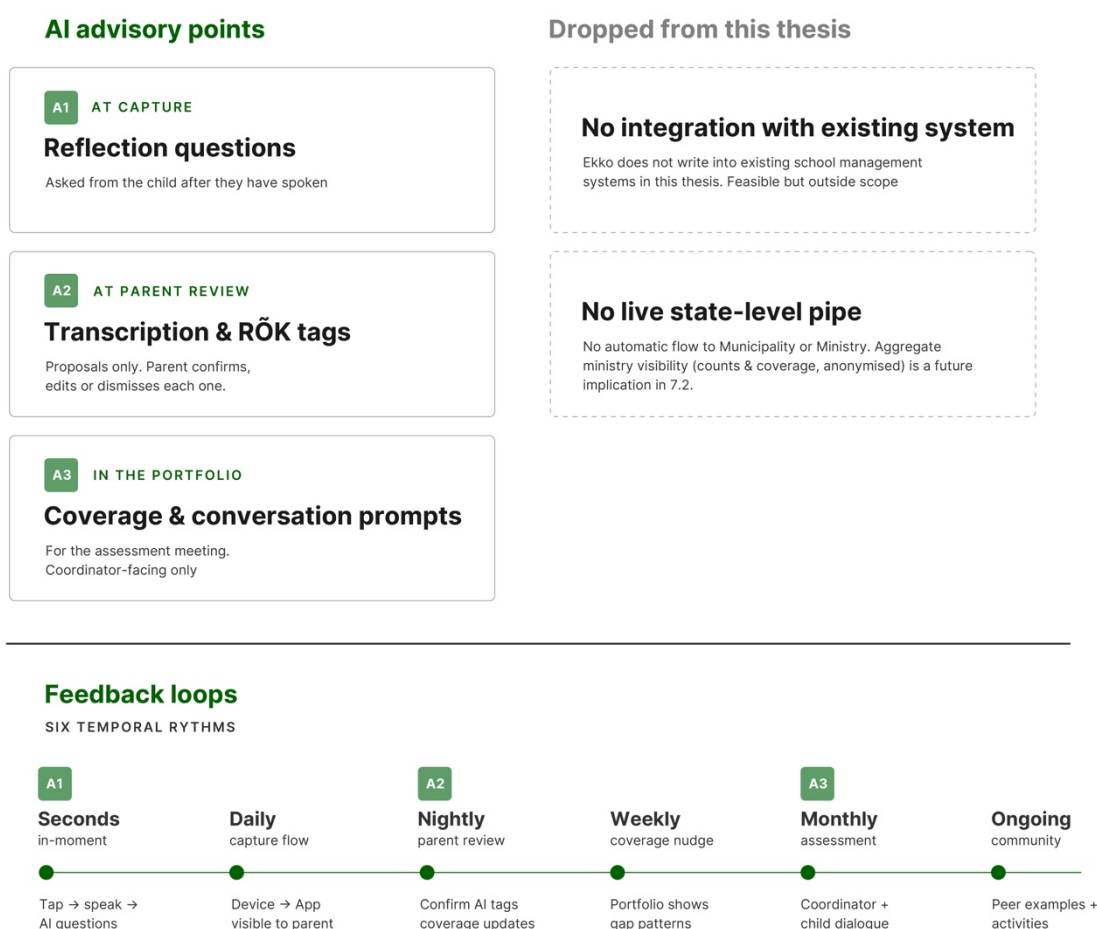


Figure 14 AI advisory points, design scope decisions, and six temporal rhythms of the Ekko system. Made by the author.

Figure 14 builds on the architecture shown in Figure 13 by setting out three things the architecture diagram does not show: where the AI sits, what the design leaves out, and the temporal rhythms the system runs at. The AI layer sits at three specific points in the flow rather than as a central hub: at capture (the reflection question), at parent review (transcription and RÖK tag proposals), and in the Portfolio (coverage analysis and conversation prompts for the assessment meeting). At each of these points the AI output is editable or dismissable by the human user before any consequence follows. The design also deliberately excludes two flows: integration with existing school systems such as eKool, and a live data pipe to the Ministry. Both are feasible but outside the scope of this proposal, and Ministry-level aggregate visibility is treated as a future implication in Section 7.2.

The six temporal rhythms shown in the lower half of the figure are not separate features but different views of the same flow. A capture made in seconds becomes part of the daily flow visible to the parent, is reviewed nightly when the parent confirms AI tags,

shows up in weekly coverage patterns, is read monthly by the coordinator, and contributes to ongoing community knowledge. Detailed service blueprints showing the workflow before and after Ekko are provided in Appendix C.

6.4 Ekko Device: the child's capture tool

The Device gives the child an active role in documenting their own learning. A smartphone could in principle perform this function, but a smartphone communicates messaging rather than capture, and its notifications and apps pull attention away from the task. The Device exists to do one thing well in a form designed for that single purpose.

6.4.1. Why a dedicated object, not a phone

Three considerations make the case for a dedicated object: developmental fit, the documented concerns around smartphones for primary-school-age children, and the temporal structure of metacognitive experience.

Developmental fit. The target user is a child in grades 1–3, roughly ages 6 to 10. This window covers Piaget's concrete operational stage (Piaget, 1952), where children learn through direct sensory and physical engagement, and the early transition to formal operations, where metacognitive capacity begins to emerge. Both phases benefit from tools that are tactile, single-purpose, and low in cognitive overhead. Lillard (2016) reports that physical, manipulable objects produce deeper encoding than screen-based equivalents in the 6–12 age range.

Smartphones and the screen-free turn. Concerns about young children's screen use have been raised in pediatric research for over a decade (Radesky et al., 2015), and recent data shows how saturated this age group's media environment has become: Common Sense Media's 2025 census of children aged zero to eight reports heavy, everyday device use from the earliest years (Rideout et al., 2025). The debate about smartphone use among primary-school children has grown alongside this, though how strong the causal evidence is remains contested (Haidt, 2024). The design implication does not depend on how that debate settles: a single-purpose tool suits this age group better than a general-purpose device. France (Loi n° 2018-698, 2018), the Netherlands (Ministerie van Onderwijs, Cultuur en Wetenschap, 2023), and now Estonia (Sikkut, 2024) have all moved toward restricting smartphones in schools, and dedicated screen-free devices for children have found a market where they serve a clear purpose.

Capture in the moment of learning. Documentation systems that rely on retrospective reconstruction capture metacognitive knowledge at best. They cannot capture the metacognitive experience: the moment of noticing, which is temporally bound and fades quickly (Flavell, 1979). When a child taps the Device and speaks, they exercise this capacity in real time, and the reflection questions that follows begins the transition from concrete experience to reflective observation that Kolb (1984) identifies as the foundation of experiential learning. The emotions that accompany learning are present in the child's voice in the moment and absent from a parent's retrospective account (Boud, Keogh & Walker, 1985).

6.4.2 The pebble as a companion

The arguments above justify a dedicated object. They do not yet capture what the Device becomes once a household has been using it. A pen and a journal both record, but only one accumulates: the journal builds a relationship with its user that the pen does not. The Device is designed to sit in the journal category. This is what distinguishes it from any screen-based equivalent.

The face that emerges from the front of the pebble is part of how this works. Two upper marks (the camera and indicator light) and one lower mark (the speaker) trigger the tendency to see faces in objects, in any human visual system, and the design chose not to fight it. The expression that results, mismatched eyes, neutral round speaker, closer to a Moomin in a quiet moment than a cartoon character, invites speech without performing back at the child. This is what permits the unselfconscious register the captures depend on.

6.4.3 Form

The form follows from tangible interaction research on how physical objects function as interfaces to digital information (Ishii & Ullmer, 1997; Hornecker & Buur, 2006), worked through as a constraint exercise rather than a starting shape.

The pebble form emerged from a small set of alternative configurations considered against the same constraints (Figure 15). A wristband was rejected as easily forgotten or removed during play, and too small to house a microphone and speaker of usable quality. A clip-on form was rejected because the attachment point becomes a single point of failure, and the form invites the child to hand the Device to an adult rather than own it. A bar shape was rejected because it has a privileged top, requiring orientation discipline that conflicts with a single-press, any-orientation interaction. A tabletop form

was rejected because it stays in one place rather than going where the learning happens, which defeats the purpose of in-the-moment capture. The pebble emerged as the form that satisfies the functional constraints (single-press, any orientation, no protrusions, pocketable, child-grip-sized) and the relational ones (a personal object the child carries, holds, and recognises).

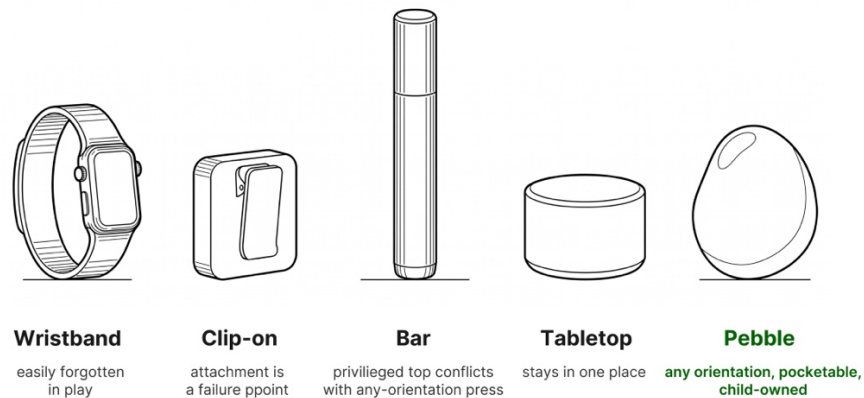


Figure 15 Form exploration: four alternative configurations considered and rejected before the pebble emerged as the form satisfying both functional and relational constraints. Made by the author.

Functional constraints. The Device is used by children aged roughly 6 to 10. It is sized to sit comfortably in a child's palm with a single-handed grip. A single-press interaction with no privileged orientation rules out designated tops, two-handed forms, and exposed glass. Pocketability excludes protrusions. Soft-touch silicone over a rigid PLA shell satisfies grip, drop, and warmth-on-skin simultaneously, and is the standard material for screen-free children's products.

Semantic constraints. Four readings had to be actively avoided. The Device must not read as a phone, because the phone form re-triggers phone-behaviour scripts the design exists to displace. It must not read as a toy, because the child, parent, and coordinator must take the captured record seriously. It must not read as consumer electronics, because the calm-technology principle requires the object to recede until invoked (Weiser, 1991). And it must not read as a microphone or recorder, because that frames the interaction as performance or surveillance rather than reflection. What remains sits between a worry stone and a found object: small, hand-shaped, matte, quiet (Krippendorff, 1989).

Outcome. The resulting form is a palm-sized pebble in soft-touch sage-green silicone (Figure 16). Three functional elements sit on the front face: a flush ultra-wide camera lens upper-left, a warm indicator light upper-right, and a circular speaker pattern lower-

centre, with the microphone set behind the same pattern. The back is intentionally empty: a single concave press depression that echoes the pebble's silhouette, two flush magnetic charging contacts at the lower edge, and a small loop for an optional wrist strap.



Figure 16 The Ekko Device, front (left) and back (right). Made by the author.

Screenless capture. The absence of a screen is addressed through the ultra-wide lens and the dialogue. The ultra-wide field of view removes the need for accurate aim: the child points the Device in roughly the right direction and the subject is inside the frame. An on-device vision model then uses the child's words to find the subject, crop the image around it, and correct the lens distortion, so what arrives in the Portfolio looks like an ordinary photograph. The Device confirms what it found in the dialogue the child is already in (*"I can see a drawing. Shall I save it?"*), and the same description informs the reflection question that follows. The visual layer is advisory in the same sense as the curriculum tagging: the parent reviews the cropped image in the App before it enters the Portfolio. Limits on present-day on-device vision-language models are noted in Section 7.6.

6.4.4 Interaction flow

The Device is used through a single repeatable interaction: tap, speak, listen, speak, save. Figure 17 shows the seven-step flow from tap to save, completed in under two minutes. The child taps once on the device surface and an indicator light shows the device is listening. The child speaks in Estonian. If the child wants to keep an image of what they are describing, they can ask the device to take a photo while speaking; capturing an image is optional and not part of every capture. The system then transcribes the speech, generates one to three reflection questions that draw on what was said, and reads them aloud to the child in Estonian. The child can answer or remain silent; silence saves too. A gentle vibration confirms the save.

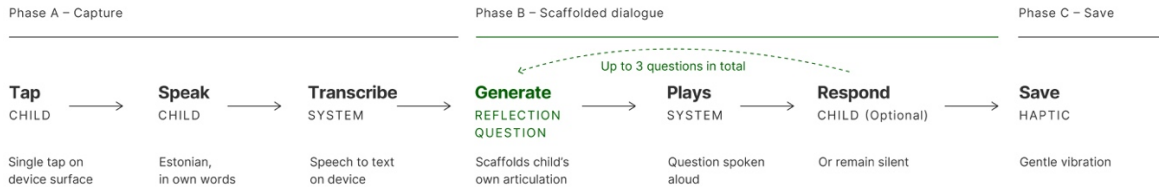


Figure 17 Ekko Device: interaction flow. Made by the author.

6.4.5 Components and technical stack

Figure 18 shows the Device's components. As a finished object, it comprises a camera lens, an LED ring, a microphone, a speaker grille, a haptic motor, a single-touch capacitive tap surface, magnetic charging contacts, and a soft fabric lanyard.

The prototype built for Round 2 testing realises this interaction in a different physical form. It houses an Android smartphone (Galaxy A12) in the pebble shell, running a Chrome PWA that uses the Web Speech API for Estonian speech-to-text and text-to-speech, the Claude API for reflection-question generation, and a Supabase backend for the shared database. The optional photo capture described in Section 6.4.3 is not implemented in this prototype; the version tested with the child is the voice-only flow, and on-device capture is a development target (Section 8.1). The aim of the prototype is to test the interaction, not to manufacture a finished object.

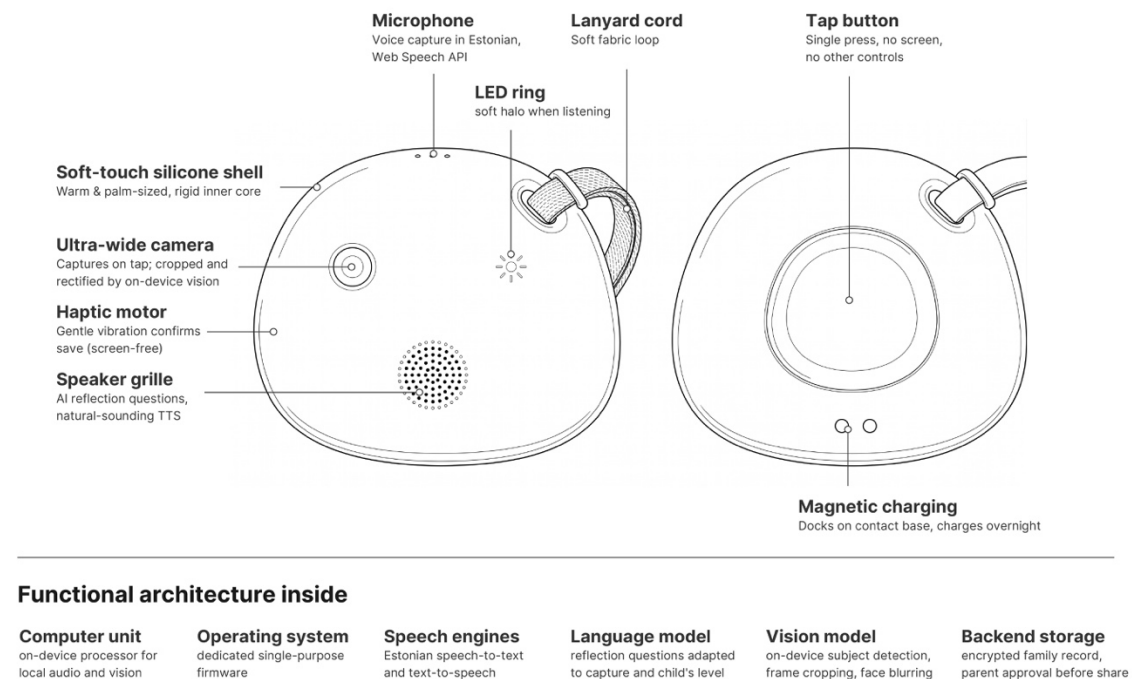


Figure 18 Ekko Device: components. Made by the author.

6.5 Ekko App: the parent's review tool

The App shifts the parent's documentation work from construction to curation. Instead of reconstructing the day from memory at night, a parent opens the App and finds captures already waiting with AI-suggested curriculum links to confirm or dismiss. The system reduces effort without removing agency: no curriculum link is applied without confirmation, and no capture reaches the coordinator without the parent choosing to share it.

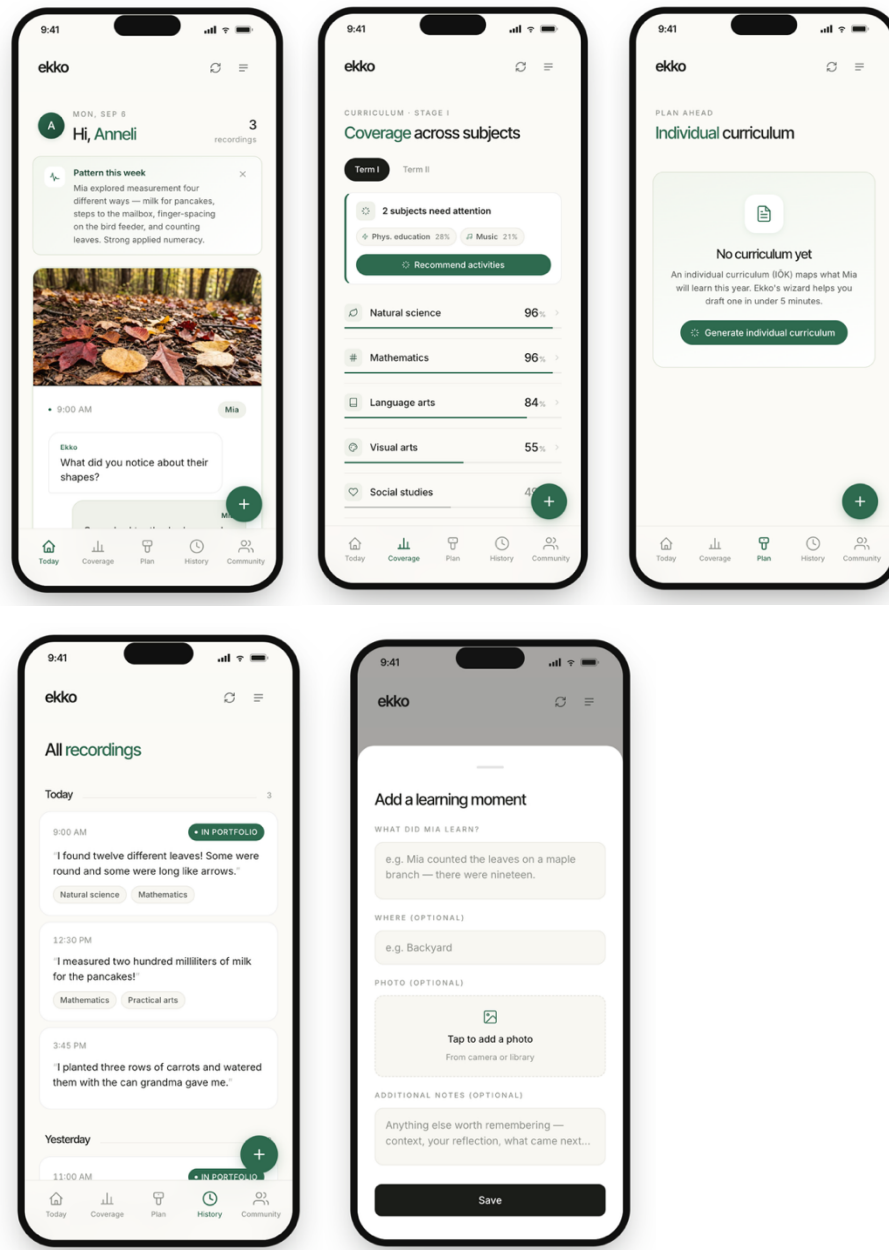


Figure 19 Ekko App: home, coverage, IOK plan, history, and add-capture screens. Made by the author.

The parent reviews captures in a short daily workflow. Each new capture appears with its image, the child's transcription, the AI questions, and any response. Detected faces are blurred by default, and the parent can adjust this or remove an image entirely if something was captured that they do not want kept. The parent can add a short context note, review the AI-suggested RÖK links, and choose which captures to share with the coordinator; the rest stay private. A term-level coverage indicator shows which subject areas are well-documented and which are thin, working as a planning aid rather than a performance metric, consistent with Firth's (2025) clarity principle.

The review is designed so that editing an AI draft is faster than starting from scratch. Suggestions are made at the level of subject area and outcome, each with a short plain-language reason, and any suggestion can be dismissed in a single gesture. The parent's role is therefore to confirm and adjust rather than to construct.

The App also includes an IÖK Assistant that helps parents draft their child's individual learning plan. IÖK drafting was the most cognitively demanding task families described in the fieldwork, with many turning to Facebook groups for help. The Assistant produces a structured draft aligned to RÖK outcomes, which the parent edits and owns before submitting to the coordinator. For any outcome, the parent can also browse suggested activities, both AI-generated and contributed by other families through the Community.

6.6 Ekko Portfolio: the coordinator's view

The Portfolio replaces the folder of unsorted photographs with a structured, subject-organised view that reduces the coordinator's review burden while presenting richer evidence than a test result could (Figure 20). It deliberately avoids automated

assessment, which the EU AI Act (2024) classifies as high-risk: the coordinator sees organised evidence, but the judgment remains theirs.

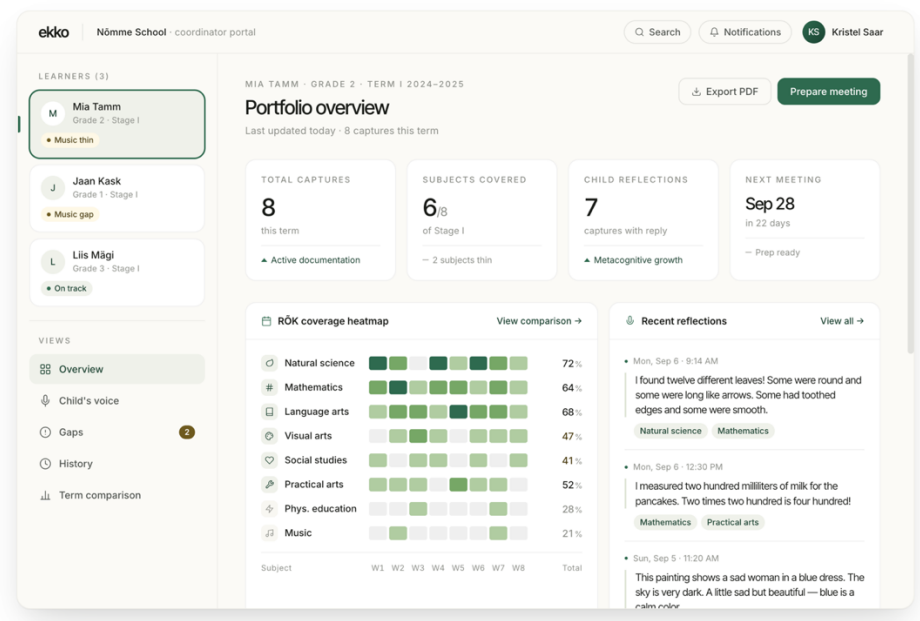


Figure 20 Ekko Portfolio: coordinator dashboard view. Made by the author.

The coverage view externalises a practice the visual audit found one family already doing privately, a weekly diary tracking which RÖK domains had received attention (Section 4.4); the Portfolio makes that private planning aid shareable. Its main elements are a coverage heatmap showing evidence density by subject for the term, a chronological capture timeline, AI-flagged gaps framed as discussion topics rather than findings, and a few AI-suggested conversation starters drawn from the child's own captures for use in the assessment meeting (Figure 21). The IÖK submitted through the App also appears here for the coordinator's review and approval.

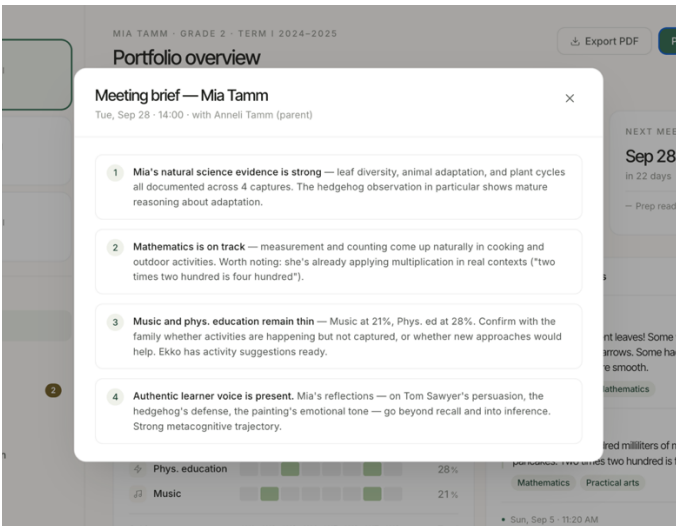


Figure 21 Ekko Portfolio: meeting brief assistant view. Made by the author.

6.7 Ekko Community: the shared knowledge layer

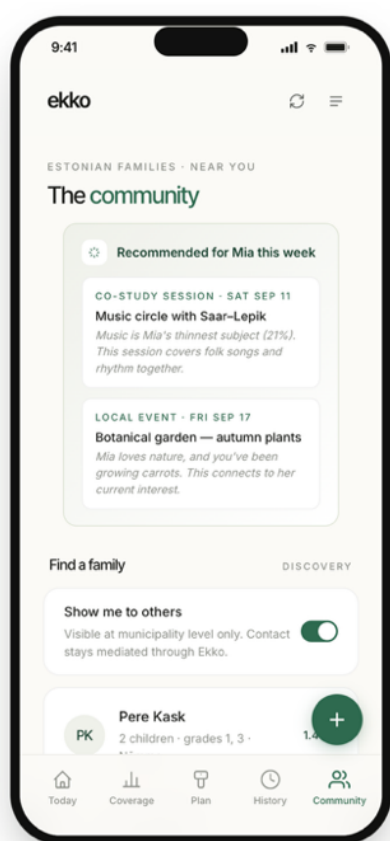


Figure 22 Ekko Community tab.
Made by the author.

The Community formalises what the digital observation found already happening informally in Estonian Facebook groups, replacing makeshift coordination with something purpose-built and curriculum-anchored (Figure 22). It is accessible from within the App and has four layers: an activity library organising submitted activities by RÕK outcome; a local events layer listing workshops, museum days, and cultural events linked to curriculum areas; a co-hub layer through which families can indicate they are open to co-study and find others nearby; and an equity library holding IÕK templates, plain-language curriculum explainers, and documentation examples. All contributed content is anonymised at source, and locations default to municipality precision unless families choose otherwise.

These resources currently circulate only through established peer networks, so placing them in the system distributes documentation competence more equitably (Kunzman & Gaither, 2013; Daigneault, 2024). The co-hub layer in particular addresses what

the observation identified as the most persistent unmet need, geographic isolation: most families are the only home-educating household their children know, and informal co-study tends to form only among the already-connected, reproducing the same equity gap. The Community addresses the social side of home education that the Device, App, and Portfolio do not, the community of practice that makes home education sustainable.

6.8 System integration: privacy architecture

The privacy architecture is structural rather than rhetorical. Data is bounded by what the family actively shares, AI processing happens close to the device wherever possible, and nothing reaches the coordinator without explicit parental approval.

Where the data is and when. A capture moves through four states (Figure 23). On the Device, audio and a wide image frame are recorded locally; nothing leaves the Device. On-device processing then runs the vision model, blurs faces, crops the frame to the subject the child described, and transcribes the speech. When a connection is

available, the cropped image, transcription, and child response sync to the family's private store in the App. Until the parent approves, the capture is treated as ephemeral: an unconfirmed item that can be deleted with no copy persisting beyond the local store. Only when the parent actively approves and selects sharing does the capture enter the Portfolio view the coordinator sees. The data boundary sits at the approval gate, not at the moment of capture.

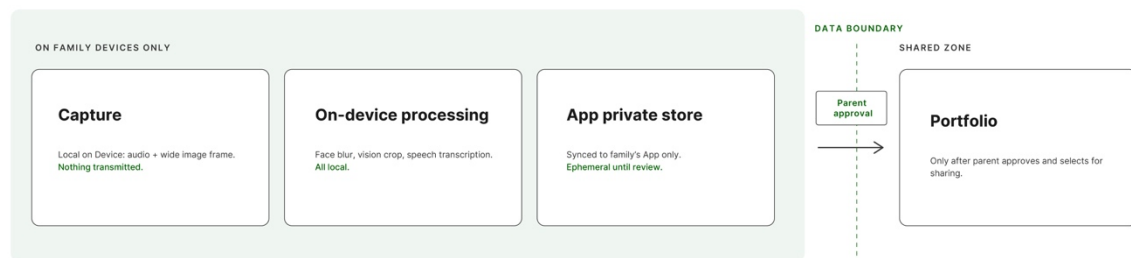


Figure 23 Privacy architecture: the four-state journey of a single capture. The boundary between private and shared sits at the parent approval gate, not at the moment of capture. Made by the author.

What stays local, what leaves. Visual processing (face detection, cropping, subject identification) runs on-device. Speech transcription and curriculum-link suggestion are advisory layers that may run in the cloud, but they operate only after sync and produce outputs the parent reviews before they have any consequences. The raw audio and the wide image frame are never sent to the coordinator; what reaches the coordinator is the parent-approved capture with its parent-confirmed curriculum links.

What this is not. Ekko reverses the usual EdTech pattern, in which student data is captured continuously, aggregated by default, and sent to vendor clouds with consent buried in the terms of service. In Ekko, data is private by default, capture is child-initiated, processing stays close to the device, and any onward sharing requires an active human decision. This is privacy by design as an architectural commitment (Cavoukian, 2009; GDPR Article 25), and it is what makes the system defensible under the EU AI Act (2024) for high-risk educational AI.

6.9 Anticipated obstacles and design responses

The system as described in this chapter sets out how Ekko behaves when each actor plays their part. Real use will not always look like this. The obstacles judged most likely to occur fall into three categories: child-side disengagement (boredom, forgetting the Device, minimal answers), parent-side disengagement (sustained non-use of the App,

uncritical acceptance of AI suggestions), and technical or use-pattern failures (vision misidentification, unintended camera capture, connectivity loss, coverage heatmap read as a scoreboard). The design responses are recorded in full in Appendix G. They do not claim that Ekko will be used as designed in every case, but that the design has been worked through with the most likely obstacles in view, and that the responses are structural choices in the system rather than instructions to users. Obstacles that sit outside what design can resolve are carried forward as limitations.

6.10 Use cases

The cases below show what the Device, App, and Portfolio do in practice across the range of moments a home-educating family encounters in a term.



Figure 24 Ekko Device in use: six embodied moments of a single capture. Made by the author.

Use case 1: Science museum visit. Seven-year-old Liisa visits the University of Tartu Museum of Natural History and stops in front of a cross-section of a spruce trunk, fascinated by the rings. She taps the Device: "*Sellel puul on nii palju ringe... ma lugesin seitsekümmend kaks!*" The Device asks what she thinks the rings tell her about the tree. She answers: "*Iga ring on üks aasta. See puu on vanem kui minu vanaema.*" Her mother confirms the suggested RÕK links to *Loodusõpetus 2.1.4* and *2.1.5* in the App that evening. Figure 24 illustrates this capture in six embodied moments.

Use case 2: Nature mathematics. Seven-year-old Kusti counts pine cones during a forest walk. He taps the Device and announces the count: "*Ma leidsin kaksteist käbi!*" The Device asks how many he would have if he found another five. He works it out: 17. His parent confirms the suggested RÕK link to *Matemaatika 1.1.4* in the App. The coverage indicator updates, and the gap detection flag (written Estonian thin this term) becomes a planning topic for the next assessment meeting.

Use case 3: Reading a book and an aesthetic response. One reflective moments illustrates how the Device handles activities with no physical artefact. Nine-year-old Annika finishes a chapter book and taps the Device: "*Ma lugesin raamatu lõpuni. Tegelane tegi vale valiku.*" The Device asks what she would have done. She thinks it through: "*Ma oleks oodanud, kuni sõber tagasi tuli.*" Mother adds context, and the App suggests *Eesti keel 2.1.3*.

6.11 Technical feasibility and prototype testing

The prototype uses only free-tier and open-source components: the Web Speech and Web Speech Synthesis APIs (Estonian, native to Chrome on Android), the Claude API for reflection-question and curriculum tagging, ElevenLabs for Estonian text-to-speech with Google Translate TTS as a fallback, and browser localStorage for captures. The Device is fully functional on a Samsung Galaxy A12 in kiosk mode; the App and Portfolio are working browser prototypes populated with test data, in line with Dahlbäck et al.'s (1993) Wizard of Oz and functional hybrid approach.

Within the Research for Design methodology established in Chapter 3, prototype testing is structured as two rounds of design experiments that feed each other rather than as a single controlled trial (Krogh, Markussen & Bang, 2015). **Round 1 is a researcher-led functional review carried out by the author.** Several design changes followed, including a patience budget on speech recognition, an invite-close turn that returns agency to the child, and the embedding of Estonian national curriculum (RÕK) I kooliaste outcomes into the reflection-question logic. The full change log is in Appendix D, Table D.2.

The Round 2 prototype is a working phone-in-shell artefact: a Samsung Galaxy A12 housed inside a cardboard shell shaped to approximate the round form specified in Section 6.4.3, with the screen, camera frame, and side buttons concealed and a single tap surface exposed on the front. The aim was to remove enough phone cues that the

child would meet the prototype as the Device described in this chapter rather than as a familiar consumer object. Industrial design validation is treated as future work in Section 8.1.

Round 2 places the stabilised Device with one child in the target age band (6–10, grades 1–3) in a home setting. The session runs approximately 30 minutes: two captures of the child's own choosing, followed by a short interview. The observation focuses on whether the reflection question lands as an extension of the child's own words rather than as a redirection, and on whether the interaction works on real hardware with a real child. The full protocol is in Appendix D.

Three of the four components are not tested here. Parent evaluation of the App, coordinator evaluation of the Portfolio, and Community evaluation are out of scope given the time budget of a master's thesis, and are discussed as a limitation and as future work. The testing of the Device focuses on the component whose interaction mechanic is novel and whose behaviour with a real child resists prediction from specification alone.

6.12 Prototype build and testing documentation

A technical limitation of the speech-recognition stack required the child to tap the surface a second time after speaking to signal they had finished. This was not part of the intended design and is documented here as an artefact of the prototype rather than as a feature of the system. The child accepted the second tap without difficulty.



Figure 25 Photo of child holding the prototype during the session. Made by the author.

Session structure

After a brief verbal introduction, the child was handed the prototype and invited to use it as they would at home. Two captures were attempted in sequence. After the second capture, the researcher conducted a short interview with the child about their experience.

First capture: the gap left by onboarding

The child held the Device hesitantly, looked uncertain throughout, and asked whether they would be given the Device at certain times or whether they should ask for it when they wanted it. The first capture ran long enough for the recognition step to time out and misbehave. In retrospect this was not a failure of the patience budget but a failure of onboarding. Chapter 6 assumes the child arrives at the first capture already knowing what the Device is and what is expected of them; the prototype offered no introduction, no rehearsal capture, no scaffolding for the encounter itself. The hesitation is best read as a response to that gap, not as a property of the interaction.

Second capture: when the dialogue lands

The second capture worked as intended. The child tapped, spoke, and the Device asked a related follow-up question rather than a generic one, exactly the scaffolded reflection behaviour described in Section 5.4. The child answered, and afterwards remarked, unprompted, that it was good Ekko had waited until they were ready to respond.

Child interview

After the second capture, the researcher asked the child short questions. The responses are reproduced below in summary form, since the interview was not recorded.

Asked whether the questions were easy or difficult, the child said they were too easy. Asked whether they felt the Device was listening, the child said yes. Asked whether there was anything they had wanted to say but did not get the chance to, the child said yes – they had wanted to add something, but felt the Device interrupted them. Asked how Ekko could be improved, the child said it should let them think for longer. Asked where they would keep the Device, the child said on the shelf in their room, or in a pocket when they were out.

Three of these responses informed the design. "Too easy" signalled that the prompt difficulty is set conservatively and can be extended. "It interrupted me" confirmed the

turn-taking tension already surfaced in Round 1. The answer about where the Device would be kept confirmed that the child read the object as a personal possession of theirs, which is what the form was designed to invite.

What Round 2 changes about the design

Three changes feed forward into the next iteration: a built-in onboarding sequence in which the Device introduces itself before the first capture; more tolerance for mid-thought pauses in the turn-taking model; and a higher floor for the reflection-question difficulty. The full change log is in Appendix D, Table D.3.

Limitations of the testing

Limitations of the testing. This was a single session with one child, so the findings are signals, not evidence. The prototype's cardboard shell, while sufficient to displace the phone reading, is several iterations away from the silicone pebble specified earlier in this chapter, and any conclusion about the form factor itself will require the validation work described in Chapter 8. The researcher was present throughout, which both supported the child and shaped the encounter; a session in the home, without a researcher in the frame, would produce a different and probably more representative reading. The child is also the researcher's own, so this is a formative test of the interaction rather than independent user evaluation. A wider evaluation, with unrelated families and across the App, Portfolio, and Community components, is treated as future work.

What the session does establish is that the central interaction of the Device – tap, speak, hear a related question, answer or remain silent – works on real hardware with a real child in the target age range, and that the reflection question, when it lands, lands as the framework predicts: as a small, welcome extension of the child's own thinking rather than as a redirection.

7. DISCUSSION

7.1 What Ekko changes

The system changes documentation work differently for each actor. For the child, it provides a structural place in the record: a personal capture tool that turns a moment of learning into evidence in their own voice. For the parent, the role shifts from construction to curation, with one capture flowing through the system and reviewed in a short evening session rather than rebuilt each cycle. For the coordinator, what arrives is a structured portfolio with curriculum links visible at a glance, rather than an unsorted folder of photographs. For the wider system, scattered private files become a portable record that travels with the child and could feed the aggregate visibility the Ministry currently lacks. None of this removes the work. What changes is who carries it, when, and at what cost to the trust between them.

7.2 Implications for policy

The 2025 regulatory changes tightened entry conditions and moved monitoring to monthly cycles, driven by cases of children disappearing from school contact (Rakaselt, cited in Raag, 2026). The logic is sound, but the regulation does not specify how schools should conduct that monitoring. Raag (2026) identifies the conditions under which monthly oversight functions as support rather than pressure: a named contact, clear expectations, flexible evidence formats, and constructive feedback. Ekko is designed to make these conditions structurally easy: the monthly rhythm maps onto the App's coverage view, flexible formats onto the Device's voice capture, the named contact onto the coordinator view. What the regulation mandates in policy, Ekko applies in design.

Estonia's e-governance infrastructure makes it a plausible candidate for piloting such a system at national scale. The international context points the same way: homeschooling in the US grew at nearly triple the pre-pandemic rate in 2024–2025 (Watson, 2025), and UNESCO (2025a) calls for AI in education to reduce workload rather than increase surveillance. What is needed beyond the prototype is institutional will: a decision that portfolio-style, voice-rich evidence counts as legitimate assessment in its own right, not as a lesser substitute for written tests.

7.3 Implications for design

Three implications follow for designers working on documentation or oversight in flexible learning.

First, treat the documentation tax as a design problem, not a usability one. The burden is not about clunky tools but about translating organic learning into institutionally legible evidence under uncertain criteria. A more usable upload form does not solve this; capturing evidence in the flow of learning and shifting the parent from construction to curation does.

Second, design AI as an advisory layer, not an evaluative one, and make the boundary structural. Families experience AI as helpful when it reduces effort but defensive when it appears to judge their child. Every AI output should require a human confirmation step before it has any consequence, treated as a structural property rather than a compliance afterthought.

Third, give the learner an entry point of their own. Documentation systems consistently treat the child as a subject rather than a participant. A dedicated, age-appropriate capture surface produces evidence that preserves the child's voice and reasoning in the moment, and across the fieldwork this was the single most underused design move available.

7.4 Framework evaluation

Round 2 offers a first, limited check on the frameworks behind the Device: Shneiderman's (2020) advisory-not-authoritative principle (DR3), the Vygotsky–Boud scaffolded reflection logic (DR2), and the autonomy dimension of self-determination theory (DR4). The reflection question landed as predicted, and the patience budget worked at the turn-taking layer. Firth's (2025) clarity and choice principles (DR5, DR6) sit at the Portfolio layer and remain theoretical here, and the relatedness dimension addressed by the Community is a design proposal grounded in fieldwork and theory rather than a tested artefact. Evaluating the four-component architecture as a system requires a future pilot.

7.5 Scaling and equity

Two questions arise beyond the prototype. The first is whether the system reaches families carrying the heaviest burden, not only those already served by peer networks. Documentation competence currently circulates through Facebook groups and informal mentoring, advantaging families with the time, language, and social capital to find them (Kunzman & Gaither, 2013). A scaled deployment that did not put this knowledge into the system itself would reproduce that gap. The Community, the IÖK Assistant, and the plain-language explanations are the design's answer; whether they actually reach families with lower digital literacy and rural households is the central empirical question for any pilot.

The second is whether this is a niche concern. As Section 3.3 argued, home-educating families are lead users (von Hippel, 1986), facing early what hybrid and flexible learners will face soon, and OECD scenarios (2020) anticipate documentation infrastructure for life-integrated learning as a coming mainstream need. Ekko is a first-generation response to it.

7.6 Limitations

The evaluation sample is small and self-selected. A single user session establishes proof of concept, not validity, and cannot show whether benefits persist, whether novelty explains positive responses, or whether trust holds in real assessment relationships with stakes attached. Stronger claims would need a longitudinal study with a more diverse cohort.

Further limitations follow from the obstacle analysis in Chapter 6. Several friction points lie outside the design's reach: a parent who never opens the App produces no portfolio, and a coordinator under municipal pressure may read the coverage view as a scoreboard rather than conversation prep. The Device is a Stage I instrument and will be outgrown, and the Stage II handover (Section 8.1) is a proposal rather than a built component. The optional photo capture depends on on-device vision models not yet routine in this form factor, and the Round 2 prototype does not implement it.

Finally, visibility is not verification. The system makes learning more visible and the evidence richer, but cannot guarantee that captured moments represent the full scope of a child's learning. Like any trust-based infrastructure, it relies on family good faith and coordinator judgment. This is a feature of the model, not a flaw to design away.

8. CONCLUSION

This thesis began with a specific problem: Estonian home-educating families spend significant time and emotional energy reconstructing their children's learning into formats institutions can accept, school coordinators struggle to assess evidence they were never trained to evaluate, and children play no part in the process. This is not a failure of individual effort but a structural failure of infrastructure.

The fieldwork identified four such failures, all tracing to the same root: an oversight system designed for classrooms, applied to learning that happens in forests, kitchens, museums, and living rooms. Ekko responds with a four-component system. The Device gives the child their own entry point into the record, the App shifts the parent's role from reconstructing evidence to curating it, the Portfolio gives coordinators a structured view in place of unsorted folders, and the Community formalises the peer knowledge that now circulates informally on Facebook. AI supports each layer as an advisory aid, never as a decision-maker.

The design responds directly to a regulatory environment that is tightening monitoring but not specifying how schools should carry it out. What the regulation mandates in policy, Ekko applies in design.

8.1 Future development

Several directions for future work follow from the limitations of this thesis. A longer field study with a more diverse cohort, including families with lower digital literacy and single-parent households, would test whether the system reaches those carrying the heaviest documentation burden. The prototype's Estonian speech recognition is a known constraint and warrants testing alternative speech services. A policy pilot with at least one school and one municipality would address whether portfolio-style, voice-rich evidence can gain formal recognition as a legitimate basis for home education assessment in Estonia.

The form of the Device is presented as a reasoned proposal, not an empirically validated industrial design. A useful direction would build several physical companions in parallel and place them with families over months, comparing how different forms shape the child's relationship with the device. A related target is the on-device vision-language model behind the optional photo capture: small multimodal models are evolving rapidly, and a version that runs within the pebble's power and thermal budget is a near-term

engineering goal rather than a settled capability. The Device is also a Stage I instrument by design, for grades 1 to 3; a Stage II version for older children who already carry phones is its own future-work programme, with the captures, curriculum links, and longitudinal log persisting in the shared database while the surface the child meets changes.

As education becomes more hybrid, mobile, and life-integrated, the problems Estonian home-educating families face today will reach a much wider population. The question this thesis addresses, how to make learning visible without turning the home into a tracked classroom, is not going away.

LIST OF REFERENCES

- Achard, P., Belot, M., & Chevalier, A. (2025). *When parents work from home* (IZA Discussion Paper No. 17957). Institute of Labor Economics.
<https://www.iza.org/publications/dp/17957/when-parents-work-from-home>
- Adams, K. S., & Christenson, S. L. (2000). Trust and the family-school relationship: Examination of parent-teacher differences in elementary and secondary grades. *Journal of School Psychology, 38*(5), 477–497. [https://doi.org/10.1016/S0022-4405\(00\)00048-0](https://doi.org/10.1016/S0022-4405(00)00048-0)
- Alfredo, R., Echeverria, V., Jin, Y., Yan, L., Swiecki, Z., Gašević, D., & Martinez-Maldonado, R. (2024). Human-centred learning analytics and AI in education: A systematic literature review. *Computers and Education: Artificial Intelligence, 6*, 100215. <https://doi.org/10.1016/j.caeai.2024.100215>
- Barrett, H. (2007). Researching electronic portfolios and learner engagement: The REFLECT Initiative. *Journal of Adolescent & Adult Literacy, 50*(6), 436–449.
<https://doi.org/10.1598/JAAL.50.6.2>
- Boud, D. (2000). Sustainable assessment: Rethinking assessment for the learning society. *Studies in Continuing Education, 22*(2), 151–167.
<https://doi.org/10.1080/713695728>
- Boud, D., Keogh, R., & Walker, D. (1985). *Reflection: Turning experience into learning*. Kogan Page.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- British Psychological Society. (2021). *Ethics guidelines for internet-mediated research*.
https://cms.bps.org.uk/sites/default/files/2022-06/Ethics%20Guidelines%20for%20Internet-mediated%20Research_0.pdf
- Broadfoot, P., & Rockey, J. (2025). Generative AI and the social functions of educational assessment. *Oxford Review of Education, 51*(2).
<https://doi.org/10.1080/03054985.2025.2455549>
- Cavoukian, A. (2009). *Privacy by design: The 7 foundational principles*. Information and Privacy Commissioner of Ontario. <https://www.ipc.on.ca/wp-content/uploads/resources/7foundationalprinciples.pdf>
- Clark, I. (2012). Formative assessment: Assessment is for self-regulated learning. *Educational Psychology Review, 24*(2), 205–249. <https://doi.org/10.1007/s10648-011-9191-6>

- Dahlbäck, N., Jönsson, A., & Ahrenberg, L. (1993). Wizard of Oz studies: Why and how. *Knowledge-Based Systems*, 6(4), 258–266. [https://doi.org/10.1016/0950-7051\(93\)90017-N](https://doi.org/10.1016/0950-7051(93)90017-N)
- Daigneault, P.-M. (2024). Reconceptualizing administrative burden around onerous experiences. *Perspectives on Public Management and Governance*, 7(4), 124–136. <https://doi.org/10.1093/ppmgov/gvae010>
- Deci, E. L., & Ryan, R. M. (2000). The what and why of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, 11(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01
- Deepshikha, D. (2025). A systematic review on the future of educational assessment: AI-driven grading and personalised feedback in higher education. *Artificial Intelligence in Education*. <https://doi.org/10.1108/AIIE-03-2025-0036>
- e-Estonia. (n.d.). *School management systems*. Retrieved January 2, 2026, from https://e-estonia.com/solutions/e-education-and-research/school_management_systems
- Education Estonia. (n.d.). *Infosystems support school life*. Retrieved January 2, 2026, from <https://www.educationestonia.org/infosystems/>
- EU AI Act. (2024). *Regulation (EU) 2024/1689 of the European Parliament and of the Council laying down harmonised rules on artificial intelligence*. Official Journal of the European Union. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32024R1689>
- Firth, M. (2025). *Framework for flexible assessment: A national model for inclusive, future-ready assessment design*. The University of Manchester / QAA. [https://www.qaa.ac.uk/docs/qaa/members/framework-for-flexible-assessment-\(5\).pdf](https://www.qaa.ac.uk/docs/qaa/members/framework-for-flexible-assessment-(5).pdf)
- Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist*, 34(10), 906–911. <https://doi.org/10.1037/0003-066X.34.10.906>
- Frayling, C. (1993). Research in art and design. *Royal College of Art Research Papers*, 1(1), 1–5.
- Gaia Kool. (n.d.). *Koduõpe* [Home education]. Retrieved April 25, 2026, from <http://gaiakool.ee/koduoppekeskused/>
- Gerrard, J., McCaw, C. T., Zonca, B., Cabiles, B., & Martinussen, M. (2025). Parental rights and state concerns: The policy problematisation of home education. *Journal of Education Policy*, 40(5), 828–847. <https://doi.org/10.1080/02680939.2025.2498884>

Haidt, J. (2024). *The anxious generation: How the great rewiring of childhood is causing an epidemic of mental illness*. Penguin Press.

Haridus- ja Noorteamet. (n.d.). *Õppurite registri kasutusjuhend (üldhariduskoolid)* [User guide for the student register, general education schools]. Eesti Hariduse Infosüsteem. Retrieved April 25, 2026, from <https://projektid.edu.ee/pages/viewpage.action?pageId=81366217>

Haridus- ja teadusminister. (2018). *Koduõppe ja haiglaõppe tingimused ja kord* [Conditions and procedure for home education and in-hospital teaching] (Määrus nr 6, 28.02.2018). Riigi Teataja. <https://www.riigiteataja.ee/akt/106032018001>

Haridus- ja Teadusministeerium. (2021a). *Haridusvaldkonna arengukava 2021–2035* [Education sector development plan 2021–2035]. <https://www.hm.ee/strateegia-ja-uuringud/strateegiline-planeerimine/haridusvaldkonnaarengukava-2021-2035>

Haridus- ja Teadusministeerium. (2021b). *Koduõppe uuring: Lõpparuanne* [Home education study: Final report]. https://www.hm.ee/sites/default/files/documents/2022-10/htm_koduoppe_uuring_lopparuanne.pdf

Haridus- ja Teadusministeerium. (2025, July 4). *Haridus- ja Teadusministeerium plaanib muuta koduõppe korda* [Ministry of Education and Research plans to change home education regulations]. <https://www.hm.ee/uudised/haridus-ja-teadusministeerium-plaanib-muuta-koduoppe-korda>

Hattie, J. (2012). *Visible learning for teachers: Maximizing impact on learning*. Routledge. <https://doi.org/10.4324/9780203181522>

Hornecker, E., & Buur, J. (2006). Getting a grip on tangible interaction: A framework on physical space and social interaction. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 437–446). ACM. <https://doi.org/10.1145/1124772.1124838>

IDEO. (2015). *The field guide to human-centred design*. IDEO.org. <https://www.designkit.org/resources/1.html>

Ishii, H., & Ullmer, B. (1997). Tangible bits: Towards seamless interfaces between people, bits and atoms. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 234–241). ACM. <https://doi.org/10.1145/258549.258715>

Jones, P. H. (2014). Systemic design principles for complex social systems. In G. S. Metcalf (Ed.), *Social systems and design* (pp. 91–128). Springer. https://doi.org/10.1007/978-4-431-54478-4_4

- Kindsiko, E. (Ed.). (2026). *Eesti inimarengu aruanne 2026: Haridus ühiskonna peeglis* [Estonian human development report 2026: Education in the mirror of society]. SA Eesti Koostöö Kogu. <https://doi.org/10.58009/aere-perennius0189>
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice-Hall.
- Krippendorff, K. (1989). On the essential contexts of artefacts or on the proposition that design is making sense (of things). *Design Issues*, 5(2), 9–39.
<https://doi.org/10.2307/1511512>
- Krogh, P. G., Markussen, T., & Bang, A. L. (2015). Ways of drifting – Five methods of experimentation in research through design. In A. Chakrabarti (Ed.), *ICoRD'15 – Research into Design Across Boundaries, Volume 1: Smart Innovation, Systems and Technologies* (Vol. 34, pp. 39–50). Springer. https://doi.org/10.1007/978-81-322-2232-3_4
- Kunzman, R., & Gaither, M. (2013). Homeschooling: A comprehensive survey of the research. *Other Education: The Journal of Educational Alternatives*, 2(1), 4–59.
- Kurian, N. (2025). Developmentally aligned AI: A framework for translating the science of child development into AI design. *AI, Brain and Child*, 1(1), 1–13.
<https://doi.org/10.1007/s44436-025-00009-z>
- Künnapuu, K. (2023). *Veebipõhine õppeprogramm koduõppijale* [Web-based study programme for home learners]. <https://kynnapuu.com/2023/05/22/veebipohine-oppeprogramm-koduoppijale/>
- Künnapuu, K., & Toots, I. (2021, March 12). Koduõpe kui muutuste kasvulava [Home education as a seedbed for change]. *Õpetajate Leht*.
<https://opleht.ee/2021/03/koduope-kui-muutuste-kasvulava/>
- Lillard, A. S. (2016). *Montessori: The science behind the genius* (3rd ed.). Oxford University Press.
- Loi n° 2018-698 du 3 août 2018 relative à l'encadrement de l'utilisation du téléphone portable dans les établissements d'enseignement scolaire [Law No. 2018-698 of 3 August 2018 on the regulation of mobile phone use in schools]. (2018). *Journal Officiel de la République Française*.
<https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000037284333>
- Meadows, D. H. (2008). *Thinking in systems: A primer*. Chelsea Green Publishing.
- Ministerie van Onderwijs, Cultuur en Wetenschap. (2023, November 7). *Mobiele telefoons ook in basisonderwijs en gespecialiseerd onderwijs uit de klas* [Mobile phones also out of the classroom in primary and specialised education] [Press

release]. Rijksoverheid.

<https://www.rijksoverheid.nl/actueel/nieuws/2023/11/07/mobiele-telefoons-ook-in-basisonderwijs-en-gespecialiseerd-onderwijs-uit-de-klas>

Monk, D. (2003). Home education: A human right? *Evaluation & Research in Education*, 17(2–3), 157–166.

Morris, T. H., & Pannone, S. J. (2024). Homeschooling in a digital age: How digital technologies can help children foster a love for (self-directed) lifelong learning. *International Review of Education*, 70, 29–50. <https://doi.org/10.1007/s11159-023-10041-x>

Moynihan, D., Herd, P., & Harvey, H. (2015). Administrative burden: Learning, psychological, and compliance costs in citizen-state interactions. *Journal of Public Administration Research and Theory*, 25(1), 43–69. <https://doi.org/10.1093/jopart/muu009>

MTÜ Eesti Koduõppe Keskus. (n.d.-a). *Esileht* [Front page]. Retrieved April 25, 2026, from <https://www.koduoape.ee/>

MTÜ Eesti Koduõppe Keskus. (n.d.-b). Koduõppe ABC [Home education ABC]. Retrieved April 25, 2026, from <https://www.koduoape.ee/abc/>

MTÜ Eesti Koduõppe Keskus. (n.d.-c). *Hindamine III kooliaste* [Assessment, school stage III]. Retrieved April 25, 2026, from <https://www.koduoape.ee/hindamineiii/>

Neuman, A., & Guterman, O. (2017). Homeschooling is not just about education: Focuses of meaning. *Journal of School Choice*, 11(1), 148–167. <https://doi.org/10.1080/15582159.2016.1262231>

OECD. (2020). *Back to the future of education: Four OECD scenarios for schooling*. OECD Publishing. <https://doi.org/10.1787/178ef527-en>

OECD. (2025). *Empowering learners for the age of AI: An AI literacy framework for primary and secondary education* (Review draft). OECD and European Commission. <https://ailiteracyframework.org/>

OECD. (2026). *OECD Digital Education Outlook 2026: Exploring effective uses of generative AI in education*. OECD Publishing. <https://doi.org/10.1787/062a7394-en>

Piaget, J. (1952). *The origins of intelligence in children*. International Universities Press.

Postimees. (2025, July 31). Uus kord: koduõppele jäämine peab olema põhjendatud [New order: applying for home education must be justified]. Postimees Haridus.

<https://haridus.postimees.ee/8280639/uus-kord-koduoppele-jaamine-peab-olema-pohjendatud>

Raag, T. (2026, February 17). Koduõpe: kas paremini kaitstud lapsed või rohkem bürokraatiat? [Home education: better-protected children or more bureaucracy?]. *Õpetajate Leht*. <https://www.opleht.ee/2026/02/koduope-kas-paremini-kaitstud-lapsed-voi-rohkem-burokraatiat/>

Radesky, J. S., Schumacher, J., & Zuckerman, B. (2015). Mobile and interactive media use by young children: The good, the bad, and the unknown. *Pediatrics*, 135(1), 1–3. <https://doi.org/10.1542/peds.2014-2251>

Republic of Estonia. (2010). *Põhikooli- ja gümnaasiumiseadus* [Basic Schools and Upper Secondary Schools Act]. Riigi Teataja. <https://www.riigiteataja.ee/akt/101032019013>

Republic of Estonia. (2025, September 19). *Haridus- ja teadusministri määruste muutmine* [Amendment of regulations of the Minister of Education and Research]. Riigi Teataja. <https://www.riigiteataja.ee/akt/116092025011>

Rideout, V., Peebles, A., & Robb, M. B. (2025). *The Common Sense census: Media use by kids zero to eight, 2025*. Common Sense Media. <https://www.common Sense media.org/research/the-2025-common-sense-census-media-use-by-kids-zero-to-eight>

Selwyn, N. (2019). What's the problem with learning analytics? *Journal of Learning Analytics*, 6(3), 11–19. <https://doi.org/10.18608/jla.2019.63.3>

Sevaldson, B. (2017). GIGA-mapping: Visualisation for complexity and systems thinking in design. In *Nordic Design Research Conference 2011: Making Design Matter*. <https://archive.nordes.org/index.php/n13/article/view/104/88>

Shneiderman, B. (2020). Human-centered artificial intelligence: Reliable, safe & trustworthy. *International Journal of Human-Computer Interaction*, 36(6), 495–504. <https://doi.org/10.1080/10447318.2020.1741118>

Shostack, G. L. (1984). Designing services that deliver. *Harvard Business Review*, 62(1), 133–139.

Sikkut, R. (2024, September 26). Sikkut nõustub: nutiseadmete liigne kasutamine on õpilaste jaoks uus terviserisk [Sikkut agrees: excessive smartphone use is a new health risk for students]. *Postimees*. <https://www.postimees.ee/8103647/sikkut-noustub-nutiseadmete-liigne-kasutamine-on-opilaste-jaoks-uus-terviserisk>

- Skollag (2010:800) [Education Act]. Sveriges Riksdag.
https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/skollag-2010800_sfs-2010-800
- Statistikaamet. (2025, March 28). *Üldharidus* [General education].
<https://stat.ee/et/avasta-statistikat/valdkonnad/haridus/uldharidus>
- Tilhou, R. (2020). Contemporary homeschool models and the values and beliefs of home educator associations: A systematic review. *Journal of School Choice*, 14(1), 75–94. <https://doi.org/10.1080/15582159.2019.1616992>
- UNESCO. (2025a). *AI and the future of education: Disruptions, dilemmas and directions*. United Nations Educational, Scientific and Cultural Organization.
<https://www.unesco.org/en/articles/ai-and-future-education-disruptions-dilemmas-and-directions>
- UNESCO. (2025b). *AI and education: Protecting the rights of learners*. United Nations Educational, Scientific and Cultural Organization.
<https://unesdoc.unesco.org/ark:/48223/pf0000395373>
- UNESCO. (2025c, May 19). *What's worth measuring? The future of assessment in the AI age*. <https://www.unesco.org/en/articles/whats-worth-measuring-future-assessment-ai-age>
- von Hippel, E. (1986). Lead users: A source of novel product concepts. *Management Science*, 32(7), 791–805. <https://doi.org/10.1287/mnsc.32.7.791>
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.
- Wang, Y., Wang, H., Wang, S., Wind, S. A., & Gill, C. (2024). A systematic review and meta-analysis of self-determination-theory-based interventions in the education context. *Learning and Motivation*, 87, Article 102015.
<https://doi.org/10.1016/j.lmot.2024.102015>
- Watson, A. R. (2024). Homeschool participation: Post-pandemic persistence and growth trends. *Journal of School Choice*, 18(4).
<https://doi.org/10.1080/15582159.2024.2422742>
- Watson, A. R. (2025). *Homeschool growth: 2024–2025*. Johns Hopkins Homeschool Research Lab. <https://education.jhu.edu/edpolicy/policy-research-initiatives/homeschool-hub/homeschool-growth-2024-2025/>
- Weiser, M. (1991). The computer for the 21st century. *Scientific American*, 265(3), 94–104. <https://doi.org/10.1038/scientificamerican0991-94>

Weiser, M., & Seely Brown, J. (1996). *The coming age of calm technology*. Xerox PARC. <https://calmtech.com/papers/coming-age-calm-technology>

Williamson, B. (2017). *Big data in education: The digital future of learning, policy and practice*. SAGE.

Zimmerman, J., Forlizzi, J., & Evenson, S. (2007). Research through design as a method for interaction design research in HCI. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 493–502). ACM. <https://doi.org/10.1145/1240624.1240704>

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APPENDICES

APPENDIX A: Interview guide

Semi-structured interviews were conducted with ten participants across four stakeholder roles: home-educating parents, school coordinators and teachers, a policymaker, and an educational psychology expert. Interviews were conducted in Estonian and lasted between 30 and 90 minutes; the questions below are translated. The guide was used flexibly. Not every question was asked of every participant, and early interviews informed the framing of later ones.

A.1 Core questions (adapted across all roles)

What is your role in the home education arrangement, and how is it currently organised in the cases you know?

How do families evidence that a child has achieved the expected learning outcomes, and what in that process works well versus creates friction or takes the most time?

If you imagine the system as a network connecting school, family, and child – where does it tear most, and what would make it more transparent and trustworthy?

If you could design one tool or system to make home education work better, what would it be?

A.2 Parent-specific

How did home education begin in your family, and did you choose a home-education-supportive school or a mainstream one?

What does a typical day look like, structured or flexible, and what tools do you use to track learning?

How do you notice whether your child has genuinely understood something, and how does the school assess this?

What is the hardest part, and what kind of support is most lacking (information, community, teachers, digital tools)?

Are you connected to a wider network of home-educating parents, or do you mostly operate on your own?

A.3 School coordinators

How is home education organised at your school, how many students learn this way, and what arrangements are most common (long-term, abroad, interim)?

What are the most common reasons a child enters home education, and how long do these periods typically last?

How do you assess a family's readiness during the intake conversation, which competencies or conditions matter most?

What do parents most often fail to anticipate before starting, and where have misunderstandings between school and family most often arisen?

What are the biggest difficulties in assessing progress and giving feedback, and which approaches have worked well, including for informal learning?

How much does the child themselves participate in decisions about their learning arrangement, and what do you think their role should be?

How do home-educated children maintain connection with their class and peers?

When do you feel a child and family are getting the *best* version of home education?

A.4 Policymaker

How has the home education landscape shifted in the past three to five years, and what is the single greatest tension the system currently perceives?

How should the balance between parental autonomy and state oversight be struck?

Given the teacher shortage and parents willing to take on a teaching role, has there been discussion of supporting families through mentors, training, or digital tools?

Has the ministry looked at how other countries (e.g. the Nordics) structure home education, and is there anything Estonia might adapt?

What role might technology and design play in making the system more transparent, fairer, or easier to administer?

A.5 Educational psychology expert

How does home education affect a child's psychological development, and why does it work well for some children but not others?

How does the parent-child relationship shift when the parent also becomes teacher or learning organiser, and which psychological challenges appear most often for each?

How does home education affect a child's sense of belonging and social identity?

In home education, assessment is often more open-ended and less frequent – is this more often a strength or a risk for the child's sense of progress, and how does a child know they are moving forward when no one is formally evaluating them?

APPENDIX B: Digital observation protocol

Purpose: This protocol guided twelve months of digital observation in a closed online community of Estonian home-educating families. It complemented the interviews by surfacing everyday concerns, language, and improvised practices that rarely appear in formal settings.

Field site and access: A closed Facebook group for Estonian home-educating families. The researcher was already a member as a parent before the research began.

Observation period and stance: January 2025 to December 2025. Non-participant: posts and comments were read, but the researcher did not post, comment, react, or message members.

What was recorded: Field notes were kept in a private, password-protected document. For each thread: date, a short topic label, post type (question, vent, resource share, advice request), approximate engagement, and analytical notes on themes and language. No verbatim quotes, screenshots, names, or thread links were recorded. Private messages, threads marked as not for sharing, and any sensitive content involving identifiable children were excluded.

Analytical use: The notes informed the thematic synthesis in Chapter 4; 42 threads were coded by topic. The observation was treated as contextual and pattern-revealing rather than attributable evidence: no post is quoted or paraphrased in a form that could identify a member or thread.

Ethical considerations: No deception was involved, as the researcher was already a member. Administrators were not separately notified, on the judgement that non-participant reading with no verbatim extraction, screenshots, or identifying details did not materially differ from ordinary member reading. Nothing is reproduced or paraphrased in a way that could be reverse-searched to its author. Field notes will be deleted in June 2026. The protocol follows British Psychological Society guidance on internet-mediated research and GDPR principles.

APPENDIX C: Service blueprints, current state and after Ekko intervention

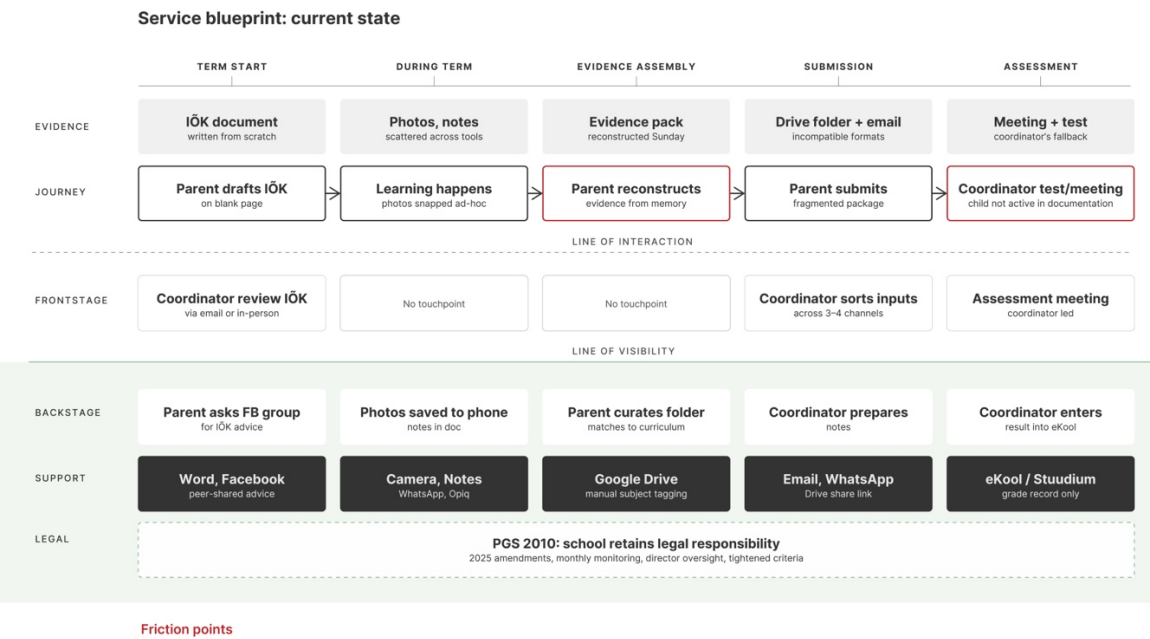


Figure C– 1 Service blueprint, current state ("before Ekko"). Made by the author.

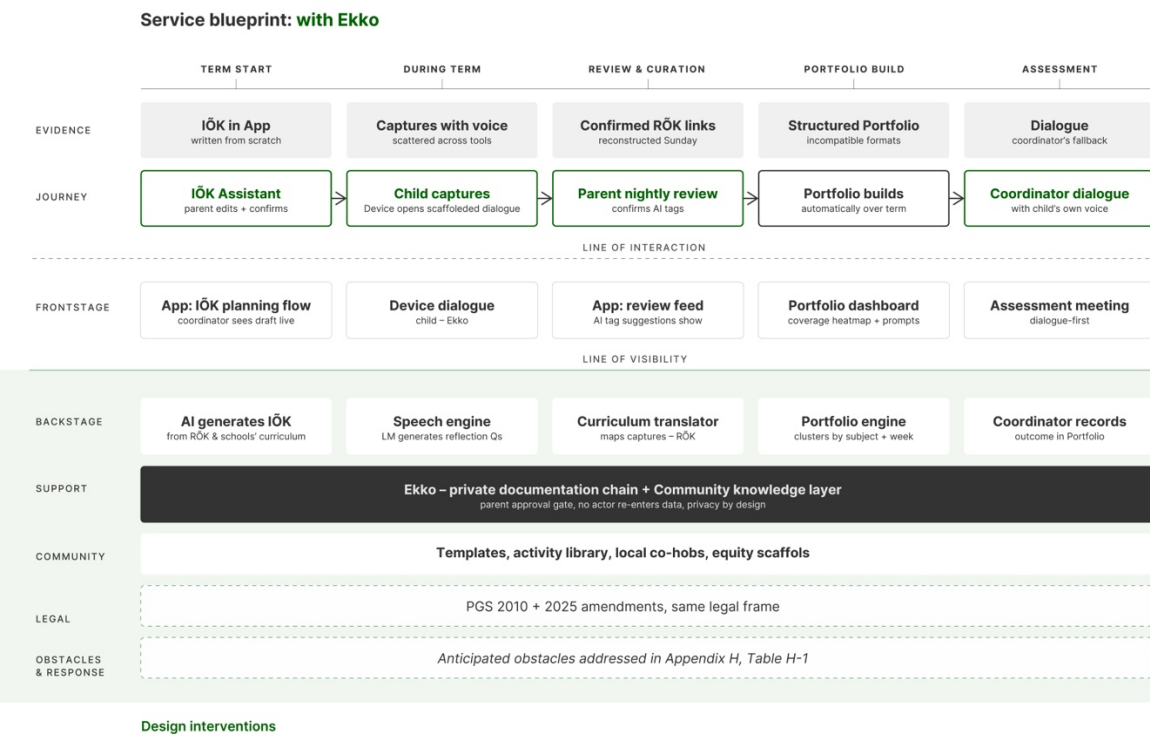


Figure C– 2 Service blueprint with Ekko intervention. Made by the author.

APPENDIX D: Prototype testing protocol

Within the Research for Design methodology of Chapter 3, prototype testing is structured as two rounds of design experiments that feed each other: a researcher-led phase and a family walkthrough. Coordinator evaluation of the Portfolio, and parent evaluation of the App, are out of scope for this thesis. Both components are specified in Chapter 6 but remain to be tested with their intended users in future work.

Table D- 1 Two rounds of testing.

Round	Who	What we want to learn	Method
1	Researcher	Does the Device work on real hardware and behave the way Chapter 5 says it should?	Structured walkthrough of the 5 use cases on a Samsung Galaxy A12, change-log kept
2	One child, age 6	How does a real child experience the reflection question on real hardware?	~30 min home session: 2 captures + short interview with child

Round 1 – what changed

Round 1 is documented as a design experiment rather than hidden preparation: the testing and the redesign ran together. Table D-2 lists the main divergences between implemented and intended behaviour that were surfaced and addressed.

Table D- 2 Round 1 change log.

What I found	What I changed
Red "ei kuulnud midagi" error fired within 2–3 s of tap, before the child could begin.	25-second patience budget that silently restarts recognition on Chrome's premature no-speech event.
Dialogue ended after one question with a unilateral "Salvestatud!" announcement.	Replaced with an invite-close turn ("Kas soovid veel midagi öelda?"); the child decides when the conversation ends. "Salvestatud!" removed.
Questions were generic, not tied to the Estonian curriculum.	Embedded I kooliaste RÕK outcomes across the seven ainevaldkonnad; Default grade set to 1.
Questions ignored situational context (museum vs home, winter vs summer).	Added time-of-day, season, and opt-in place name

Round 2 – the session

The Round 2 session surfaced three divergences between the design as specified in Chapter 6 and the design as it behaved in use with a real child. Unlike the Round 1 changes, these were not addressed within the scope of this thesis. Table D-3 records them as items that feed forward into the next iteration of the Device.

Table D- 3 Round 2 change log (feeds forward into future work).

What I found	What feeds forward
The child hesitated through the first capture and asked questions about how the Device fits into their day before using it. The interaction assumes the child arrives at the first capture already knowing what the object is and what is expected of them.	The Device needs a built-in onboarding sequence: a voice-led first-use experience in which the Device introduces itself, walks the child through one rehearsal capture without saving it, and explains what the indicator light, the camera, and the speaker do.
The 25-second patience budget protects against the technical timeout but does not protect against the Device speaking too soon after the child stops, treating the child's first pause as the end of their thought rather than a breath in the middle of it.	A short silence after the child's apparent end-of-utterance, before the Device responds, would change the felt rhythm of the dialogue without changing any other parameter.
The child described the reflection question as "too easy". Round 1 tuned the prompt to be developmentally safe for a Stage I learner, but the floor was set lower than the child needs.	The difficulty of the reflection question can extend further into the Stage I learner's zone of proximal development without overshooting.

Appendix E: Interview data analysis

The thematic analysis described in 3.6 produced three sequential artefacts: an open coding matrix, an axial coding consolidation, and a nine-theme synthesis. The four structural findings in Chapter 4 are derived from the cross-cutting patterns across these layers.

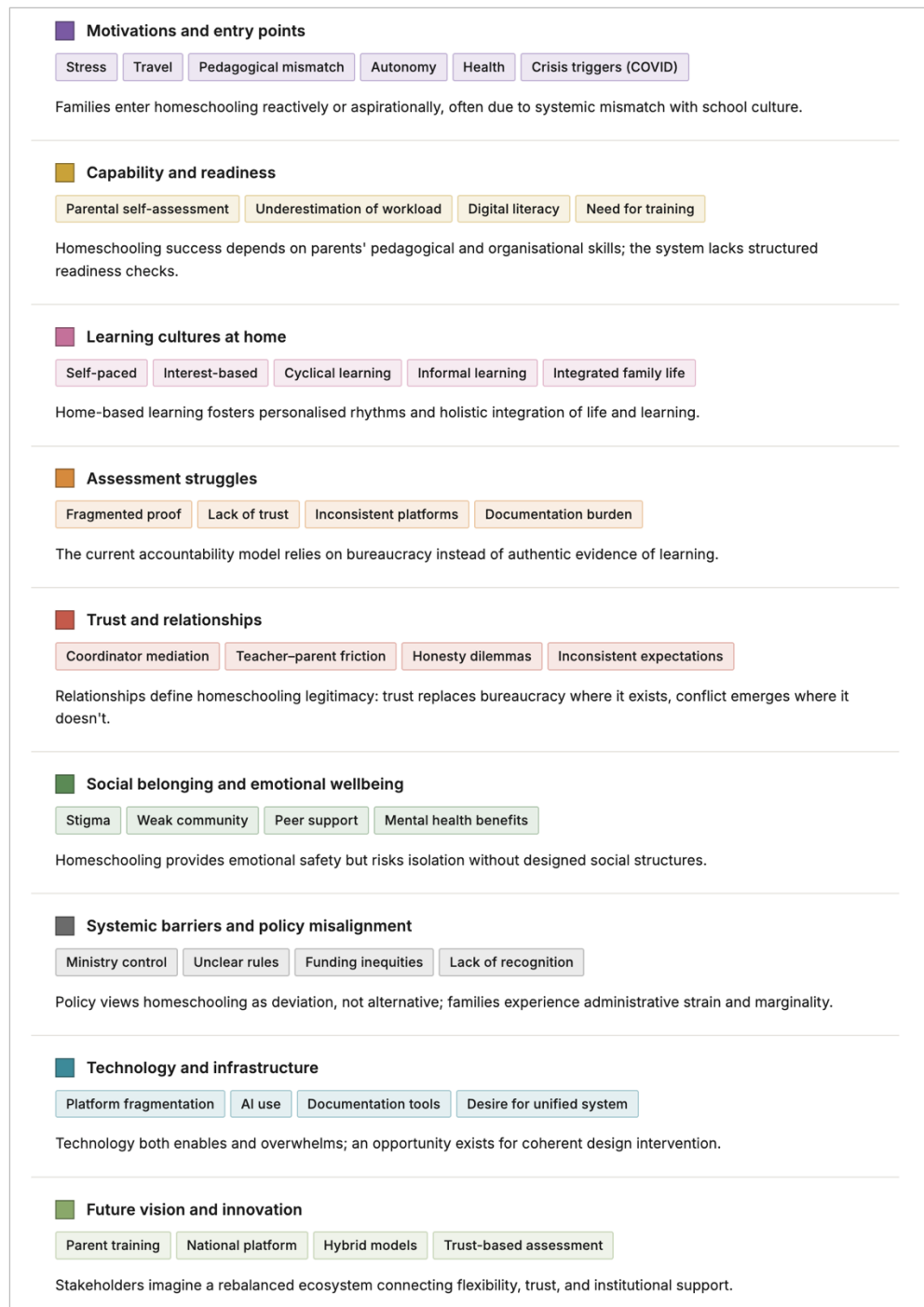


Figure E- 1 Axial coding: codes consolidated into higher-order categories, each with a summary analytical statement. Made by the author.

0 1 Fragmented systems and uneven support structures Families use multiple disconnected platforms to document learning, communicate with schools, and access materials. Schools lack shared protocols, amplifying cognitive and administrative load for both sides.	The homeschooling ecosystem operates through a patchwork of tools and informal systems; learning processes are opaque and inefficient. A unified digital infrastructure is needed. → F 3
0 2 Burden of documentation and assessment Parents and teachers describe documentation as the most exhausting aspect of homeschooling. Parents struggle to translate informal evidence; teachers spend excessive time verifying materials of varying format and credibility.	Current assessment relies on manual interpretation and subjective trust. A systematic yet flexible approach to documenting learning is needed. → F 1
0 3 Parental preparedness and emotional load Parents consistently underestimate the pedagogical and emotional burden of homeschooling. The boundary between parenting and teaching often blurs, creating stress and occasional guilt about "not doing enough".	Sustainability depends on strengthening parents' pedagogical confidence and wellbeing. Design must scaffold guidance, validation, and emotional support, not just instructional resources. → F 1 · F 2
0 4 Control, trust, and autonomy A recurring tension between institutional oversight and family autonomy: schools fear loss of educational standards, parents fear bureaucratic interference. Both sides express anxiety.	A balanced system must rest on mutual trust and transparency, where visibility of learning replaces control mechanisms: observability without rigid monitoring. → F 2
0 5 Social and collaborative learning needs Parents rejected the stereotype of isolation but acknowledged the difficulty of organising peer interaction. Opportunities for joint activities or group learning were sporadic and uncoordinated.	Homeschooling requires designed opportunities for structured social learning: contexts that preserve flexibility while enabling peer exchange and belonging. → COMMUNITY
0 6 Inequality and access to resources Interviews revealed significant disparities in families' access to resources, digital tools, and support networks. Few schools allow partial attendance or subject-based flexibility, narrowing options.	The current system privileges resourceful families; hybrid and digitally inclusive models could make homeschooling more equitable. → COMMUNITY · EQUITY
0 7 Motivation, rhythm, and learning experience Parents and experts described the challenge of sustaining motivation without school's external structure. Multitasking and household routines disrupted consistent learning rhythms.	Success depends on supporting intrinsic motivation and sustainable rhythms: tools that visualise progress, encourage reflection, and balance autonomy with structure. CONTEXT
0 8 Positive practices and adaptive strategies Despite challenges, parents described meaningful learning emerging from everyday life: nature walks, household projects, real-world creative contexts. Some already use AI or portfolio tools to compile evidence.	Digital tools can amplify experiential learning by capturing informal moments and translating them into visible progress without reducing them to standardised measures. DESIGN OPPORTUNITY
0 9 Systemic tensions and policy-level frictions Officials stressed that homeschooling is a parental responsibility, not a replacement for school. Schools are tasked with verification but lack resources or digital mechanisms; the line of responsibility remains ambiguous.	The ecosystem lacks coherent governance and data infrastructure. Policy-aligned digital systems could clarify accountability and make the home-school relationship more transparent. BACKGROUND

Figure E- 2 Mid-stage synthesis of interview data: nine themes with associated insights, mapped to the four structural findings developed in Chapter 4. Made by the author.

Appendix F: Visual audit materials

The materials reproduced here come from one participating family who consented to share examples of their documentation. Figure F.1 shows the family's private weekly learning diary, kept by the parent across the term and never submitted to the school. Figures F.2 and F.3 show two of the items that were submitted to the coordinator via Google Drive: a photograph of the child's outdoor "used items shop" and a page of arithmetic exercises. All identifying metadata has been cropped; shared with consent.

3. nädal	• Tutvuda sügavamalt gloobusega • Küllastada seenenäitust • Samal ajal peaks olema seal ka putukate fotode näitus – uurida ka putukaid • Kellaajad • Jätkata kirjatähtedega • Lugemine, päevik	• Materjalid ja kuidas neid saadakse. Vaatasime lisaks paari videot plastiku tootmise ja reostuse kohta. • Tunnused, rühmitamine • Lugemine, päevik • Koduümbruse puudega tutvumine, nende lehtede korjamine ja pressides kuivatamine. Okaspuu, lehtpuu. Igihaljas, raagus. • Käisime seenenäitusel, tutvusime Eestis enamlevinud seentega, tuvastasime tingmärkide järgi, kas need on söödavad, mürgised jms. Tutvusime mikroskoobiga. • Gloobus. Meri, laht, ookean, Eesti, Läänemeri. • Akrobaatika, rattasõit. • Meeter. Mõõdulindiga mõõtmine. • Koolon, jutumärgid. • Luges lõpuni esimese raamatu (luulevormis), tegi selle kohta lugemispäeviku sissekande (autor, pealkiri, tegelased, sisukokkuvõte, enda hinnang raamatule) • Meisterdamine. Tegi paberist raamatu, elutoa maketi, nuku ja nukuriided. • Alustas uue raamatuga. • Käis tähetornis, osales aardejahis, kus pidi küsimusteke vastama. Vaatas spetsiaalse teleskoobiga päikest. Päike, planeedid, tähesüsteemid, teleskoobid, telegraaf, tähed, komeedid jne. • Kordas peast liitmist ja lahutamist.	• Puude ja seente vastu huvi puudub. Läbisime selle üsna pinnapealselt. Siiski omandas põhiteadmised. • Loeb omast initsiatiivist rohke, kui meil kokku lepitud. • Putukatega ei jõudnud tegeleda. • Kellaga ei jõudnud tegeleda.
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Figure F– 1 Excerpt from the family's private weekly learning diary (Week 3). Three columns track planned activities, what was actually done, and what was not done. The diary covers fifteen weeks of first-grade home education but was never shared with the school.



Figure F- 2 Photograph submitted to the coordinator via Google Drive: the child's outdoor "used items shop", a self-initiated learning moment combining writing, pricing, and entrepreneurship.

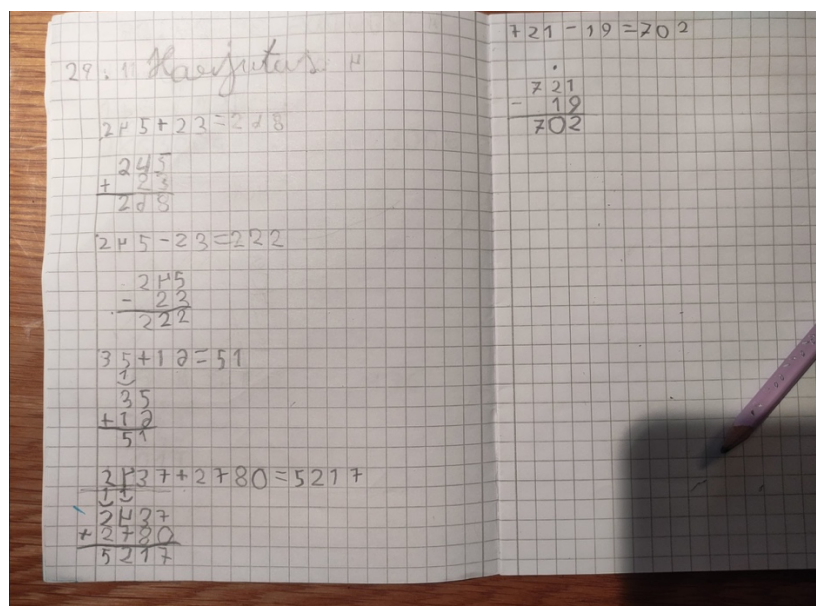


Figure F- 3 Photograph submitted to the coordinator via Google Drive: a page of arithmetic exercises (column addition, column subtraction).

Appendix G: Anticipated obstacles and design responses

Table G– 1 Anticipated obstacles to Ekko in use and the corresponding design responses.

Obstacle	How the design responds
Child gets bored of the Device over time	The reflection question difficulty adapts as the child progresses through Stage I (Section 5.4). The Device is a Stage I instrument by design; a Stage II Device is treated as future work. Boredom is not eliminated and is acknowledged as a limit of any single-form companion object.
Child forgets the Device	The Device is designed as a personal object the child carries on a lanyard or in a pocket. Missed captures are not treated as a system failure: the parent can add a retrospective capture in the App, and the coverage indicator does not penalise gaps.
Child gives a minimal or off-topic answer	The capture is saved with whatever the child said. The parent sees the transcription and decides whether to share it. A minimal answer is not framed as a failed capture. The Device does not press the child for a better one.
Parent does not form the habit of using the App	The App is designed for a five- to ten-minute review session, short enough to fit existing evening routines. Captures accumulate until the parent opens it; nothing is lost by a delayed review. Sustained non-engagement is acknowledged as a limit.
Parent accepts AI suggestions without thinking	Each suggested RÖK link is presented with a plain-language explanation of why the link was made making review the easier path than blind acceptance. The Portfolio surfaces the captures themselves alongside the curriculum links, so the coordinator can see what the evidence actually says, not only how it was tagged.
AI suggests the wrong curriculum link	Every AI-suggested link is editable: confirm, edit, or dismiss. The design treats AI as advisory, never as authority. The cost of a wrong suggestion is the second or two it takes to dismiss it.
Vision system misidentifies what is in front of the camera	The child can correct it verbally in the same dialogue: <i>"No, that is not a drawing, that is my homework"</i> . The Device re-runs the detection with the corrected intent. The fallback is a stored wide frame the parent can crop manually in the App. The cost of a wrong identification is one extra spoken sentence, not a misclassified capture reaching the coordinator.
Camera captures something the family does not want recorded	The image is reviewed by the parent in the App before it enters the Portfolio. The parent can dismiss any capture, with no copy persisting beyond the local store. Human faces detected in the frame are blurred by default; the parent can override this per capture. Visual processing is bounded to the capture window the child triggers and is not always-on. The design treats the camera as an opt-in sensor under the child's control, not as an ambient observer
Connectivity fails during a capture	The Device captures and stores recordings locally and syncs when a connection returns. Speech-to-text and curriculum tagging happen on sync. The child experiences the same interaction whether online or offline.
Coordinator reads the coverage heatmap as a scoreboard	The Portfolio frames coverage and gap detection as conversation prep, not as findings, with AI-suggested discussion starters drawn from the child's actual captures. A thin colour is a question to bring to the meeting, not a verdict. This is a use-pattern obstacle the design can shape but not fully control.