

Design Phases and Stages

In this section, we describe the 5 phases of research that evolved over a 4 years journey starting from 2021 to 2025. For each phase, we have divided the section into stages in order to bring clarity to how each phase was structured. Figure 1, gives a visual overview of the 5 phases of design and the associated stages.

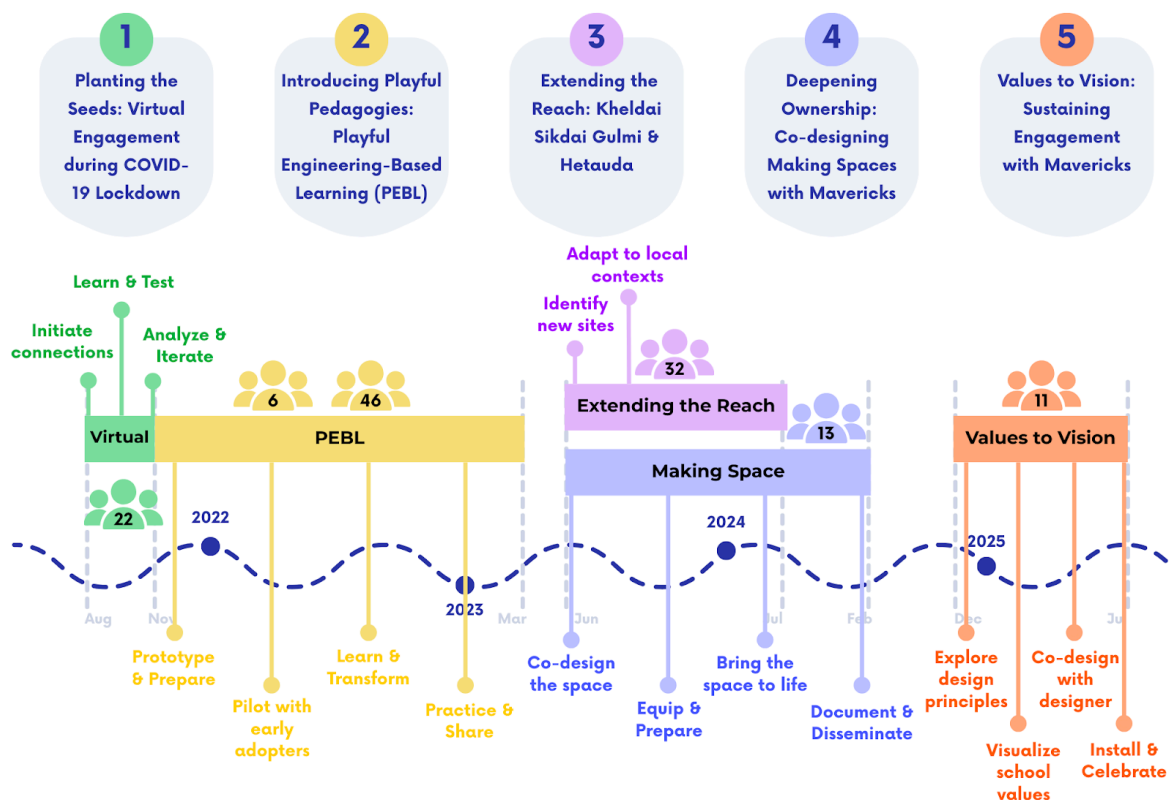


Figure 1: Overview of the 5 design phases and their corresponding stages

Phase I: Virtual Engagement during COVID-19 Lockdown

Introduction (August 2021-October 2021)

Phase I began during nationwide school closures due to COVID-19 pandemic. We noticed a sense of confusion among teachers and the broader education community about how to continue student learning outside of a school setting. While many initiatives focused on technical training for online tools, we saw an opportunity to rethink broader educational assumptions. Rather than centering technology use alone, the program invited teachers to reimagine learning by drawing on a shared cultural model of a mandala, to explore connections among key components of teaching and learning. We were particularly curious about how play, materials, storytelling, design, and making contribute to more connected and relational sensemaking.

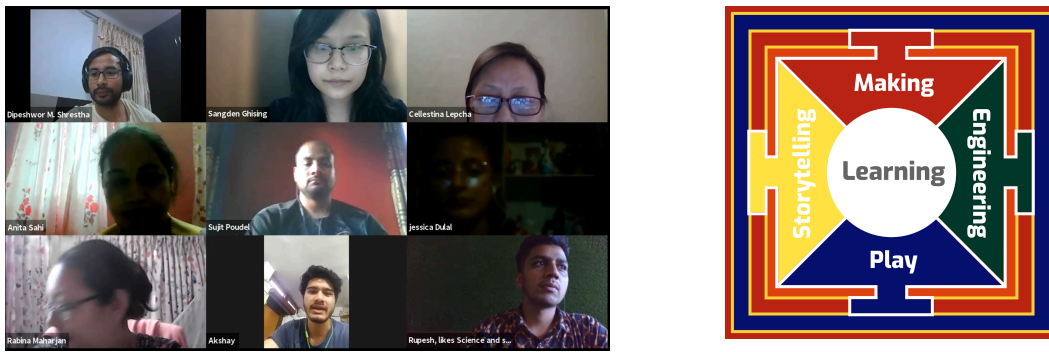


Figure 25: Virtual gatherings on Zoom (left) and components of a learning mandala (right)

Learning Community

22 teachers were recruited through an open call circulated within the Karkhana network, complemented by follow-up phone calls and email correspondence with school principals to ensure administrative awareness and support. The group included teachers from public and private schools, as well as informal educators who facilitated learning outside traditional classrooms, often drawing on expertise in areas such as making, design, or coding. Interested teachers completed an online application form after reviewing a one-page project overview that clearly outlined the goals of the study, the nature of the activities, and the expected time commitment. School administrations were informed about the project's purpose and structure through this outreach process. Participating teachers received compensation at a rate of USD 15 per hour, as specified in the consent form, which also detailed the statement of research, purpose, duration, procedures and activities, and potential risks and benefits. Teachers' motivations for participating included interest in playful, hands-on pedagogies, opportunities for professional growth, and the chance to contribute to a research-informed learning community.

Stages

1. **Initiate connections:** In January 2021, during nationwide COVID-19 school closures, we began conversations with educators and school leaders in our network in Nepal, noticing widespread uncertainty about how to sustain student learning beyond physical classrooms. These conversations informed the design of our sessions, addressing immediate concerns while foregrounding emerging possibilities, and helped us recruit teachers for the study.
2. **Learn and Test:** The teachers gathered virtually as schools in Nepal were still closed because of COVID-19. To accommodate teachers' schedules, we created two groups of participants who gathered on Zoom for 90-minutes each week, for a total of 8 weeks (See Appendix A: Teacher Workshops).
3. **Analyze and Iterate:** We analyzed 11 interview transcripts and accompanying drawings to identify emerging themes, sharing developing insights with peer researchers to guide iterative analysis. A case study of Rupesh's engagement served as a focal point, beginning with open coding of transcripts and followed by detailed examination of his iterated drawings. Comparing these representations revealed shifts in his thinking about play, making, engineering, and storytelling. This

multimodal approach, combining fine-grained analysis of drawings with interview narratives, provided a rich lens into how teachers' understanding evolved over time. We restructured the 8 workshops based on the analysis and emerging themes.

Key Insights

1. **Centrality of Play:** Participants increasingly positioned play at the core of learning, interwoven with storytelling, making, and engineering, suggesting that playful engagement was not peripheral but foundational to their evolving pedagogical thinking. Peer discussions within the PLC appeared to reinforce and refine this shared understanding. Based on this realization, Phase II introduced two sessions based on LEGO Education's Learning through Play (LtP) framework, emphasizing the elements of joy, iteration, social interaction, active engagement, and meaningfulness.

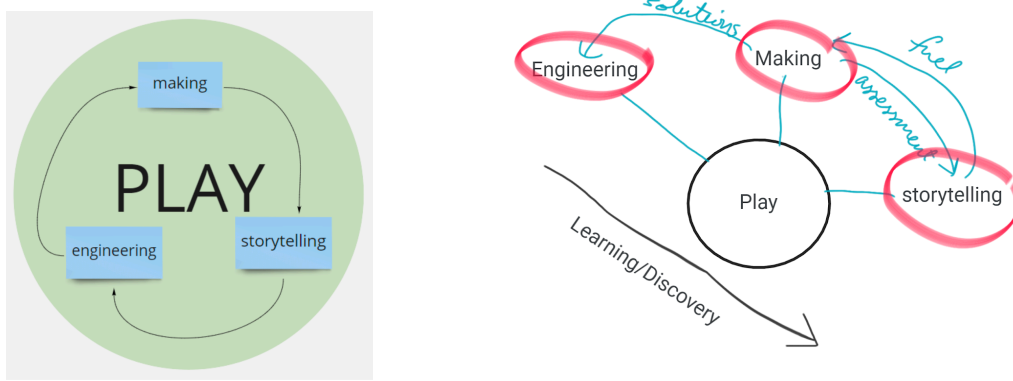


Figure 26: Teachers' final iterations of how they constructed connections among play, making, engineering and storytelling

2. **Supporting feedback culture:** Teachers described a cultural hesitation toward giving and receiving feedback, shaped by norms that position teachers as authorities expected to have correct answers. This “no feedback” culture often discouraged the sharing of incomplete ideas or confusion, limiting opportunities for authentic reflection. The representational activities, however, created space for teachers to externalize and examine their evolving thinking. To further cultivate constructive peer critique, Phase II introduced a session titled Austin's Butterfly, drawing on Ron Berger's feedback framework: Be kind, be specific, be helpful, to normalize revision and establish a feedback culture.
3. **Hybrid engagement as a possibility:** Phase I validated that meaningful, hands-on learning could occur even in virtual settings as teachers actively participate in materials-based, playful activities from their own spaces. At the same time, in-person gatherings deepen relational trust and strengthen community bonds, allowing participants to connect more personally. For Phase II, we decided on a hybrid model that combined virtual flexibility with physical connection.

Phase II: Playful Engineering-Based Learning (PEBL)

Introduction (November 2021 - March 2023)

PEBL aimed to enable children to experience learning through play in their classrooms every day, with a particular focus on ensuring equity in schools with limited resources. To achieve this, we worked closely with teachers to strengthen their capacity to facilitate hands-on, playful learning. We supported teachers through three interconnected approaches. First, we developed learning kits with 12 curriculum-aligned, hands-on activities for students aged 10 to 14, complemented by digital resources such as videos, blogs, and guides. Second, we conducted professional development workshops for 46 teachers to build their facilitation skills. Third, we fostered a Community of Practice where educators shared experiences, discussed learning strategies, and participated in collaborative reflections.

Learning Community

1. **Early Adopters:** We identified 6 early adopters who were participants in Phase I of the study to pilot selected activities in 5 schools. The schools were deliberately selected to ensure that testing could happen in diverse learning environments.
2. **PEBL Implementers:** We received a total of 66 applications from 36 schools, out of which we selected 46 teachers from 24 schools after conducting interviews with school leaders. The group included 11 teachers from public schools and 13 teachers from private schools.

Stages

1. **Prototype and Prepare:** Sameer, a participant in Phase I, led the efforts to develop the toolkit by adapting existing Karkhana activities. These activities were redesigned to intentionally integrate the five characteristics of learning through play (LtP): joyful, actively engaging, iterative, socially interactive, and meaningful. Team members completed an online LtP course offered by the Australian Council for Educational Research (ACER) which helped them collectively make sense of the new framework.
2. **Pilot with early adopters:** The early adopters tested the activities we had designed with their students and shared their experiences and gave us feedback on the changes needed to be made to the activities.



Figure 27: Beta-version of the PEBL learning kits

3. **Learn and Transform:** The teachers participated in 12 sessions (6 in-person and 6 virtual) which were organized around three interconnected themes. **Theme 1, Understanding PEBL**, introduced teachers to core ideas of playful learning through critical readings, hands-on activities, and collaborative ideation. Teachers explored how the five characteristics of play could be integrated into classroom practice, while engaging with research papers through critical discussion. This theme also included experiences with Novel Engineering - as an integrated approach to literacy and engineering, and design thinking as an approach to address classroom challenges. **Theme 2, Making Learning Visible**, focused on deepening cognition by externalizing thinking through documentation and reflection. Teachers worked with tools to capture and share classroom stories, used Project Zero's thinking routines to document student learning, and explored feedback approaches to support a culture of constructive feedback within students. **Theme 3, Implementing PEBL**, centered on practice, with teacher participants designing and delivering PEBL experiences in their own classrooms using the PEBL toolkit.



Figure 28: Teachers attending PEBL sessions

4. **Practice and Share:** After the completion of the 12 sessions, the teachers then facilitated lessons for their own students using the PEBL toolkit. They utilized the support of the educator guide, videos, learning kits, and activity sheets to build a world of play in their classrooms. In addition to that, the teachers also were asked to capture stories in their classrooms by taking pictures and videos of students during the activities and they would reflect on their teaching experience and share it with the rest of the teaching community. Moreover, Karkhana team members went to 6 schools to observe the teachers implement the PEBL lessons in their classrooms. After each observation, our team members provided feedback to the teachers using the What Went Well (WWW)/Even Better If (EBI) framework, to identify things that the teachers were doing well as well as opportunities for improvement.

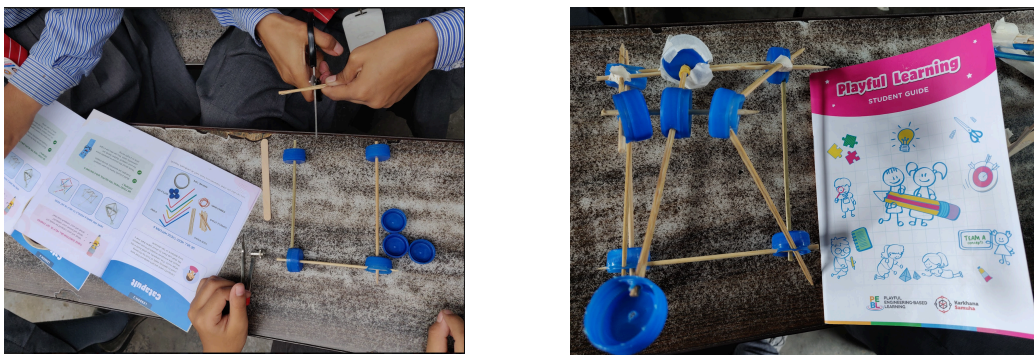


Figure 29: Students using student guide and materials from the toolkit to make a catapult

Key Insights

1. **Localized Resources:** Translating the student guide into Nepali improved accessibility for public school students, highlighting the importance of language and context in resource design. (Refer to Appendix B for links to the resources).
2. **Supporting Iteration and Solution Diversity:** Lessons were revised to allow multiple approaches and iterative work, reinforcing the role of experimentation in learning through play.
3. **Time-Efficient Teacher Support:** Short videos offered a practical alternative to lengthy educators' guides, helping teachers quickly understand facilitation strategies and anticipate classroom challenges.
4. **Practical Adjustments from Class Observations:** Classroom observations informed refinements, such as suggesting the use of a randomizer for student participation and assigning students to distribute materials, improving engagement and management. In Phase III, a dedicated session on classroom management was added to support teachers in handling materials and managing the messiness of hands-on activities.

Phase III: Extending the Reach: Kheldai Sikdai Gulmi & Hetauda

Introduction (June 2023 - February 2024)

Kheldai Sikdai focused on working with teachers in Hetauda and Gulmi to help them deliver playful engineering-based learning experiences to their students using simple low-cost and easily accessible materials. Similar to PEBL, we aimed to build a community of practice focused on playful learning, and provided professional development sessions and learning toolkits in order to help the teachers bring hands-on learning to their students.

Learning Community

1. **Hetauda:** To recruit participants in Hetauda, we collaborated with the school leaders at Jana Priya School to select 7 public schools. Additionally, three

low-cost private schools were added after conversations with the school leaders about the program and the required commitments.

2. **Gumli:** To recruit participants in Gulmi, we collaborated with United World School (UWS Nepal) which is a non-profit entity that is dedicated to providing free, accessible, quality education to children in the most remote and marginalized areas. In Nepal, UWS runs a fellowship program that places young people who have finished their undergraduate degree in different schools for a year, to support the school leaders and teachers. The learning community comprised 4 UWS Nepal fellows and 8 community teachers.

Stages

1. **Identify new sites:** To extend the reach of the resources we had developed in Phase II, we wanted to expand to two sites outside Kathmandu. The first site, **Hetauda** is 82 km away from Kathmandu and is the capital of Bagmati Province. The majority of the students attending public schools belonged to marginalized communities, with more female students in the cities attending public schools compared to private ones. The second site, **Gumli** is a rural district located in the hills of Lumbini Province which is 356 km far from Kathmandu. We collaborated with teachers from 8 public schools in Gulmi to help them deliver playful experiences to 570 students.
2. **Adapt to local contexts:** In Gulmi, teachers engaged with locally meaningful stories, materials, and practices to design learning experiences. In a Novel Engineering activity, the teachers identified relevant problems, such as poverty, and created tangible solutions using simple materials like paper, string, and toothpicks. Hands-on tasks, like building animals from LEGO, encouraged playful experimentation, sharing, and feedback once teachers were given time and support to explore unfamiliar materials. Material constraints prompted teachers to adapt standard kits by incorporating local resources such as leaves, bamboo, clay, and straw. The teachers also had to organize the kits in huge boxes and distribute them to different rural locations from the town center at Resunga municipality.



Figure 30: Teachers organizing learning kits for distribution to the rural sites and designing solutions using simple materials in a Novel Engineering activity.

Key Insights

1. **Local leadership strengthens implementation:** In Hetauda, partnering with

local educators was critical to meaningful engagement. Hiring a local, Safalta, as a coordinator and community mobilizer enabled consistent classroom observations and timely feedback. With support from Yukta Lal Bishwakarma, whose extensive teaching experience and connections with local government ensured diverse school selection, the project was grounded in local knowledge, trust, and institutional alignment. This reinforced the importance of community-based leadership for sustained impact.

2. **Flexible design overcomes distance:** In Gulmi, geographical barriers required restructuring the delivery model. Rather than replicating the original format, we consolidated sessions into intensive in-person workshops during three site visits and supplemented them with monthly virtual check-ins. Facilitators also adapted materials to local contexts. For example, selecting the culturally relevant Nepali story Sanu and the Storm for the Novel Engineering session to strengthen linguistic accessibility and cultural resonance.
3. **Virtual support sustains momentum:** Monthly virtual catch-ups created continuity between in-person workshops, offering space to discuss pedagogical ideas and reflect on challenges using the toolkits.

Phase IV: Co-designing Making Spaces with Mavericks

Introduction (June 2023 - July 2024)

Phase IV focused on increasing access to open-source resources that promote STEAM education through Making Spaces in Nepali schools. This allowed us to continue working with participants from previous phases. We worked with 3 public and 2 non-profit schools in Kathmandu, Kavre and Lalitpur throughout the year to support them in creating a making space and co-designing engagement programs for students. The local government and the schools co-funded the setup of these spaces.

Learning Community

We worked with 4 schools which we already had good relations with and one more public school was added by the recommendation of the Lalitpur local government. The co-design process began in collaboration with 2 teachers and 1 school leader from each school. There were 15 participants in total, out of which 8 were mavericks, defined as educators who went beyond scheduled sessions, stayed actively engaged with the teaching community, and invested significant time and effort in bringing playful learning experiences to their students..

Stages

1. **Co-design the space:** During the first two-quarters of the project, we focused on building the spaces. This included identifying available spaces in these schools, determining themes the schools wanted to focus on, designing 3D models of these spaces, and conducting teacher development sessions. These efforts helped the schools understand how to run a making space, figuring out values that helped

envision the making space, how to find resources for teachers and students, and ways to conduct both curricular and after-school programs in these spaces.

2. **Equip and Prepare:** Finding dedicated spaces in public schools was challenging. At Panchakanya School, the only option was a storage room with water tanks, while at Saraswoti Niketan and Shramjit School, we shared space with the library. At Saraswoti Niketan, we organized the cluttered library by designating one wall for books and another for making materials, with the center serving both purposes. Construction was completed within two months during vacations and off days, after which teachers finalized the space by lending hands in painting walls, arranging tables, and setting up activity stations.
3. **Bring the space to life:** After-school programs activated the making spaces, with schools like Saraswoti Niketan integrating Novel Engineering sessions into weekly activities and initiatives like Book-Free Fridays. At Niten Memorial, the school created a new role of Making Space Lead, for one of our teacher participants, which proved critical for structuring and sustaining the program as he structured grade-specific hands-on activities and trained senior students to support facilitation, ensuring continuity and student leadership. Peer visits across schools inspired new ways to display student work and share strategies, reinforcing engagement and playful learning while fostering collaboration among teachers.



Figure 31: Students and teachers collaborating to bring the making spaces to life, creating a vibrant environment for hands-on, playful learning.

4. **Document and Disseminate:** We created a making space toolkit with the objective of helping schools and organizations create their own making spaces (Refer to Appendix B for links to the resources).

Key Insights

1. **Teachers rediscover the joy of making:** Co-designing the making spaces allowed teachers to step out of their traditional instructional roles and re-engage as learners. This shift from delivering content to experimenting and exploring, revealed how making can rekindle curiosity and professional growth among teachers themselves.



Figure 32: Teachers enjoying being learners.

2. **Shifting teacher-student roles:** Moments emerged where teachers positioned themselves as learners. For example, Saradha sought help from her student to debug code and invited the student to modify it on her computer. Running the simulation together, they shared the success of producing the desired result. Such instances demonstrated how making spaces can flatten hierarchies and foster reciprocal learning relationships.
3. **Persistent hierarchies across grades:** Cross-grade interactions revealed entrenched hierarchies. Older students often positioned younger peers as assistants rather than collaborators, limiting opportunities for mutual learning. These dynamics underscored the need to intentionally structure collaboration to promote equity and shared agency.

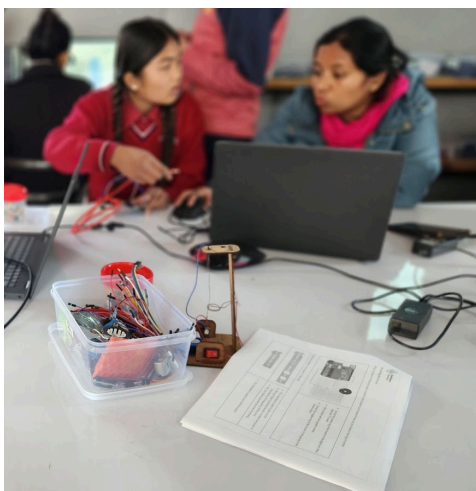


Figure 33: Contrasting moments in the making space: teachers learning alongside students in collaborative work, and cross-grade interactions where hierarchies persist.

4. **The importance of acknowledgment:** Student motivation was visibly affected when successful work went unrecognized. Brief or distracted responses from

teachers dampened excitement, pointing to the critical role of timely acknowledgment in sustaining engagement within playful, hands-on environments.

5. **Balancing structure and autonomy:** Teachers sometimes redirected students to strictly follow guided activities, even when students were creatively extending their work. While structure provides clarity, overemphasis on completion can inadvertently suppress exploration. Co-designing making spaces requires balancing curricular goals with room for student-driven innovation.
6. **Foundational skill gaps:** Basic digital literacy barriers such as unfamiliarity with browsers or difficulty in locating keys in a keyboard, surfaced unexpectedly. These challenges revealed the importance of scaffolding foundational skills when introducing technology-based making activities.

Phase V: Values to Vision

Introduction (December 2024 - July 2025)

As a continuation of Phase IV, we received funding from The Rogers Foundation to continue working with maverick teachers. We planned to work on multiple iterations of teachers' representations to share their evolving values and pedagogical commitments. We designed structures for the teachers to reflect on their personal as well as educational values to design tangible artifacts to communicate their values with the broader educational and school community.

Learning Community

We worked with 11 teachers: 3 from Phase I, 4 from Phase II, 2 from Phase IV, and 2 new participants.

Stages

1. **Explore design principles:** For almost all the teachers except Niki, an art teacher, concepts such as design aesthetics, principles of design, and design critique were entirely new. To help them get started, we created activity worksheets that allowed teachers to practice principles like continuity, balance, similarity, and closure. Additionally, a digital activity sheet in Inkscape enabled them to apply color theory: complementary, contrasting, analogous, and monochromatic, allowing teachers not only to understand design composition theoretically but also to actively learn and practice using a new digital tool.



Figure 34: Teachers exploring visual design principles through hand-drawn as well as digital worksheets, actively practicing and developing new digital skills.

2. **Visualize school values:** Teachers first created quick hand-drawn sketches to generate many ideas during the divergent phase and selected one during the convergent phase. They then transformed these sketches into digital artwork using Inkscape, a vector graphics editor. In a design critique session, we printed and distributed the latest versions of the designs for peer review. During the first 10 minutes, teachers silently rotated through each design as they spent two minutes per design to answer first-impression prompts such as: Which part of the design grabs your attention? What is most memorable? In the next 10 minutes, the focus shifted to design questions like: How do you feel about the color choices? Will it resonate with the intended audience? What elements would you add, remove, or clarify? After this structured review, teachers shared their feedback aloud while the design teams noted input for refinement. This turnwise, collaborative process not only refined individual designs but also strengthened teachers' collective capacity to notice salient design elements, critique constructively, and iterate thoughtfully.



Figure 35: A teacher's hand-drawn value tree sketch accompanied by peer feedback, illustrating iterative design and collaborative refinement.

3. **Co-design with designer:** The teachers collaborated with an artist to finalize their designs. As many teachers struggled with Inkscape in refining their designs, they connected virtually with the artist who made the necessary changes to the designs.
4. **Install and Celebrate:** Finally, the polished designs were printed, framed, and installed at selected sites, allowing students and teachers to engage with the visual

representations and spark discussions around school values. To celebrate the teachers' efforts, we organized a closing ceremony where the teachers presented their design journey along with their final designs with an audience that comprised teachers from other schools, representatives from the department of education, and educators from non-governmental organizations.



Figure 36: Students observing the installed value designs and engaging in discussion, reflecting on the meanings

Key Insights

1. **From abstract values to tangible representations:** Phase V revealed the power of making school values visible. What initially existed as words in documents, often unnoticed, became tangible, shared artifacts through collective reflection and design. Teachers revisited institutional histories, rediscovered foundational values, and reimagined how these could be represented meaningfully within school spaces. This process transformed values from abstract statements into lived, visible commitments.
2. **Design as professional growth:** For many teachers, concepts such as continuity, balance, closure, and color theory were entirely new. Although learning tools like Inkscape were initially challenging, the sessions expanded teachers' understanding of design aesthetics and digital literacy. Even those with no prior design experience reported a shift in perspective, seeing visual representation not as decoration, but as a powerful communication tool. The integration of art, culture, pedagogy, and technology enriched their professional identities and rekindled enthusiasm for teaching.
3. **Iteration through collaboration:** Translating complex ideas into digital formats proved difficult for many participants. Partnering with a visual artist/designer created an important bridge, enabling teachers to refine their concepts through multiple iterations. This collaboration modeled the very principles the project promoted: feedback, revision, and co-creation, demonstrating that meaningful design is an iterative and collective process.
4. **Inclusivity across disciplines:** The sessions were accessible to teachers of all subjects. Participants emphasized that the learning extended beyond art or design; it strengthened reflective thinking, enhanced presentation skills, and offered new ways to integrate aesthetics and values into classroom practice.