Decolonising Engineering Education through Locally Relevant Problem-based Learning: A Reflective Analysis of the Bambasonke Design Challenge Toolkit Implementation

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***Abstract*— The decolonization of engineering curricula in South Africa requires pedagogical approaches that connect academic learning with local socio-technical challenges. This paper describes the development and implementation of a Bambasonke Design Challenge Toolkit (DCT), a locally relevant Problem-Based Learning resource. Using Gibbs' (1988) reflective cycle as an analytical framework, we analyzed the simultaneous pilot implementation of the DCT across two South African institutions during 2024: an introductory civil engineering course at a Traditional University (119 students) and a communications course at a University of Technology (35 students). Data were collected through structured reflective conversations between implementing researchers and analyzed using inductive thematic analysis.**

Our findings reveal both significant challenges and promising outcomes. While real-time material development created pressure on educators, students demonstrated enhanced engagement with contextually relevant problems and improved understanding of relationships between social and technical systems. The contrasting experiences across institutional contexts highlight the toolkit's adaptability, while revealing critical implementation factors including adequate preparation time, appropriate class sizes and institutional support structures.

This work contributes practical insights into developing locally relevant PBL materials for decolonizing engineering education, demonstrating both the transformative potential and implementation realities of context-specific pedagogical approaches.

Keywords—Engineers Without Borders, Problem-based Learning, Reflective Analysis, Decolonizing Education

I. Introduction

The decolonization of engineering education in South Africa represents both a moral imperative and a practical necessity for the development of graduates who can address local challenges effectively [1]. This movement emerged from recognition that engineering curricula, often derived from Western contexts, frequently fail to engage South African students with the realities and complexities of their immediate environments [2]. This disconnect between academic learning and local realities prompts calls for more contextually relevant pedagogical approaches that can bridge the gap between technical knowledge and social understanding.

The BambaSonke Design Challenge centers on a 30-minute documentary video showcasing real-world challenges faced by informal settlement residents in Cape Town, South Africa, including water access, security, and infrastructure issues. The accompanying Design Challenge Toolkit (DCT), developed through collaboration between the Innovative Engineering Curriculum (IEC) initiative and Engineers Without Borders South Africa (EWB-SA), provides implementation guides, supporting materials, and assessment frameworks to facilitate locally relevant Problem-Based Learning experiences.

Using Gibbs' (1988) reflective cycle as our analytical framework, this paper examines our parallel implementation of the DCT across two institutions during 2024, providing practical insights into both the transformative potential and implementation challenges of context-specific pedagogical approaches for decolonizing engineering education.

II. Problem-Based Learning for a Decolonised Curriculum

Educational decolonization in the South African higher education context refers to the process of challenging and transforming educational structures, content, and pedagogies that perpetuate colonial knowledge systems and power relations [3]. In engineering education specifically, this involves moving beyond curricula that primarily reflect Western technological solutions toward approaches that recognize and integrate local contexts, indigenous knowledge systems, and community-identified challenges. This imperative gained particular urgency following student movements such as #RhodesMustFall and #FeesMustFall, which highlighted the persistence of colonial epistemologies

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and demanded more inclusive, locally relevant educational approaches.

Amidst this, Problem-Based Learning (PBL) emerges as a promising pedagogical framework for engineering education that addresses calls for more contextually relevant and student-centered approaches. Schmidt et al. [4] describe PBL as an instructional method where students acquire knowledge and develop skills through facilitated problem-solving. They advance PBL as a cognitive constructivist approach that aims to help learners construct mental models relevant to problems while acquiring knowledge within specific domains.

On the other hand, Hmelo-Silver [5] portrays PBL as focused, experiential learning organized around the investigation, explanation, and resolution of meaningful problems. They explain students work in small collaborative groups while learning what they need to know, to solve a problem. Despite having different theoretical emphases, both perspectives [4; 5] converge on several key elements that characterize the PBL process. These include 'problems' serve as triggers for learning through ill-structured or complex, and open-ended challenges designed to activate students' prior knowledge; students collaborate in small groups; learning occurs under facilitated tutor guidance; curricula include time for self-directed learning; and reflection on problem-solving and learning relationships are emphasized throughout the process [4; 5]. This suggests that PBL can achieve multiple interconnected goals including developing flexible knowledge, effective problem-solving skills, self-directed lifelong learning skills, effective collaboration skills, and intrinsic motivation [4; 5]. These characteristics position PBL as potentially aligned with decolonized pedagogical approaches as, based on the foregoing, it is apparent that PBL emphasizes collaborative knowledge construction, contextual relevance, as well as student agency in learning processes.

Notably however, research of Mitchell et al. [6] proposes that alongside disciplinary content coverage, PBL fosters the development of transferable skills. This claim faces substantial criticism from other educational researchers [8; 9; 10;11], who question PBL's effectiveness in developing truly transferable competencies and adequate knowledge foundations. For instance, Kirschner *et al*. [8] argue that PBL violates fundamental principles of human cognitive architecture by requiring novice learners to simultaneously manage problem-solving processes while acquiring new knowledge. They assert that this leads to cognitive overload that impedes effective learning. Supported by cognitive load theory, they caution that minimal guidance approaches like PBL overwhelm students' working memory capacity, particularly for those lacking substantial prior domain knowledge [8]. Furthermore, Alfieri *et al*. [10] directly contradict Mitchell's [6] claims, as they found a small, but significant-sized negative effect (d = -0.38) in their research, meaning students trained with traditional approaches, and who received explicit instruction, performed slightly better than students who were only exposed to unassisted learning approaches.

Similarly, Dochy *et al*. [11] analysed 43 empirical studies and found "*a tendency to negative results when considering the effect of PBL on the knowledge of students*". This suggests that while some skills application benefits may exist, PBL students consistently acquired less foundational knowledge than their traditionally taught counterparts. In addition, other research [12] demonstrates that skills developed in PBL contexts often remain context-specific, with students struggling to apply problem-solving strategies to dissimilar domains. This transfer failure occurs because novice learners lack the prerequisite domain-specific knowledge necessary for effective analogical reasoning across contexts [13]. Ultimately, these findings raise important questions about whether PBL can effectively support decolonized engineering education. Instead research [10; 11; 12;13] implies that it fails to provide students with the robust knowledge foundations needed to critically engage with and transform existing disciplinary structures.

From a social realist perspective, Wheelahan [14] provides a particularly damaging critique of approaches that displace theoretical knowledge (such as PBL), in favour of workplace relevance. She argues such pedagogical shifts exclude students from accessing the specialized knowledge necessary to participate meaningfully in societal debates and professional discourse. Her analysis of competency-based training models, which share structural similarities with PBL's emphasis on applied learning, demonstrates how these approaches can systematically disadvantage students by denying them access to what she terms "*powerful knowledge*" [14]. This critique is especially pertinent for engineering education, where the boundaries between theoretical and everyday knowledge are key to developing professional expertise and maintaining disciplinary coherence [15]. The social justice implications of Wheelahan's contentions [14; 15] are significant. A knowledge-light curricula effectively reproduces educational inequality by providing working-class students with procedural skills while reserving theoretical knowledge for more privileged cohorts [14; 15; 16].

Foregrounded by this, Case [17] offers a more nuanced perspective on the knowledge versus student-centered learning debate in engineering education. She argues that these positions are "*unproductively seen as polarities*." Her research suggests that effective engineering education requires conceptualizations that understand higher education as "*a crucial encounter of the student with knowledge*" that is fundamentally transformative [17]. Case acknowledges that many calls for PBL fall within a longer and broader tradition of progressivism in education, however she argues for more sophisticated approaches that integrate knowledge-centered and student-centered concerns [18]. Her work suggests that while PBL approaches require careful consideration of their knowledge implications, the solution may not be a wholesale rejection of PBL. Rather, a more thoughtful implementation of PBL that ensures adequate attention to disciplinary knowledge structures [17] might be appropriate.

Despite the above-mentioned criticisms, proponents argue that PBL's emphasis on collaboration, empowerment, and inclusion aligns with decolonized pedagogical principles. They contend that these core values can be enhanced through digital technologies and locally relevant contexts to create more equitable and culturally responsive learning

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experiences. Research [6; 7] demonstrates that PBL's effectiveness lies in its capacity to present students with authentic, contextually relevant problems that activate prior knowledge while providing opportunities for elaboration, facilitating comprehension of new information and enhancing long-term retention [4].

Therefore, it can be assumed that the PBL pedagogical approach is particularly valuable for engineering education as it enables students to engage with real-world challenges while developing both technical competencies and essential professional skills required for contemporary engineering practice, though careful consideration must be given to implementation approaches that address the cognitive load and knowledge access concerns raised by critics.

Thus, building on PBL's purported capacity for authentic, contextually relevant problem-solving, this paper explores our experience developing and implementing the BambaSonke DCT across two South African higher education institutions during 2024. Using Gibbs' (1988) reflective cycle as our analytical framework, we autoethnographically examine both the successes and challenges encountered in creating and delivering locally relevant PBL experiences that ultimately aimed to contribute to the decolonization of engineering education.

III. Methodology

The Gibbs' reflective framework is a sequential six-stage cycle comprising Description, Feelings, Evaluation, Analysis, Conclusion, and Action Plan [8]. The framework provides a systematic approach to examining experiences through structured reflection, making it particularly valuable for analyzing complex implementation processes such as educational innovations. The cyclical nature of the model facilitates both emotional processing and analytical insight, which proved essential given the multifaceted nature of developing and implementing locally relevant PBL materials.

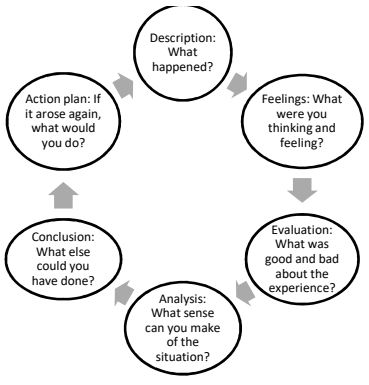


Figure 1 Gibbs' (1988) Reflective Cycle

A. Implementation context

The BambaSonke Design Challenge (DC) was implemented simultaneously at two different institutional contexts, namely a Traditional University (TU) and a University of Technology (UoT), both located in the Cape Town area in South Africa. The implementation occurred over one semester from July to November 2024. Through a collaborative partnership between the IEC team and EWB-SA, a case study was developed centered around a 30-minute video documenting informal settlement life in Cape Town, South Africa. The video showcased multiple perspectives on challenges faced by informal settlement residents, including water and sanitation access, security concerns, overcrowding, fire hazards, transportation issues, and other socio-technical challenges. This video content was embedded within a curated website developed by EWB-SA.

The parallel implementation across two different types of higher education institutions provided an opportunity to examine the toolkit's adaptability across varying learning objectives, class sizes, and institutional contexts. At the TU, the DC was integrated into a first-year design course, while at the UoT, it was implemented within a first-year communications course focused on interpersonal skills development.

B. Data collection and analysis

Data for this reflective study was gathered through a recorded conversation between the two researchers who implemented the DC at their respective institutions. The reflective session was conducted six months after the completion of the pilot implementations, allowing sufficient temporal distance to provide analytical perspective on the experiences while maintaining clarity of recall.

The reflective session was structured using Gibbs' six-stage framework and conducted via an online Microsoft Teams meeting. During the session, following a systematic approach, each participant shared their institutional experience sequentially through each stage of the Gibbs cycle. For instance, during the Description stage, the TU participant first described the events that transpired at their institution, followed by the UoT participant describing their parallel experience. This structured sharing was followed by collaborative discussion and analysis of similarities, differences, and emerging themes.

All sessions were recorded, transcribed, and analyzed using inductive thematic analysis. Initial themes were identified independently by both researchers and subsequently reviewed collaboratively with the broader research team to ensure analytical rigour and validation of findings.

IV. A Tale of two univeristies through the lens of Gibbs' Reflective Framework

A. Description

Guided by Gibbs' reflective framework, we commenced a systematic exploration of our respective implementation experiences, with particular attention to how PBL might support the decolonization of engineering curricula through contextually grounded, socially responsive learning. This stage focuses on establishing the factual foundation of what transpired during implementation at both institutions. By documenting the specific events, contexts, participants, and outcomes at each site, we created a comprehensive record that serves as the basis for our subsequent analysis and reflection.

The description phase addresses fundamental questions about what happened during our pilot implementations: the specific activities and processes that unfolded, the timing and

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locations of key events, the participants involved (both students and facilitators), the actions taken by various stakeholders, the immediate outcomes observed, our motivations for implementing the challenge, and our initial expectations for the experience. This detailed documentation from both institutional perspectives provides the necessary groundwork for understanding the complexities and nuances that emerged during our parallel implementation of locally relevant PBL materials.

1) Traditional University

Our implementation at the TU took place within an introductory civil engineering course comprising of 119 first-year students. Over the course of 12 weeks, students were introduced to fundamental engineering concepts while developing their understanding of urban metabolism and technical design through the lens of the BambaSonke case study video. The students were organized into teams of eight, creating a learning environment where collaboration was essential. Each team member initially focused on investigating different Sustainable Development Goals (SDGs), building individual expertise before coming together to identify the complex conflicts and synergies that exist between different development objectives in informal settlement contexts.

Throughout the semester, the learning experience was enriched by guest lecturers from industry and NGOs who brought real-world perspectives to complement the academic content. Students engaged with basic technical calculations related to civil engineering fundamentals while participating in human-centered design thinking activities that challenged them to consider both technical feasibility and human needs.

The assessment structure reflected this multifaceted approach through five distinct submissions. Students completed numerous mini-tasks individually before working in pairs on technical design reports focusing on specific infrastructure aspects such as transport, waste management, or water systems. These paired technical investigations culminated in a comprehensive team inception report that synthesized all the mini technical tasks into a cohesive analysis of the current situation, including population counts, existing infrastructure, and technical failures. Additionally, students submitted individual SDG reports and delivered a final human-centered design team presentation, demonstrating their ability to integrate technical knowledge with design thinking principles

2) University of Technology

In contrast, our implementation at the UoT created a more intimate learning environment within a communications course of 35 students. This smaller class size facilitated deeper interactions and allowed for more personalized attention to individual student development needs.

The 12-week journey began with the same powerful video introduction, but the subsequent learning path diverged significantly from the TU approach. Students first explored the fundamental question ‘What is an engineer?’ through a visualization exercise where they imagined themselves as future engineers with strong communication capabilities. This foundational reflection, developed collaboratively with the students, shaped the decision to pursue diverse assessment formats including reports, presentations, artistic expression, and social media content.

The DC unfolded as a series of interconnected lessons. In lesson one and two students explored the SDGs framework, developed problem identification skills through root cause analysis using Ishikawa diagrams and the ‘5 Whys’ technique, and engaged with design thinking methodology including interview techniques. A formative presentation of their problem analysis in lesson four which provided an opportunity for peer feedback and refinement of ideas.

Recognizing the importance of professional skills development, the course incorporated specialized lesson on conflict resolution and academic writing, delivered by the institutional Writing Centre. Perhaps most innovatively, students collaborated with an art student in a creative session (lesson 9) that challenged traditional boundaries between technical and artistic expression.

The assessment strategy reflected the course's communication focus through a self-reflection essay and oral presentation emphasizing SDGs and personal growth as individual submissions, complemented by collaborative group work that produced both an artistic artifact created from waste materials and a TikTok video. Notably, these assessment formats emerged from collaborative discussions with the students themselves, ensuring authentic engagement with the learning objectives while maintaining focus on developing professional communication competencies within an engineering context.

B. Feelings

Exploring our emotional landscape throughout this implementation reveals the deeply personal and often vulnerable nature of educational innovation. Our feelings before, during, and after the experience significantly shaped both the process and outcomes, while also influencing how students and colleagues perceived and engaged with the BambaSonke DC.

1) Pre-Implementation Emotions

Our emotional journey began well before students encountered the case study video. At the TU, the pre-implementation period was marked by overwhelming anxiety and a sense of inadequate preparation. As one researcher reflected: “*I was very under prepared when I came in and I was really overanxious. I was having like anxiety attacks through the whole thing because it was so disorganized*.” This anxiety stemmed from the recognition that we were attempting something ambitious with limited preparation time and unclear institutional support structures.

In contrast, the initial response at the UoT was one of excitement and discovery. The researcher described feeling immediately moved by the potential of the toolkit. “*I was really excited when I saw your video. I thought it was such an amazing video that moved me and I want to share that with [students]. I was also very, very happy and excited... I saw a*

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gap like I could use this in the communications class." This excitement was however tempered by nervousness about venturing into uncharted pedagogical territory, "*I was so nervous because I'd never done anything like that before. And I was feeling the pressure of the responsibility getting this right.*"

2) During Implementation Emotions

The emotional experiences during implementation diverged significantly between the two contexts. At UoT, there was a growing sense of comfort and mutual vulnerability, "*I could be vulnerable with [students]. There were certain things that I realized I do well. There were certain things that I realized I don't do well*."

This vulnerability created a democratic space where students felt comfortable sharing personal information. "*They are relaxed, they really are relaxed, and they tell me too much. The one student told me that he's made space muffins, and he was selling space muffins... But you forget -I'm the lecturer. You're* [the student] *telling me you're a drug dealer?*"

At the TU, the experience was different. "*My overwhelming feeling of it was just highly distressed through the whole thing*." In addition, the large class size and resource constraints created ongoing stress. "*I would pivot in the space in the class when things weren't working... And the tutors just had to catch up and it wasn't fair*."

3) Post Implementation Emotions

As we reflected the different experiences we had navigated, it became clear that the emotional repercussions of our implementations continued to diverge. At the UoT, there was a sense of pride in what had been accomplished and excitement about future possibilities "*I had so much pride when we did that last assessment... This year I'm really looking forward to doing more and doing it better.*" This positive emotional resolution suggested that both the process and outcomes had validated the initial excitement and risk-taking.

Conversely, at the TU, the post-implementation period was tinged with disappointment and emotional avoidance. "*To be perfectly honest, I didn't even want to look at it* [the feedback]. *That was how bad I felt about the whole exercise.*" This reluctance to engage with student feedback reveals the depth of emotional investment and the personal impact of perceived failure, highlighting how educator emotions can significantly influence our willingness to learn from challenging experiences.

Reflecting on our emotional journeys described above, we recognize that our feelings significantly shaped how we facilitated PBL within our respective contexts [4; 5; 8]. These emotions may also have influenced the extent to which the learning environments advanced our decolonial aims, particularly by mediating how vulnerability, authority, and agency were experienced by both students and educators in our respective contexts [6; 14; 17].

C. Evaluation

Having gained some analytical distance from the emotional intensity of our experiences, we now critically assess what aspects of the parallel implementations were successful and where they fell short. This evaluation involves an honest appraisal of both the strengths and limitations of our approaches. It also required reflection on how our facilitation of PBL contributed to, or constrained, the broader goal of curriculum decolonization.

1) What Went Well

The most significant success across both implementations was the power of contextual relevance in driving student engagement. Students at both institutions demonstrated genuine enthusiasm when working on challenges that connected directly to their immediate environment and social context. The authentic nature of the informal settlement case study helped students grasp the complex relationships between technical and social systems in ways that theoretical examples could not achieve. This engagement was particularly evident in student feedback and the quality of their final submissions, which showed deeper critical thinking about real-world engineering challenges.

The adaptability of the toolkit across different institutional contexts proved to be another major strength. Despite vastly different learning objectives and class sizes, the core challenge successfully accommodated both technical engineering skill development and communication competency building. This flexibility demonstrated that well-designed PBL materials can maintain their pedagogical integrity while adapting to diverse educational contexts and institutional constraints.

At the TU, the integration of guest lecturers from industry and NGOs was particularly effective. These external perspectives provided students with authentic exposure to professional engineering practice and complemented the academic learning environment in ways that enhanced the credibility and relevance of the challenge. Students consistently rated these sessions highly and referenced them in their final work.

Both implementations succeeded in developing professional skills within quasi-authentic contexts. Students engaged with teamwork, communication, and critical thinking in ways that traditional lecture-based approaches struggle to achieve. The multidisciplinary nature of the challenge required students to navigate complexity and ambiguity, skills that are essential for professional engineering practice but often underdeveloped in conventional curricula.

The smaller class size at the UoT revealed significant advantages for PBL implementation. The intimate environment facilitated personalized attention, stronger educator-student relationships, and more effective identification of individual learning needs. This context allowed for the kind of vulnerable, democratic learning environment that PBL advocates often describe but rarely achieve in larger settings.

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2) What Could Have Been Done Differently

Our most significant failure was inadequate preparation and scaffolding across both implementations. The real-time development of materials created unnecessary stress for both educators and students, resulting in students receiving incomplete information about expectations and assessment criteria. As one researcher reflected, "*What I could have done better is... it would have been nicer to give them some of the scaffolding before the time.*" This lack of preparation compromised the learning experience and placed unfair burdens on all participants.

Assessment design emerged as a persistent challenge requiring multiple iterations during implementation. The continuous revision of rubrics created uncertainty for students about evaluation criteria and undermined their confidence in the process. This highlighted our insufficient pre-implementation testing of assessment instruments and revealed how assessment complexity can overwhelm the learning objectives we intended to support.

At the TU, inadequate tutor training and support significantly compromised the quality of student facilitation. As noted, "*Any of these things... requires facilitation, not teaching, and we don't have the resources for that.*" The large class size exacerbated this problem, creating situations where unprepared tutors struggled to facilitate meaningful PBL activities, ultimately disadvantaging student learning.

Our decision to use eight-person teams at the TU proved counterproductive, leading to unequal participation where "*strong students were doing everything and weak students were doing nothing*." This team structure undermined the collaborative learning that PBL is designed to foster and created frustration for both high-achieving and struggling students.

Perhaps most fundamentally, we struggled with effectively integrating technical engineering content with broader professional skills development. There was persistent tension between ensuring students developed fundamental engineering knowledge while engaging with human-centered design aspects of the challenge. Neither implementation successfully resolved this tension, leaving questions about whether we were adequately serving either objective.

D. Analysis

Having evaluated what worked and what did not, we then turned to making sense of why these outcomes occurred. For this analysis we drew on our experiential knowledge alongside relevant academic literature discussed above to understand the deeper patterns and mechanisms that shaped our implementation experiences.

1) Resource Constraints and Pedagogical Innovation

Our contrasting experiences highlight the complex relationship between resource constraints and pedagogical innovation in South African higher education. While PBL is lauded for engaging students with authentic, contextually grounded problems that activate prior knowledge and promote elaboration [3], our experience revealed that this potential is highly dependent on institutional capacity.

The difference in scale between our two contexts, that is, 35 students at UoT versus 119 at the TU, demonstrated how smaller classes enabled facilitation aligned with PBL principles such as active tutor guidance and collaborative problem-solving [4]. In contrast, the large class size at the TU made such practices difficult to sustain. This raises fundamental questions about the scalability of decolonized pedagogical approaches in resource-constrained environments. In addition, we believe that this specifically resonates with the concerns of other researchers [8; 10]., that minimally guided approaches like PBL may overwhelm novice learners when resources are limited.

Our above-mentioned deduction aligns with Kirschner et al.'s [8] cognitive load critique, which argues that learners struggle when expected to manage both content acquisition and problem-solving simultaneously. The lack of adequate facilitation at the TU may have contributed to this overload. Furthermore, the absence of scaffolding, what Schmidt et al. [3] describe as "*flexible guidance*" raises critical questions about the scalability of decolonized pedagogies in under-resourced environments. Without structural support, PBL may inadvertently reinforce the very inequalities it seeks to address.

2) The Role of Vulnerability and Authenticity

One of our most significant analytical insights concerns the role of educator vulnerability in creating effective learning environments. The UoT experience demonstrated how an educator's willingness to admit uncertainty and learn alongside students created what could be characterized as '*cognitive congruence*' [3], which is the ability of the facilitator to express themselves in the language of students and create non-threatening learning environments.

This vulnerability appeared to be reciprocated by students, who became more willing to engage with difficult concepts and share their own uncertainties. Achieving this kind of authenticity requires more than methodological change [13]. It involves reshaping power dynamics that typically position educators as knowledge gatekeepers. Vulnerability can disrupt these hierarchies, allowing students to contribute meaningfully to knowledge construction. From a decolonial perspective, this represents a pedagogical shift that values local knowledge, emotional intelligence, and human connection as legitimate components of engineering education [1], [14].

3) Technical vs. Professional Skills Integration

Both implementations revealed persistent tensions between technical content delivery and the development of broader professional competencies. This challenge reflects what Mitchell et al. [6] identify as the "*multiple demands of contemporary undergraduate engineering education*" Our reflection revealed that the tension between technical and professional skills may be especially pronounced in decolonized contexts. Traditional engineering education typically separates these two domains of skills, making it

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fundamentally incompatible with the holistic, context-sensitive approaches we attempted. This experience supports calls for 'integrated PBL' [6]. Integrated PBL reconceptualizes how engineering knowledge is constructed and validated within local contexts, rather than simply adding social content to existing technical curricula. The difficulty we experienced in achieving this integration suggests that successful decolonization requires more than curricular modification. Rather, it demands epistemological transformation that challenges Western paradigms of knowledge compartmentalization.

4) Assessment in Decolonised Contexts

Consistent with the findings of our reflection on technical and professional skills, the iterative development of assessment criteria during implementation showcased what we now recognize as a fundamental incompatibility between traditional assessment approaches and decolonized educational contexts. PBL assessment should reward both process and outcomes, promoting intrinsic motivation rather than purely summative evaluation [5]. However, we encountered what might be termed an 'assessment lag' where our initial rubrics failed to accommodate emergent learning or support intrinsic motivation [13].

This mirrors concerns in the literature that summative, high-stakes assessment structures inhibit the epistemic openness required for decolonized learning [14]. Our experience underscores the need for responsive, formative assessment models that allow space for ambiguity, reflection, and multiple ways of knowing. Without such models, pedagogical innovations risk being undermined by inflexible evaluation systems.

5) Institutional Context and Change

Perhaps most significantly, our analysis reveals how institutional contexts fundamentally mediate the implementation of decolonized pedagogical approaches. This institutional mediation suggests that decolonizing engineering education cannot be achieved through curriculum changes alone. Instead, it requires what we describe as 'systemic decolonization'. Systemic decolonization addresses resource allocation, class size policies, assessment frameworks, and institutional support for innovative pedagogical approaches. Our experience demonstrates that without such systemic change, even well-intentioned pedagogical innovations may reproduce the very constraints they seek to address.

E. Conclusion

Reflecting on our overall journey implementing the BambaSonke DCT, we are now able to articulate specific learning that has fundamentally shifted our understanding of what it means to develop and implement locally relevant PBL materials in South African engineering education contexts.

Several key insights emerged from our reflection. Ostensibly, the most profound learning concerns the intricate relationship between educator preparation, institutional context, and pedagogical success. We learned that good intentions and innovative content are insufficient without adequate preparation time, appropriate class sizes, and institutional support structures. The stark contrast between our experiences taught us that PBL is not simply a methodology that can be dropped into existing educational frameworks. Instead, it requires systemic alignment of resources, expectations, and relationships.

We also learned the transformative power of educator vulnerability and authenticity in creating learning environments where students feel safe to engage with complex, ambiguous challenges. This was particularly evident at the UoT, where admitting uncertainty and learning alongside students created a democratic space that traditional teacher-student hierarchies rarely achieve.

Perhaps most importantly, we learned that decolonizing engineering education through locally relevant content requires more than curriculum modification. It demands epistemological transformation in how we conceptualize knowledge construction, assessment, and the purpose of engineering education itself.

1) Opportunities for Development

With hindsight, we can identify several changes that would have significantly improved the experience for all participants. Adequate preparation time emerges as the most critical factor. Had we dedicated 3-6 months to pre-implementation planning, including development of assessment rubrics, tutor training materials, and student scaffolding resources, we could have prevented much of the stress and confusion that characterized both implementations.

Smaller class sizes or team-teaching approaches at the TU would have enabled the kind of relationship-building and individualized attention that proved so effective at the UoT. If institutional constraints made smaller classes impossible, co-teaching with additional facilitators could have provided more appropriate student-to-educator ratios.

Comprehensive tutor training focused specifically on PBL facilitation rather than content delivery would have dramatically improved the quality of student support. This training should have included practice with facilitating small-group discussions, managing conflicts, and providing formative feedback on ill-structured problems.

Finally, collaborative assessment design involving students in developing evaluation criteria could have reduced the uncertainty and multiple iterations that frustrated participants. Such co-creation aligns with decolonized pedagogical principles while ensuring assessment approaches match learning objectives

2) Skills for Future Implementation

Our reflection reveals several areas where we need to develop greater competency. We need to better plan timelines, resource requirements, and risk mitigation strategies for future implementations, thus we believe project management skills specific to educational innovation are essential for future implementation.

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We also need to develop facilitation skills that go beyond traditional lecturing. This includes learning how to ask powerful questions, manage group dynamics, provide effective formative feedback, and create psychologically safe learning environments where students feel comfortable engaging with uncertainty.

Assessment literacy in PBL contexts requires further development. We need to understand how to design rubrics that capture both process and product, how to balance individual and group assessment, and how to create evaluation approaches that reward the kinds of learning PBL is designed to foster.

Perhaps most critically, we need to develop change management skills that help us navigate institutional resistance, resource constraints, and the complex politics of educational innovation in higher education contexts.

F. Action Plan

Based on our forgoing reflective analysis, we identify several priorities for future development and implementation of the BambaSonke Design Challenge Toolkit, however they should be achievable changes that work within our institutional constraints rather than against them.

1) Working within our reality

Building on our 2024 learnings, in 2025, we continue our pilots at the UoT and TU, and are implementing at one additional TU. At the new TU, all first-year students across all engineering disciplines (approximately 1,300 students from Chemical Engineering, Civil and Biosystems Engineering, Electrical Engineering, Electronic Engineering, Computer Engineering, Mechanical and Aeronautical Engineering, Industrial and Systems Engineering, Metallurgical Engineering, and Mining Engineering) will participate. This represents our most ambitious implementation to date.

At the UoT, we have shifted from first-year communications to final-year Work-Integrated Learning (WIL) students (approximately 300 unplaced students from Industrial Engineering, Mechanical Engineering and Mechatronics, Civil Engineering and Geomatics, Construction Management and Quality Surveying, Clothing and Textile Technology, and Chemical Engineering). This change addresses our identified challenge of integrating technical and professional skills by working with students who already have substantial domain knowledge.

Most innovatively, at the TU where we piloted in 2024, the student number has doubled. The course is being restructured around what the lecturer describes as a ‘quest’ approach. That is, the course will be organised around team formation by identifying needed skills, site-based challenges and will incorporate artistic elements with assessment based on critique quality. This gamified approach directly addresses several challenges we identified without requiring additional institutional resources.

Most significant, a key difference for our practice in 2025 is dedicated preparation time. We are using semester breaks to develop core materials, assessment rubrics, and scaffolding resources during vacation periods when we have concentrated time blocks, rather than attempting real-time creation during implementation.

2) Realistic skills development and accountability

Moreover, in 2025 we implemented informal peer observation and when possible and provide feedback on our peers’ facilitation approaches. Additionally, EWB-SA has appointed a research assistant to support our work. The new TU has also appointed a research assistant to assist with the implementation in 2025. With the assistance of the two research assistants, we are able to maintain brief weekly reflection notes during implementation. This creates a real-time feedback loop without overwhelming our existing responsibilities.

V. Closing Thoughts

Our application of Gibbs’ reflective cycle to the BambaSonke DC implementation has highlighted the complex realities of implementing locally relevant PBL as a vehicle for decolonizing engineering education in South African contexts. Through the systematic examination of our experiences across two institutional settings, we gained valuable insights into both the transformative potential and practical limitations of pedagogical approaches that attempt to bridge the persistent disconnect between academic learning and local socio-technical realities.

The stark contrasts between our implementations illuminate how resource availability, class sizes, and institutional culture fundamentally shape what decolonized pedagogical approaches can potentially achieve in practice. While our implementations faced significant challenges, the enhanced student engagement with contextually relevant problems and the development of professional skills in authentic settings demonstrate the capacity of such approaches to address local challenges when thoughtfully adapted to institutional realities.

Our reflective analysis reveals that the moral imperative to decolonize engineering education must be balanced against the practical necessity of working within existing institutional structures. The journey from idealistic aspirations toward pragmatic strategies for meaningful educational change requires not only innovative content that connects students with their immediate environments, but also realistic preparation, appropriate resource allocation, and sustainable implementation approaches.

Most critically, our experience demonstrates that successful curriculum decolonization demands systemic transformation rather than isolated pedagogical interventions, challenging us to reconceptualize how engineering knowledge is constructed, validated, and transmitted in postcolonial contexts. This understanding positions our work as a contribution to the broader project of developing graduates who can effectively address the socio-technical

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complexities of contemporary South African engineering practice.

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