Silk Roots - A Design Template for Interdisciplinary Learning Projects

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Abstract

This paper introduces a design template for interdisciplinary project-based learning (PBL), utilising a design thinking approach, with the "Silk Roots" project as a case study. Traditional education often compartmentalises knowledge, limiting students' understanding of real-world complexities. In response to these limitations, the paper presents a comprehensive four-stage framework for the implementation of interdisciplinary PBL rooted in design thinking principles.

Empathise: The design process begins with identifying users and stakeholders, recognising teachers as designers. The primary user is the student, but the community and curriculum are also significant stakeholders.

Define: Students seek real-world relevance and complex systems understanding. The process of crafting projects must address these needs while promoting collaboration, diverse perspectives, and student agency.

Ideate: The context of the educational system, the desired learning outcomes and the practical realities inform the possibilities that can be envisaged.

Prototype: The implementation stage involves a student cohort studying the silk industry near Bengaluru, India, with teachers facilitating their exploration. A unique outcome is the facilitators' transformation into co-learners, enriching the educational journey.

Implement: The success of the "Silk Roots" project led to the creation of a generalised design template. The template supports a project designer through logistical and philosophical considerations. It begins with conceptualisation and definition of the project study area, logistics and planning, the process of student research and the final outcomes of the project.

While such interdisciplinary PBL experiences might have cultural and practical limitations, the larger learning outcomes justify their consideration.

Keywords: Design Thinking, Interdisciplinary Project-Based Learning, Student-Centered Education, Co-learning, Project Design, Curriculum Innovation, Problem-Solving, Student Engagement, Holistic Education, Educational Reform

1. Introduction

Traditional academic courses typically guide students through a linear trajectory, advancing from knowledge assimilation to conceptual comprehension to the demonstration of specific skills, often focusing on isolated topics (Peng et al., 2021). However, this compartmentalisation of knowledge into distinct categories can limit the appreciation and understanding of intricate, real-world systems (Henriksen et al., 2017). The historic focus in India has also been on examination proficiency and not necessarily real-world applicability of knowledge or skills. Mallya Aditi International School, established in 1984, aspires to educate its students beyond the examination as outlined in its philosophy and vision (as stated on the school website):

> "...urge the students to question the conventional, challenge theories, validate hypotheses and employ analytical reasoning. At Aditi, students have exposure beyond books and academia."
>
> "Aditi creates opportunities for students to become confident, thinking, independent individuals who are sensitive to diversity, aware of their heritage and able to face the challenges of their time."
>
> "...provides an education that is broad-based, encompassing a range of inter-connected disciplines."

The students of Mallya Aditi International School, hailing predominantly from upper-class families, are well-acquainted with the modern face of Bengaluru as a technology hub. However, they often remain largely oblivious to the deep-rooted silk industry, which is an integral part of Bengaluru's rich culture and tradition. This 300-year-old heritage thrives in the northern outskirts of Bengaluru, India, not far from the campus of Mallya Aditi International School, Bengaluru. This small-scale industry encompasses every step of silk production, from cultivating mulberry leaves to producing silkworms and cocoons, extracting silk fibres, to weaving fabrics.

In keeping with the vision and objectives of the school, the Silk Roots project was launched to achieve the following objectives:

1. Provide students an opportunity to collaboratively study a multidimensional entity through first-hand research
2. Facilitate interdisciplinary study and the appreciation of real-world complexity
3. Encourage appreciation for the history and heritage of Bengaluru and provide visibility to a heritage industry
4. Develop faculty capacity in guiding students in student research projects

1.1. The Design Thinking Approach

We opted for a holistic, design thinking approach (Panke, 2019; Razzouk & Shute, 2012) to craft an interdisciplinary project, enabling students to grapple with the intricacies of complex systems (Bender-Salazar, 2023). In this approach, students actively participated in defining the problems, generating potential solutions, and establishing methods for evaluating their work (Lor, 2017). Teachers assumed the role of facilitators, guiding the process, and learning alongside the students (Daws, 2005).

Our important primary aim was to meet the unique needs of our learners. We wanted to prioritise collaborative learning, break down silos in the mind and embrace an interdisciplinary approach. This also involved building in feedback cycles as and when needed during the process to foster an iterative course design. Furthermore, design thinking would allow us to craft a curricular template attuned to the specific context in which we planned to implement it (Design Thinking for Educators. 2018).

From a pedagogical standpoint, our application of the design thinking process allowed for fostering collaborative and creative problem-solving skills amongst the learners. This philosophy aligns with social constructivist, sociocultural, and relational theories of learning (Bandura, 1986; Vygotsky, 1978). Consequently, design thinking lends itself to pedagogical strategies that actively engage students with reflective, experiential and authentic learning experiences. Most importantly, design thinking plays a pivotal role in cultivating a design thinking mind-set among students. It encourages a shift away from the conventional, teacher-led approach to a more flexible and creative one that emphasises experimentation.

Our journey did not merely follow design thinking principles for knowledge discovery and understanding but also embedded capacity-building throughout the entire process. Learning experiences, collaborative activities, and creative problem-solving were interwoven into the fabric of the project. These activities nurtured competencies such as critical thinking, reflective learning, adaptability, effective collaboration, and systems thinking, ensuring a well-rounded educational experience that extends beyond the boundaries of traditional learning (Koh et al., 2015).

2. The Design Thinking Process

The five stages conventionally associated with design thinking helped provide a framework that allowed us to clarify, contextualise and communicate our intentions. The section below is a discussion on how the different stages of design thinking informed our design of the interdisciplinary learning project and culminated in the design template.

2.1. Empathise

The first step was to identify the ‘users’ or the stakeholders. The parallel identification of the teacher as the ‘designer’ makes the project immediately practitioner-based, with awareness of the scope and limitations of the curriculum and practical realities.

The primary ‘user’ of the learning project is the student. The pedagogical requirements and outcomes of the project can vary depending on the grade level of the intended students, the affiliated syllabus and cohort ability.

The second stakeholder we identified was the community. We believe that learning should be people-centric and help our students acquire a deeper understanding of the people they share space with. Project Based Learning (PBL) can help improve awareness and provide visibility to crafts, industries and cultural artefacts that often get relegated to the margins of public awareness.

As teachers, the third stakeholder we cannot ignore is the curriculum. Curriculum includes components that may be externally mandated (by government or by an academic board), institutionally designed, course specific or even teacher generated.

Thus the design of projects must factor in all of the aforementioned; it must balance the tension between the practicality and convenience of the compartmentalisation of subjects and the larger, more complex goal of interdisciplinarity.

2.2. Define

As teachers, it is incumbent on us to create and present opportunities to students where learning can take place. The process of designing a project must be primarily student-centred. In our experience, students seek opportunities to apply their learning to the real world, to study the complex real-world systems they encounter in their lived realities and not the simplified contexts presented in textbooks and syllabi. We, as teachers, similarly recognise that students need exposure to complex, information-rich inputs to learn how to process and solve multidimensional problems, build self-confidence and prepare them for real-world problem solving.

Students also need opportunities to develop and refine their ability to meaningfully and productively collaborate. Our conception of PBL necessitates collective sense-making. Students have room to work synergistically and combine their learning into a larger holistic picture, support each other's learning and appreciate diversity of experiences, learning and ability. The intended target of our PBL activities also aims to help students appreciate the value of the historic and the modern.

2.3. Ideate

The design of the project therefore began to take form organically starting from the principles outlined above. Some of the key points that were explicitly stated were:

- The process of discovery is more important than the final product
- All students cannot undergo the same process and therefore need differentiated support
- Directed learning must be avoided and teachers involved in the project will act as guides and facilitators
- Multiple perspectives must be considered at all levels of study
- Students must collect data and collectively arrive at conclusions
- Students must be able to communicate their learning

These tenets were arrived at collectively by the core team designing the project and were shared with all participating faculty. These become not just design principles for the project, but also operational principles during the course of the project.

2.4. Prototype

A student cohort of 50 students guided by 9 facilitators engaged in a study of the silk industry situated in the outskirts of Bengaluru, India. The study was designed around the silk industry for two reasons:

1. The historic silk industry in Bengaluru has become effectively hidden from public knowledge by modern priorities like IT, biotechnology and the service sector. This is due to a number of factors including cultural visibility of the industry, its location, and the information the general populace and specifically, our students are exposed to.

2. The components of the industry are situated approximately an hour away from the school making the logistics of the project much easier. School buses can easily transport student teams to various study sites.

After the planning of the project (which will be detailed in the subsequent section) the participating teachers visited the various locations and processes involved in the silk industry with the help of local experts from the Indian National Trust for Art and Cultural Heritage (INTACH). Based on this visit, teachers identified different study areas, formed facilitator teams and created support structures for students to carry out their study. The study areas that were decided upon were the spaces and environments – biotic and abiotic components – associated with the industry, the mapping of human interventions in biological processes for economic gain, the communities that participate in this industry, and the process and its economics. Teachers facilitated student teams using their expertise in their respective disciplines as well as in disciplines unfamiliar to them. This study had dedicated time in the academic schedule for visiting the study site and collecting data, and analysing and discussing findings. Research groups documented their process, observations, measurements, findings and conclusions. They made presentations within the group and to other groups to share knowledge and help construct a cohesive and holistic picture of the industry.

2.5. Implement

The success of the project "Silk Roots" led to the creation of a generalised design template that considers the logistical sequence of events and pedagogical underpinnings in the planning and execution of interdisciplinary project-based learning. The formalisation of this process, in no way rigid or immutable in structure, was carried out in the hope that it will empower more teachers to design their own interdisciplinary project-based learning explorations at different academic levels and scales. The design template is structured as four stages which will be described below.

2.5.1. Stage 1

The project begins with the constitution of a core team that shares passion for the topic or theme of the project. In our experience, we find that members with very diverse skill sets and a willingness to take risks strongly support interdisciplinarity by design and promote a problem-solving approach to the planning and execution of the project. The vision of the core team and the definition of the learning outcomes is the starting point for interdisciplinarity. The selection of the intended student cohort is an important choice that factors in student workload, and background knowledge and skills. This leads to the definition of the intended learning outcomes that are strongly associated with the student cohort, the area of study, and the desired curricular and co-curricular learnings. The core team also envisaged the entire project as a co-learning process where teachers (who might be inexperienced in investigative projects or working in unfamiliar disciplines) and students engage in discovery-based learning.

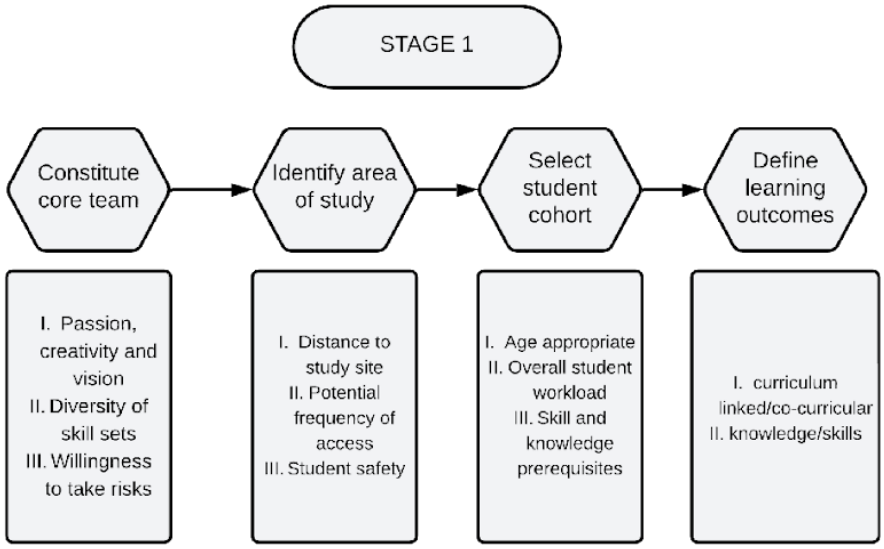

Fig 1. Stage 1 of project design: conceptualisation and definition

2.5.2. Stage 2

The second stage involves the administrative and pedagogic processes prior to student involvement. A successful project is built on support from the larger administrative framework at a school. This includes the scheduling and timetabling of project work hours for students and faculty, allocating budget to execute the project and devising a student safety plan. Once administrative permissions are received, there are several parallel actions that were taken.

The project timeline creates practical constraints that limit and guide the scale of work that can be carried out. This includes the number of visits to the study site and their frequency, and the frequency of meetings between students and facilitators and between facilitators. It also defines checkpoints for tangible submissions and sets deadlines for work by students.

Project based learning in external environments does often require the input of local experts and resource people. They will also help facilitate communication with the community directly involved in the area of work. The consent and collaboration of the local community is vital to obtain and school personnel may not be best suited to initiate these conversations.

Internally, the core team may also need to recruit additional facilitators. Maintaining the focus on interdisciplinarity requires team members from diverse disciplines with a willingness to work outside their area of expertise, a willingness to themselves learn alongside students and the ability to problem solve in unfamiliar contexts. This is important as real-world systems under study do not fit into neat boxes that can be compartmentalised as subjects. In our experience, all our colleagues who worked on the project did not necessarily understand what was meant by interdisciplinary study, however their work with students in this project enabled their learning as well.

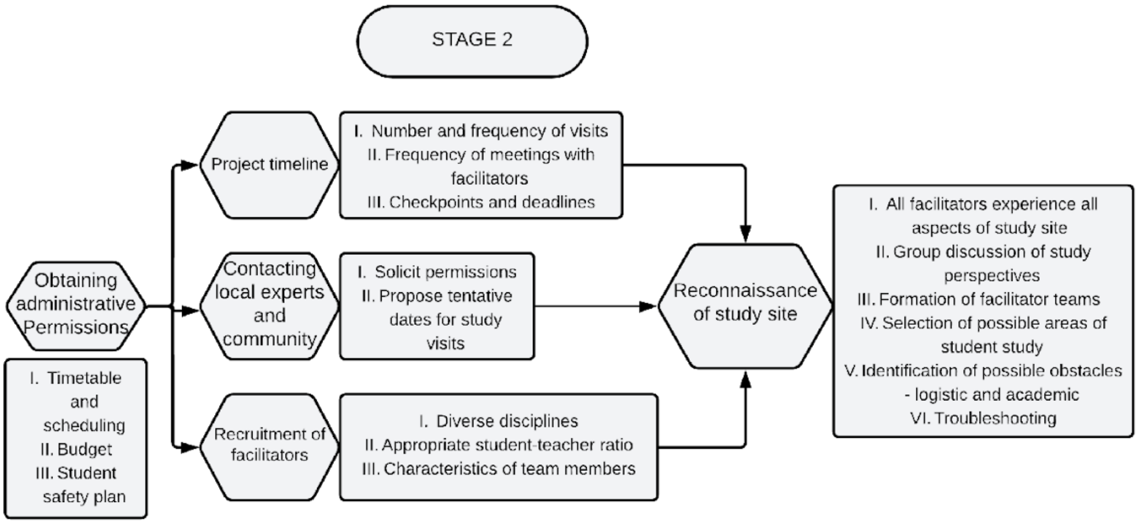

Fig 2. Stage 2 of project design: Logistics and planning; faculty onboarding

2.5.3. Stage 3

The third stage of the project is implementation with the selected student cohort. Since this template has been designed for high school students, typically minors, parent communication is a necessity. Parent buy-in and support also aids students in maintaining engagement with work over longer time frames. Therefore parents need to be given sufficient information – a concept note, the learning outcomes and the logistics – to give informed permission for the participation of their ward.

The involvement of students should begin with a brief introductory session, but care must be taken to communicate their ownership of the study and to not avoid creating preconceptions based on facilitator biases. In mixed group cohorts or contexts where PBL is not a frequent part of curriculum, it may be necessary to carry out some preparatory activities and exercises in observation and measurement, data collection and data analysis; this can be done on campus, even as a workshop, to pre-skill students. This will also help raise the average level of student efficacy in the project.

The student groups can be formed in several ways – random allocation, facilitator allocation, or student choice. Each group works with one or more facilitators. Facilitators can offer specific study areas based on their technical expertise or can have the student group propose the scope of their study. In both cases, all the students must first visit and observe the study site in its entirety. They can subsequently narrow their focus of study in discussion with their facilitator(s). They also identify the details of their study – sample sizes and the data/samples they will collect. This will be carried out on subsequent visits. The collected data or measurements involving the samples provides information that students must first analyse on their own, following which facilitators can help evaluate the findings. This discussion with the facilitators is important to help students understand the bigger picture, but should not be done prematurely to provide opportunity to foster student agency and hone their skills.

After the student group discussion with their facilitator, there should be a facilitator coordination meeting. This is required for the sharing of expertise among the facilitators, enables problem-solving and helps the project facilitator team construct the overarching narrative of the project. This also scaffolds the entire project for the facilitators and students, helps with resource allocation and planning the way forward. This process of data collection, analysis, discussion, evaluation and coordination is done in a cyclic manner, as many times as required and is feasible. This culminates in each group having developed coherent, evidence-based narratives or conclusions.

An interesting outcome of the process was the evolution of the facilitators as co-learners. Teachers navigated uncharted territory alongside the students. Nearly half the facilitators involved in the project were working in areas outside their domain. They were guiding student teams while also generating their own knowledge of the specific study area, the academic domain of their study and the pedagogy of facilitating PBL. Much of this learning came from the knowledge produced through research by the student team or arose organically through their interaction with the team. Consequently, the educational journey transforms into a two-way co-learning process, where both students and teachers engage in a reciprocal learning process.

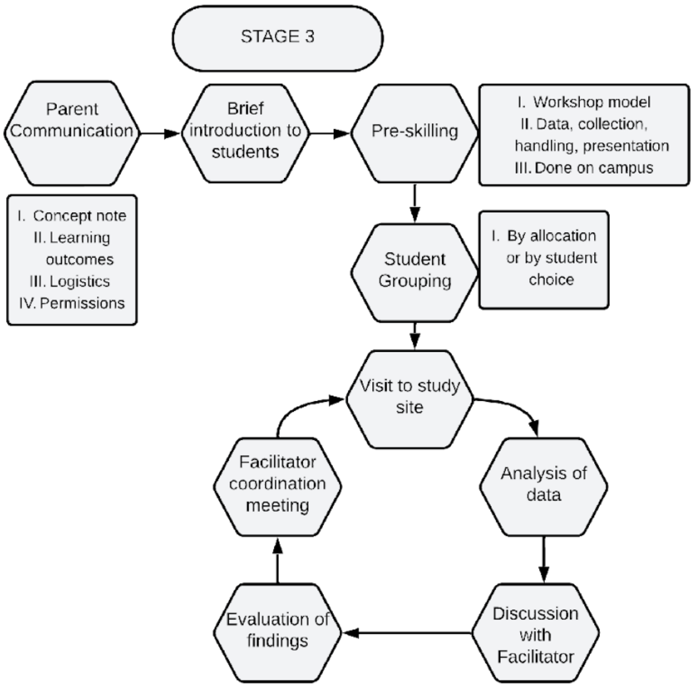

Fig 3. Stage 3 of project design: Student research

2.5.4. Stage 4

The fourth and final stage is the communication of individual group outcomes, the collective project outcome and evaluation of the project as a whole. Student groups have previously studied individual elements of the research area and now have to communicate and integrate their learning. This can be done through presentations and discussions complemented by peer evaluation. The planning for the final presentation must first identify the target audience – internal audience, larger school community, general public - and mode of presentation. This must also factor in the timeline to prepare students and materials, the logistics involved and ample time to set up and/or rehearse.

The final presentation should ideally communicate the process, outcomes and student reflections. Different modes of presentation will prioritise these differently and via different media, visuals and experiences. The last step is a necessary debrief. Student feedback is vital to improving the experience and refining the process for subsequent cohorts. This is combined with project evaluation by the facilitators and the core team in the final report. This is important and necessary institutional documentation for the institutional portfolio and for future ventures.

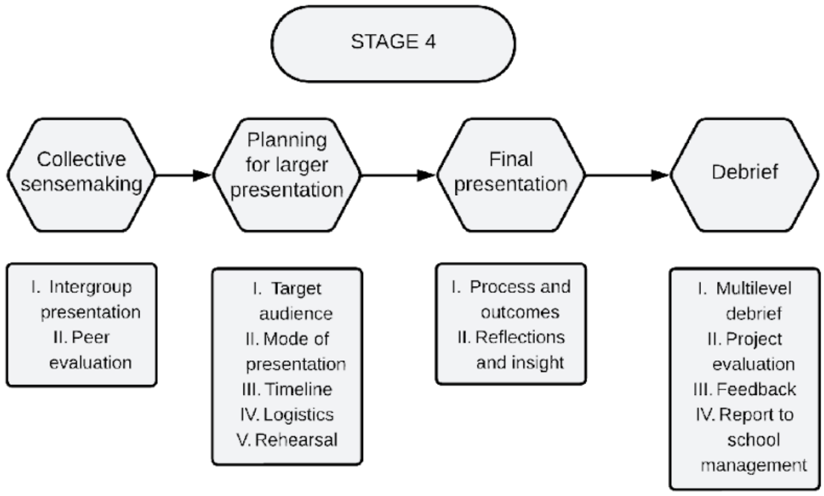

Fig 4. Stage 4 of project design: Collective sensemaking, presentation and final documentation

3. Conclusion

We advocate for the integration of culturally relevant and interdisciplinary teaching practices as a driving force within an institutional curriculum. The design template we have produced has broad applicability - transcending age groups, and geographical and cultural boundaries. It offers a versatile framework that can be implemented across diverse educational settings worldwide. It is not envisaged to be immutable, but offers a starting point and general framework that should be adapted to the specific needs, outcomes and realities of a given project.

This template however presupposes high intrinsic motivation among the organisers and facilitators. Interdisciplinary projects require multiple facilitator inputs, additional time and resources and enhanced engagement with students. This design template also seeks to facilitate the co-learning of teachers and create an environment for the development of pedagogical skills and knowledge. These add to the pre-existing demands on teachers that may not be healthy or viable. The considerable infrastructural requirements necessitates substantial institutional support and an understanding of the value of such learning experiences, which may not always be present. Sustaining student motivation through the duration of the project, especially when allocated time is limited to once or twice a week, is a challenge. In examination-oriented systems, students may view the time spent on the project as detrimental to their short-term academic success.

Despite these limitations, the benefits of interdisciplinary PBL, stated at the outset, can motivate educators to design such learning experiences. These equip the institution, teachers and students with the skills necessary to address novel challenges. By approaching these issues from a human-centric perspective, they can reframe problems, shedding light on what truly matters to their specific user groups. This approach transcends cultural and regional differences, ensuring that the core principles of effective and meaningful education remain universally applicable.

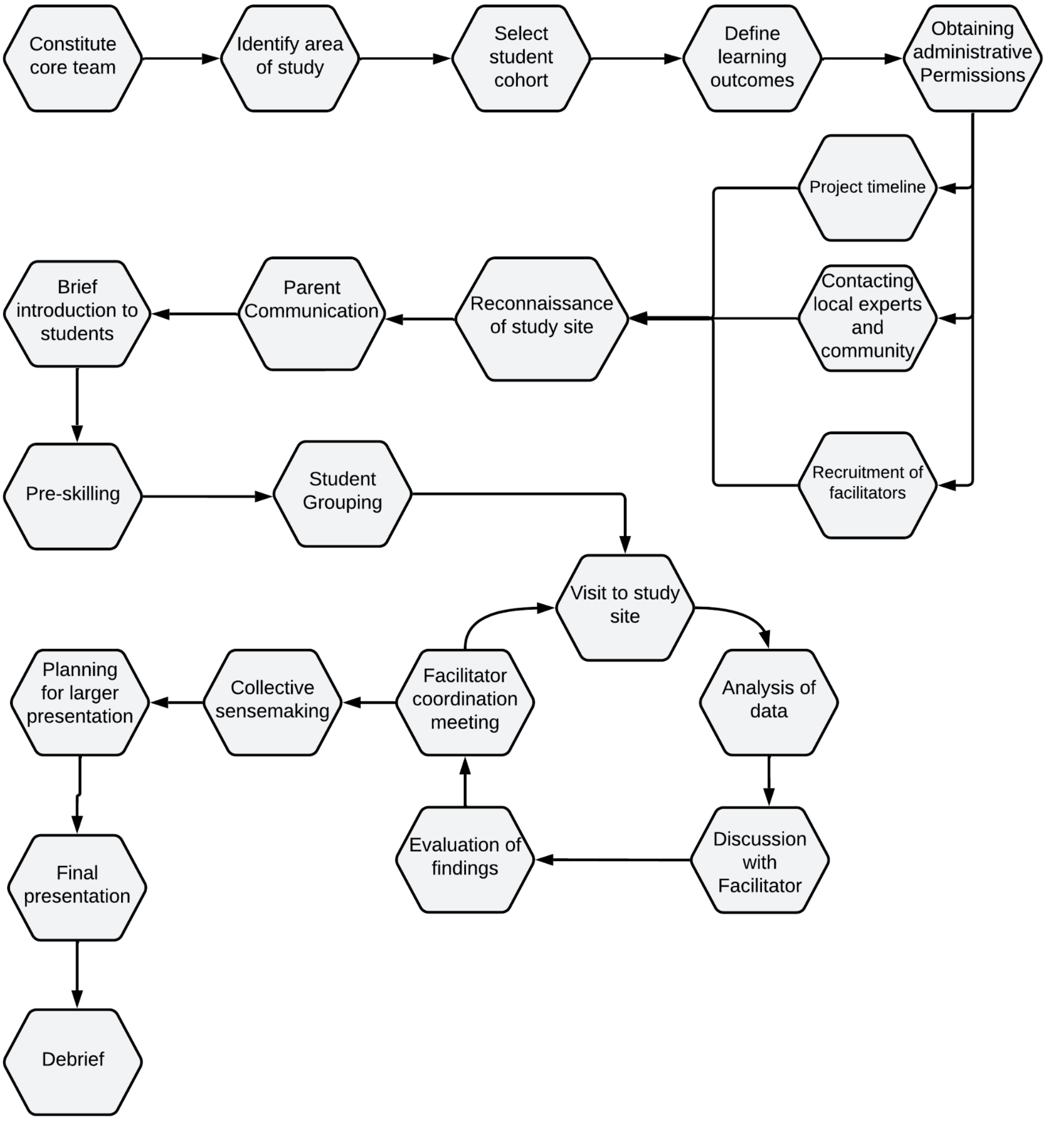

Fig 5. The project design template

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