

Exploring the Entanglement Between Technology and Pedagogy: A Case Study of Knowledge Building

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Abstract: Does technology drive pedagogy, or should pedagogy guide technological integration in teaching and learning? This paper, by examining teachers' implementation of Knowledge Building (KB), argues that this dichotomy inadequately describes the intertwined nature of teaching and learning, especially in approaches like KB. Technologies such as the Knowledge Forum® (KF) are crucial for capturing students' idea development over time, and most KB teachers consider KF a vital tool. However, there is limited understanding of how teachers use KF for KB, and how this shapes KB in classrooms. This study, part of a multi-case investigation aimed at characterising KB design and enactment in Singapore, highlights (a) variability in teachers' KF usage, (b) the presence of several reinforcing barriers to technology integration, and (c) how these barriers influence KB enactment. The analysis showed that three out of five observed teachers faced significant barriers to KF integration, which constrained their KB practices. This study advocates for exploring the 'entangled pedagogy' concept further and invites discussion on how principle-based educational approaches like KB are affected by various contextual factors.

Keywords: Technology integration, barriers to change, Knowledge Building, entangled pedagogy

1. Introduction

The Knowledge Building (KB) educational approach immerses students in a knowledge-creating culture (Scardamalia & Bereiter, 2006). While teachers can initially implement KB without technology, most will eventually use computer-supported collaborative tools like the Knowledge Forum® (KF) to advance students' knowledge (Tan, 2022). The KF serves as a key online communal space, enabling KB's socio-cognitive and technological aspects (Scardamalia, 2002), offering more affordances for KB than a physical classroom alone (Tan, 2022). Additionally, effective KB implementation requires more than a mere understanding of the KF's features; teachers must adapt their instruction to their students' progress and use the twelve KB principles to guide their KB. This challenge has led to an articulated demand for practical implementation guidance. In this vein, a meta-lens was proposed to analyse KB design and lesson enactments. Consequently, the findings illuminated the presence of an entangled pedagogy in how teachers considered and used KF and other elements, and suggest that impactful KB design and implementation reflects an aspirational view of entangled pedagogy (Fawns, 2022).

2. Literature Review

This section outlines the intended affordances of the KF and its role in supporting KB. To illustrate how we identified the barriers to changes in teachers' use of KF, we briefly explain the theoretical basis of our meta-lens. We then examine the implications of presence of barriers to technology integration, discuss the concept of entangled pedagogy, and conclude

by listing the research questions for this study.

2.1 Role of the Knowledge Forum® in Knowledge Building

The intended affordances of the KF were derived from, and tightly coupled with KB principles (see Tan, 2022, pp. 58-60 for a detailed mapping). The KF affords a shared digital space for students to engage in knowledge building discourse – the epistemic way of talking and thinking which is critical to KB. By enabling students to flexibly construct and externalise their ideas on a communal space through a myriad of modalities, the KF grants students' ideas the property of permanence, and facilitates the creation, sharing and the collective advancement of student idea.

2.2 Theoretical Basis of the Meta-lens

The Cultural Historical Activity Theory (CHAT) (Engeström, 1999) and orchestration graphs (Dillenbourg, 2015) are used to describe, visualize, and analyse Knowledge Building (KB) enactment at the activity system and lesson levels. CHAT activity systems comprise 6 nodes: subject, object, community, mediating tools, rules, and division of labor. 4 types of contradiction can occur within or between these nodes: primary, secondary, tertiary, and quaternary. CHAT posits that internal and external contradictions in activity systems highlight challenges impeding the activity's object attainment (Yamagata-Lynch, 2010). Organisation graphs model learning activities' pedagogical relationships across time and interaction planes, enhancing KB activity understanding by detailing teachers' lesson-level pedagogical structures. This meta-lens affords a tiered, comprehensive analysis integrating (1) a zoomed-out holistic understanding of situational factors shaping teachers' KF usage, (2) a zoomed-in observation, description, and analysis of teachers' KF usage at the lesson level, and (3) an examination of the alignment between the first two tiers, and how KF usage shapes enacted KB.

2.3 Barriers to Change in Technology Integration

Ertmer (1999) categorised obstacles to technology integration as first and second-order barriers to change. First-order barriers are extrinsic factors that impeded teachers' technology integration such as inadequate provision of resources while second-order barriers consist of intrinsic factors such as teachers' beliefs and perceptions. Such barriers are harder to reconcile because they require a fundamental shift in both the teaching style and vision of classroom life. While the relationship between these types of barriers remains complex and not clearly understood, Becker (1994) posit that it would be more effective to address both types of barriers simultaneously as they fluctuate in relative strength in the process of integration.

2.4 Entangled Pedagogy

Fawns (2022) argued that the model of entangled pedagogy more accurately represents the interplay between pedagogy and technology. He criticised Column 1 ('technology first') and Column 2 ('pedagogy first') in Figure 2 as illusory, suggesting that they implied unrealistic predictability in education. Instead, educational activity is a complex entanglement of factors like the purpose, context, values, methods, and technology, as shown in Column 3 (the entangled view) and Column 4 (the aspirational view). These intertwined elements, or agencies are dynamic and co-constitutive, with claims made in relation to the phenomenon, and not meant to be taken out of context (Oliver, 2011).

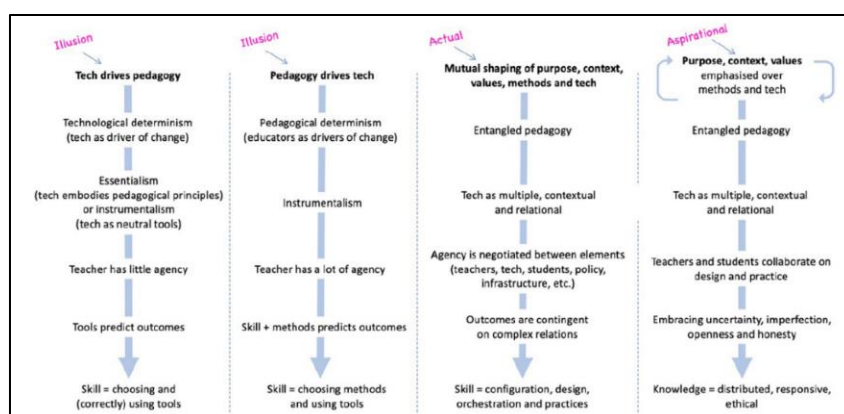


Figure 2. An Entangled Pedagogy, including an Aspirational View (Fawns, 2022).

2.5 Research Questions

In this paper, we sought to answer the following research questions (RQ): (1) 'How do KB teachers use the KF for their KB enactments?', (2) 'What are the underlying barriers to change that resulted in the contradictions experienced by the teachers when integrating KF into their classrooms?', and (3) 'How did the presence of barriers to change shape the nature of KB enacted for these teachers?'

3. Methodology

This study employs a multi-case study approach (Stake, 2013) By examining individual cases (the teachers), the study aims to better understand how the KF is utilised to facilitate KB. 5 teachers (in 2 schools) teaching English, Social Studies or History participated in this research. Pseudonyms are used in this paper.

3.1 Data Collection and Analysis

Data collection included semi-structured interviews, lesson observations, post-lesson debriefs, and KF interactions. Each teacher was observed for five lessons, on average, with each lesson lasting between 30 to 90 minutes. The Mwanza's Eight-Steps Model (2001) was used to construct the teaching activity system for each teacher's KB cluster, and the CHAT framework employed to identify contradictions (Engeström, 2001) An orchestration graph was also created to visualise the pedagogical scenario for each lesson.

4. Findings

4.1 RQ 1: How do KB teachers use the KF for their KB enactments?

Of the 5 teachers observed, only Alice (34 years of teaching experience with less than 1 year in KB) did not use the KF. For the remaining teachers, the KF is used to (a) enable students to brainstorm, organise and improve on their ideas, (b) develop metacognition and sharpen idea improvement, and (c) assess students' mastery of content. We illustrate each KF usage by presenting orchestration graphs that typified the associated tendencies (Figure 3 to 5).

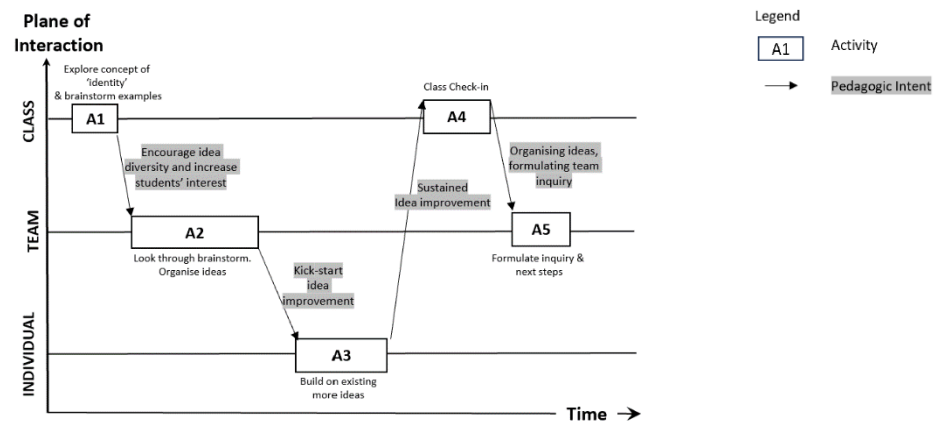


Figure 3. KF for brainstorming, organising and improvement of ideas : Sam (9 years teaching experience with 6 years in KB).

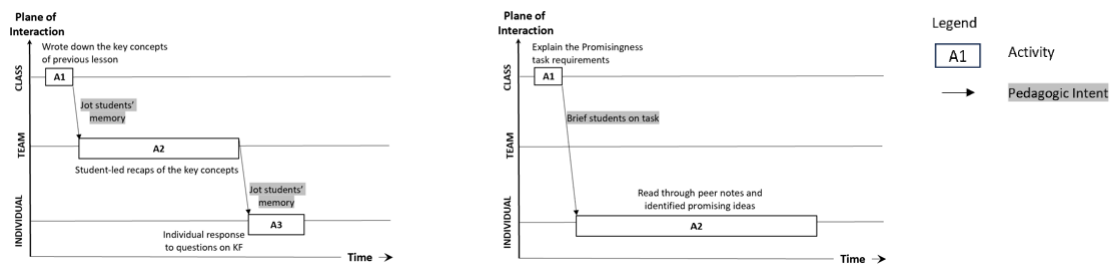


Figure 4. KF for developing metacognition and sharpening idea improvement: Jack (13 years teaching experience with 10 years in KB).

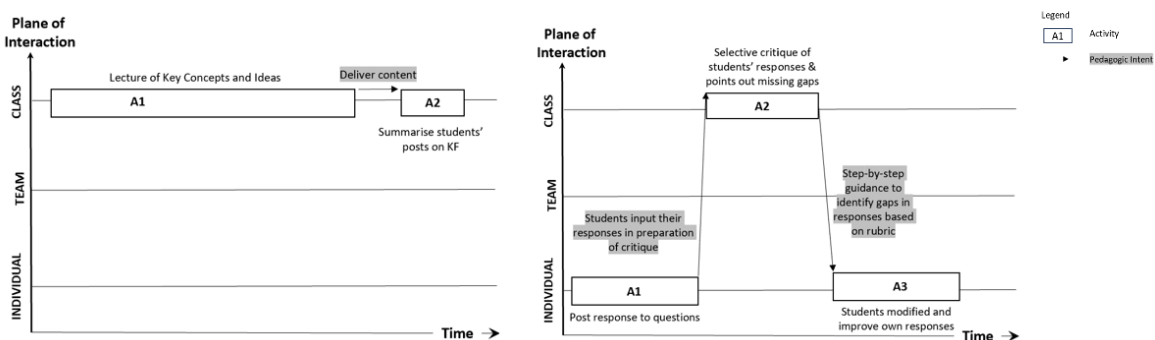


Figure 5. KF for assessing students' mastery of content: Anna (Left, 22 years in teaching with 2 years in KB) and Louis (Right, 8 years in teaching with 5 years in KB).

4.2 RQ 2: What are the underlying barriers to change that resulted in the contradictions experienced by the teachers when integrating KF into their classrooms?

This section addresses the contradictions related to the 'Tool' node in the KB teaching activity systems. Table 2 details the contradictions encountered, the underlying barriers to change, and illustrative quotes from the teachers' interviews.

Table 2. Contradictions and the Underlying Barriers to Change

Teacher	Contradictions	Underlying Barriers to Change	Illustrative quotes
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Alice	7 (3 Primary and 4 Secondary)	2 first-order barriers: (i) Inadequate troubleshooting support and (ii) Inadequate device to ensure 1-to-1 access 3 second-order barriers: (i) teacher-students' roles in teaching and learning, (ii), curricular emphases, and (iii) role of KF in KB	“(b)ecause in reality, sometimes you just don't have the time for that. So to me, I see KF more as a platform that is good to have... [M]y first question [...] is that, do the kids need to go onto this KF platform...?... that's worrying for me...”
Anna	2 Secondary	1 second-order barrier: teacher-students' roles in teaching and learning	“(s)o the moment [the students gave] feedback that they are weary or they are uncomfortable, right? I mean [I will] just drop [the] KF.”
Louis	1 Secondary	Not due to barriers of change to technology integration but driven by an existing purpose of using KB to support his inquiry-based lessons, instead of KB being a distinct Object (and Outcome) of his KB activity system	NIL

4.3 RQ 3: How did the presence of barriers to change shape the nature of KB enacted for these teachers?

Table 3 summarises the nature of the KB enactment by Alice and Anna, as shaped by the underlying barriers to change.

Table 3: *Nature of KB Enactment.*

Teacher	Alice	Anna
Nature of KB enacted	Used simple technologies (videos and powerpoint presentations). Invested considerable time conducting regular read-aloud sessions. Key pedagogical goals were to ensure the coverage of all necessary content and boost students' fluency in speaking English.	Used KF to monitor students' mastery of content. Regarded the KF as optional, can be removed if the students respond negatively to it. Strong content acquisition intent and tendency. Perception that she, alone, was responsible for students learning, illustrated in how she made it a point to respond to every student post on KF.

5. Discussion

Through analysing the underlying barriers to change, we have illuminated the interplay of factors that affected teachers' KF integration in their KB enactments. Table 4 compares the teachers' KF use and KB enactment against the two views of the Entangled Pedagogy.

Table 4. Comparing *KF use and KB Enactments*

Column 3: 'Actual View'	Column 4: 'Aspirational View'
Teachers: Alice, Anna and Louis	Teachers: Sam and Jack
- Mutual shaping of purpose, context, values, methods and tech	- Purpose, context and values emphasised over method and tech

- Perception of KF as a good-to-have (by Alice and Anna) as opposed to being the core enabling technology	- KF is used to drive idea improvement and enable greater epistemic agency of the students
- KF used to drive content mastery (by Louis) over its intended goal of enabling epistemic agency in students	- Teachers illustrated more adaptive expertise and adapted the lessons based on the progress of the students
- Teachers adhered more strictly to the specified syllabus and demonstrated a greater focus on content acquisition and mastery.	- Teachers possessed epistemic beliefs that are more aligned to KB ontology and epistemology

6. Conclusion

This study informs professional development for KB by highlighting the entanglement of considerations that could influence KF integration and potentially undermining effective KB. While the detailed examination of the 5 teachers illuminated their KF usage for KB, future research could survey more KB teachers to generalize findings, develop a typology of KB enactments, and investigate how the disciplinary nature of subjects affects KB enactment.

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