The Contradictions of Implementing Flipped Classrooms at Pre-university Education: An Activity Theory Perspective

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Abstract
A limited body of research has investigated on the factors that primarily affect the implementation of Flipped Classroom Model (FCM) at pre-university education. This study aims to uncover the contradictions that emerge when applying a whole-school FCM approach in a pre-university institution in Brunei Darussalam. The Activity Theory (AT) lens was applied to examine the intricate dynamics of FCM activities from various perspectives. Combining questionnaire data with semi-structured interviews revealed a multi-faceted view of the participants, shedding light on both the adoption and non-adoption of FCM. The discursive manifestations of the identified contradictions unveiled numerous dilemmas, conflicts and critical conflicts within the activity system. Interestingly, teachers' positive attitude and disinterest for FCM co-exist, primarily due to the 'conflicting' nature of the A Level curriculum within the pre-university education system. A range of contradictions emerged encompassing disparities in pedagogical approaches, lack of ICT skills and insufficient familiarity with FCM amongst teachers. Furthermore, the study underscored contradictions evident in students' struggle to embrace self-directed learning, coupled with a preference for procedural learning over conceptual learning, further exacerbating the conflicts within the activity system. These findings substantially contribute to our understanding of how participants are affected by contradictions inherent within and between the elements of the FCM activity system. By utilising AT as an analytical tool, educators, administrators, and researchers can proactively anticipate challenges and devise solutions to address contradictions that might hinder the effective integration of FCM within the existing pre-university education framework.

Keywords: Flipped Classroom Model, Activity Theory, Contradictions

Introduction

Aligning pre-university education with the Flipped Classroom Model (FCM) may seem straightforward in theory, but its practical application presents challenges in effectively merging efforts to benefit pre-university students. Despite its intuitive appeal and promising outcomes, achieving this alignment proves complex due to various factors, such as overly mechanistic viewpoints and a lack of strong theoretical foundations. To deepen our understanding of this dynamic interplay between educational domains and teaching methodologies, we propose adopting a theoretical perspective rooted in Activity Theory (AT). Through this lens, we aim to address limitations in existing research and explore the complexities and obstacles of aligning pre-university education with the FCM.

This analytical approach aims to enrich our understanding of the shift towards blended learning in a pre-university setting by presenting a well-grounded theoretical viewpoint. Building on AT, we argue that pre-university education and the flipped classroom model constitute interconnected yet distinct activity systems. AT provides a structured framework for analysing these systems, their elements, and their intricate connections. By leveraging AT's concept of tensions, it enables the identification and resolution of misalignments within and between these systems, driving their mutual development. Thus, AT offers a comprehensive framework for describing and examining the intricate relationships between these two domains.

To illustrate the effectiveness of AT in understanding the alignment between pre-university education and the FCM, we conducted an extensive case study focused on this institution. Our analysis spanned three school terms of implementing the FCM and delved into how pre-university education and FCM evolved within the intricate organisational setting. Our empirical findings highlight that consistently addressing emerging tensions within and between these systems, coupled with implementing necessary adaptations, fosters the co-evolution of both systems. While more research is necessary to validate this framework's practicality, our initial evidence suggests that employing activity system analysis empowers practitioners to systematically identify and resolve misalignments.

Utilising AT for School Transformation Initiative

AT stands as a contemporary paradigm for analysing and reshaping collaborative activities embedded within social contexts and their associated networks. At its core, this theory asserts that human psychological processes' structure and evolution stem from culturally mediated and historically evolving practical activities (Leont'ev, 1978; Luria, 1979; Vygotsky, 1978). Cole (1996) underscores the importance of incorporating the social-institutional context of the activity when conducting a cultural-historical analysis.

Originating from Vygotsky (1978) and Leont'ev's (1978) foundational work, AT builds upon the premise that human activity inherently aims toward an object (Engeström, 1995) and is mediated by various tools that enhance achieving desired outcomes (Blackler, 1993). This mediating network is typically represented as a fundamental activity system model, depicted as a triangle involving a subject, object, and tools (Vygotsky, 1978).

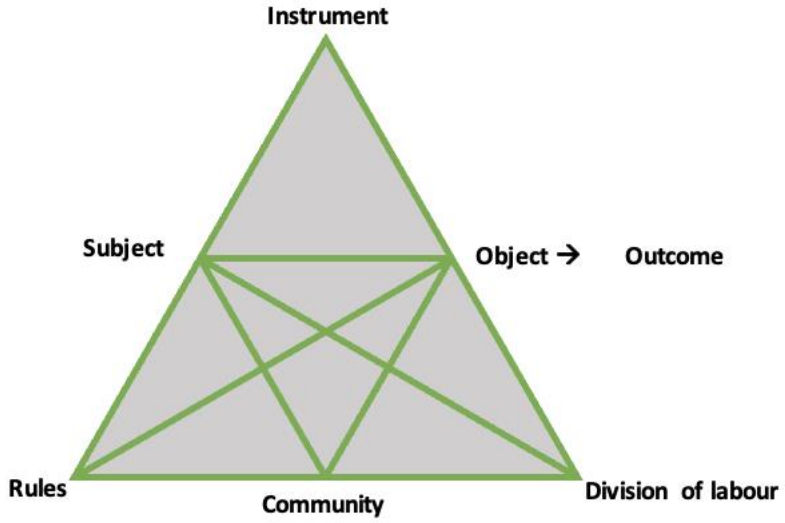

Figure 1: Engeström third generation AT triangular system (Engeström, 2001)

The "object" in an activity is the central focus guiding human agents' efforts to achieve specific goals within a culturally defined framework (Engeström, 2001). This object serves as a motivating and organising force driving the activity's progression (Kaptelinin, 2005; Nicolini et al., 2012). To improve goal achievement, individuals use cognitive and physical "tools" (Blackler, 1993; Engeström, 1995), which draw from accumulated experience and skills while aligning with their capacities (Kuutti, 1995). Therefore, the success of human activity hinges on the availability and suitability of these material or symbolic artifacts.

Engeström (1987) expanded the foundational triangular model of human activity by introducing community, division of labour, rules, and norms, emphasising their interplay within activity systems. This framework highlights that human activity involves more than just subject, object, and tools. Engeström underscores that a community, with varied motivations, rules, norms, and labour divisions, emerges around the object, mediating between the subject and the broader community. This approach acknowledges the conflictual nature of human activity, marked by ambiguity, interpretation, sense-making, and potential for change (Engeström, 2001).

This extension of AT reveals how complex work systems evolve, viewing activities as networks of interacting systems (Blackler et al., 2000). These activities are open systems, capable of adopting external elements or being influenced by related systems. New mediating artifacts may emerge from the community or through related activities, potentially introducing contradictions. These contradictions, tensions within or between elements or activities, challenge objectives and create instability. While problematic, contradictions also prompt opportunities for change, driving collaborative efforts towards evolution (Allen et al., 2013).

Contradictions fuel human progress (Engeström, 2001), where stability is rare, and disruptions and innovations are commonplace (Cole and Engeström, 1993). Development involves iteratively altering elements within activity systems to address emerging contradictions, often historically rooted. Culturally advanced systems evolve through these

transformations, fostering expansive learning cycles where objectives and motives broaden. Organisations adept at expansive transformations gain a competitive edge.

AT is instrumental in school transformations, offering a structured framework to analyse and improve educational processes. It promotes a holistic view of educational systems, encourages collaboration, and guides interventions for better teaching and learning practices. The study's framework involves flipped learning for out-of-class activities and active collaborative learning for in-class instructions, aiming to cultivate effective habits and skills. Flipped learning was used outside class, leveraging video lectures for new information and exercises targeting basic cognitive skills. Students assessed their understanding through self-reflection forms, using technology as a tool for autonomous knowledge construction beyond traditional homework assignments.

Incorporating flipped learning and structured collaborative learning rooted in socio-constructivist principles, this study aims to assess both the benefits and challenges of employing the flipped approach in pre-university education. It specifically focuses on its potential for positive learning outcomes and addressing any tensions revealed through the lens of AT.

Rationales of the Study

The goal is institution-wide adoption of FCM for transformative change. AT is pivotal for comprehensive analysis of educational processes, providing a structured approach to pinpoint contradictions, encourage collaboration, guide design, and align with educational objectives. This multi-layered approach empowers institutions to navigate complexities and improve teaching practices in today's dynamic educational setting.

Research Question

This study primarily focuses on a fundamental research inquiry: What contradictions arise during the implementation of FCM within the institution?

Methodology

i. Surveys and Participants

The study involved various participants: 860 Year 11 and Year 12 pre-university students completed the FCM questionnaire, while 108 teachers responded to one questionnaire about their experience, and 99 provided insights into their perceptions. Additionally, 164 parents shared their views on their children's blended learning experiences. Descriptive statistical analysis was used to uncover emerging themes from the surveys.

In addition, the research integrated semi-structured interviews involving 35 participants, comprising 25 students and 10 teachers selected through purposeful sampling criteria.

ii. Student Group Interviewees

Twenty-five students from Year 11 and 12 pre-university institutions were selected for interviews. The selection criteria for student participants included their experience with the FCM, academic performance and willingness to participate. Efforts were made to ensure

diversity among student participants, considering factors such as age, gender, and academic achievement.

iii. Teacher Group Interviewees

Ten teachers who were actively involved in implementing the FCM in various subjects were selected for interviews. Teacher participants were chosen based on their expertise in the subject matter, experience with the FCM, and willingness to contribute to the study. All participants provided informed consent, and their confidentiality and anonymity were rigorously maintained throughout the study. Pseudonyms were used to protect the identities of the participants in any study reports or publications.

Thematic analysis was employed to interpret and process the interview transcripts.

Results

By utilising Engeström's third-generation model of the activity system (2001), we analysed how goal-oriented actions are mediated by a wide array of pertinent factors, encompassing psychological, technical tools, and even social structures within the activity system for implementing FCM across the entire school. The activity system (Figure 2) is depicted below:

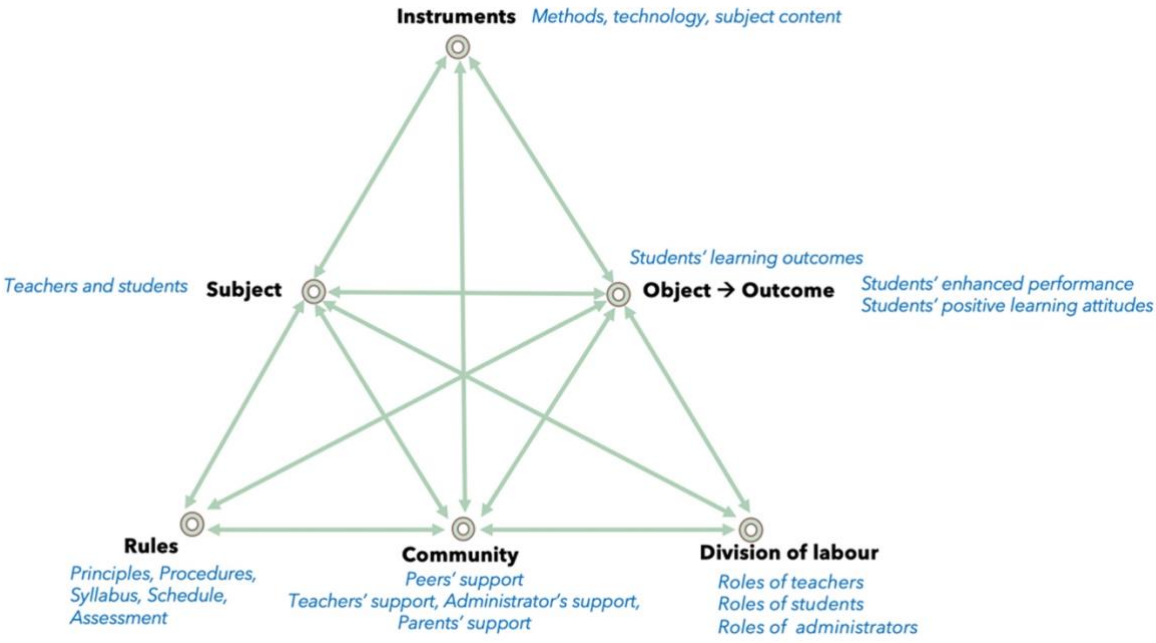

Figure 2: The activity system of FCM implementation in the pre-university institution

The survey results reveal a multitude of advantages associated with integrating the FCM at the activity level for both students and teachers. The implementation of FCM has yielded numerous benefits that significantly influence both students and teachers within the educational sphere. This innovative pedagogical approach has resulted in positive outcomes, particularly evident in terms of students' self-regulation, self-efficacy, independence, collaboration, and engagement (Table 1). FCM plays a crucial role in empowering students by enhancing their self-regulation skills. By transferring the responsibility of acquiring foundational knowledge to individual out-of-class preparation, students are encouraged to

oversee their own learning pace and style. This approach nurtures students' self-awareness regarding their learning needs and preferences, ultimately leading to enhanced self-regulation. This newfound autonomy not only equips students with essential skills for their academic journey but also for continuous learning throughout their lives.

Table 1: The emerged themes resulting from survey analyses

Instrument	Item	n	Quantitative	Emerged themes
Student's perception on FCM	34	860	Cronbach's $\alpha = 0.95$	Self-regulation, self-efficacy, independence & collaboration among students
Tutors' perception on blended learning - FCM	19	108	Cronbach's $\alpha = 0.91$	
Tutors' understanding of FCM	21	99	Cronbach's $\alpha = 0.97$	
Parents' perceptions and experiences with FCM	28	164	Cronbach's $\alpha = 0.91$	

Additionally, the FCM contributes significantly to the cultivation of students' self-efficacy. Within the dynamic learning environment shaped by FCM, where students actively participate in problem-solving and critical thinking exercises, a sense of competence and confidence in their academic abilities is instilled. As students successfully navigate complex content and tasks, their belief in their academic capabilities strengthens, potentially enhancing their overall academic performance. Moreover, FCM plays a pivotal role in fostering collaboration among students. In-class sessions often feature collaborative activities that encourage interactions among peers, promoting cooperative learning. These interactions facilitate the exchange of knowledge, diverse perspectives, and teamwork, thereby nurturing a sense of community and belonging among students. This collaborative approach not only enriches their learning journey but also prepares them for future collaborative efforts in professional settings.

Most importantly, FCM enhances student engagement. The interactive and participatory nature of flipped classrooms captures students' attention and enthusiasm. They are actively involved in discussions, problem-solving, and knowledge application during in-class sessions, which creates a dynamic and stimulating learning environment. This increased engagement can lead to heightened motivation and a deeper understanding of the subject matter. All in all, the integration of FCM presents significant advantages for both students and teachers, encompassing enhanced self-regulation, improved self-efficacy, boosted collaboration, and heightened engagement. These positive effects not only contribute to students' academic achievements but also equip them with essential skills and attitudes that extend beyond the classroom, shaping their future endeavours.

Affordances can be used as a valuable framework for generating interview questions, particularly in the context of educational research or when studying how individuals interact with specific environments or technologies. By identifying the specific affordances, we can explore valuable insights into how individuals perceive and interact with the features and possibilities offered by a particular environment, technology, or context. This approach can be especially useful in user experience research, educational research, and studies involving the evaluation of technologies or systems. It can also be a useful framework for identifying contradictions within an activity system. Contradictions in an activity system arise when

there are conflicts, tensions, or inconsistencies between different elements or components of the system. Affordances, which refer to the opportunities and possibilities that an environment or technology offers, can help pinpoint where these contradictions may occur. By identifying the specific affordances within the activity system to examine. These might be features or aspects of the system that are relevant to your research or analysis, assess how each identified affordance functions within the activity system and influences the actions, behaviours, or interactions of the participants. By using affordances (Table 2) as a lens to examine the interactions and relationships within an activity system, we can uncover contradictions that may affect the system's functionality, effectiveness, and the experiences of participants. Identifying and addressing these contradictions is essential for improving the design and implementation of the system.

The interview questions were carefully crafted to probe deeper into any contradictions or discrepancies that participants might have experienced. For instance, questions were framed to inquire about situations where students felt both highly engaged and, at times, disengaged within the FCM. Similarly, teachers were asked about moments when they observed students demonstrating self-regulation effectively and instances when they struggled with it. During the data analysis phase, researchers paid close attention to responses that indicated conflicting experiences, viewpoints, or challenges faced by participants. These discrepancies were noted as potential contradictions within the activity system of FCM implementation. Contradictions signify areas of tension, conflict, or inconsistency within the FCM's implementation and operation. Recognising these contradictions provides valuable insights into the complex dynamics at play within the educational setting. It allows educators and researchers to pinpoint challenges that students and teachers may face, facilitating the development of targeted solutions and interventions. Moreover, understanding contradictions helps refine the FCM's design and implementation, aligning it more effectively with educational objectives. By addressing these contradictions, educators can harness the full potential of FCM, enhancing its impact on students' self-regulation, self-efficacy, collaboration, and engagement. Therefore, the identification of contradictions is not merely a research endeavour; it is a strategic tool for refining and optimising the FCM to create a more conducive and effective learning environment. Based on interview data analysis, several contradictions were uncovered in the FCM activity system (Table 2).

By integrating this approach into the research process, the study aimed to not only highlight the affordances but also uncover and analyse the contradictions within the FCM activity system. This comprehensive examination provided a more nuanced understanding of how FCM impacted both students and teachers, encompassing both positive and challenging dimensions of the educational approach. Students' experiences with the FCM reveal several noteworthy affordances and contradictions within their activity system. The affordances corroborate the positive emerging themes from the survey outcomes. The contradictions, on the other hand, encompass challenges related to a heavier workload caused by FCM's out-of-class assignments, disparities in technology access and technical issues, difficulties in providing constructive feedback during peer assessment, the absence of immediate feedback during out-of-class activities, a preference for teacher-created video content over generic resources like YouTube, the need for precise instructions when assigning out of class tasks, struggles in adapting to the autonomy required for in-class active learning, and a tendency to focus on procedural learning for exam preparation rather than the desired conceptual understanding. These contradictions underscore the need for careful consideration and adjustments when implementing FCM to ensure its effectiveness in fostering student learning outcomes.

Table 2: Thematic analysis of students' affordances and contradictions on FCM

Theme	Students' Learning	Affordances	Contradictions
Active learning	Organisation	Students generally have a positive attitude and are open to both out-of-class and in-class tasks and activities.	Students unable to complete out-of-class task due to a busy schedule with other subjects and extracurricular activities.
	Engagement	Clear lesson objectives in FCM tasks ensure students actively participate.	No specific contradictions in this area.
	Independence/ Initiative	Students show independent learning behaviors when they can watch videos at their own pace and take the initiative to do additional research and make notes or summaries.	Some responses show that students need the teacher's guidance or feedback right away during out-of-class activities.
Student-centered learning	Collaboration	Students have a very positive attitude toward group activities, provided everyone shares the responsibility for completing the task. They mentioned that their speaking skills and confidence have improved, leading to more interactions with both peers and the teacher, who acts as a facilitator.	Most responses pointed out that group members did not contribute equally. Others mentioned they could not give helpful feedback during peer assessment.
Integration of ICT in learning	Use of ICT	Students have a positive attitude toward using technology in education. Different tech tools have been used for both at-home and in-class activities to encourage independent and group learning.	Some students mentioned problems with internet connections, data costs, and not having enough devices as their main challenges.
Effective use of resources	Use of resources	Students' responses show that the out-of-class task was used well and improved their understanding of the topic. They also mentioned how this gave them more time for meaningful learning in class.	Some students said teachers should give shorter videos and clear instructions for homework. They like when teachers made their own videos rather than using YouTube.

Teachers' Activity Contradictions

The activity system of teachers implementing the FCM reveals several notable contradictions (Table 3). Firstly, there is a contradiction related to the increased workload associated with designing a flipped class. While FCM aims to optimise learning, teachers find themselves

dedicating more time and effort to create suitable flipped materials, including videos and interactive activities. This increased workload can be at odds with the goal of reducing teachers' burdens.

Table 3: Thematic analysis of teachers' contradictions on FCM

Theme	**Contradictions**
Increase in workload	Responses show that making flipped learning materials takes a lot of time. Teachers struggle to find or make videos that match their lessons. Designing in-class activities, resources, and tests that fit FCM and TPA criteria is hard and stressful for teachers. Some students need extra supervision to finish their out-of-class work, which makes teachers' work even busier.
Accessibility of technology and other technological issues	Responses show that only a few students have these issues.
Lack digital competence	All interviewed teachers show strong digital skills, with some even conducting training for other departments on teaching apps. However, according to their feedback, many teachers lack the digital competence needed for effective integration of ICT in the flipped classroom.
Lack understanding of FCM (based on one of the 4 pillars of flipped learning)	Teachers expressed concerns about the need to use exam-style questions/resources to maximise curriculum time, which may not be suitable for the flipped classroom.
	Some teachers may not fully understand how to prepare 'intentional content' for in-class activities, where students are expected to apply learned concepts and engage creatively to build new knowledge.

In addition, there is a significant contradiction concerning teachers' digital competence. While some educators demonstrate proficiency in using digital tools and resources, others lack the necessary skills to effectively incorporate technology into their FCM lessons. This contradiction highlights the need for ongoing professional development to ensure that all teachers can leverage technology to enhance their teaching. Another contradiction emerges in terms of accessibility and technological issues. Teachers may assume that students have equal access to technology, but this is not always the case. Variations in students' access to devices and internet connectivity can hinder the successful implementation of FCM, leading to unequal learning opportunities.

Furthermore, there is a contradiction related to teachers' pedagogical knowledge. Some educators may not possess up-to-date pedagogical knowledge, particularly regarding student-centered approaches like FCM. This discrepancy can result in inconsistent instructional practices. A lack of understanding of FCM among teachers is another contradiction. Some educators may not fully grasp the principles and benefits of this pedagogical approach, which can lead to resistance or sub-optimal implementation.

Lastly, there is a contradiction tied to the prevalent exam-oriented mentality among teachers. While FCM encourages a shift towards conceptual learning and active engagement, teachers entrenched in exam-focused teaching methods may struggle to align their practices with

FCM's objectives. Table 4 provides a summary of the primary contradictions identified among teachers and students within the institution. These contradictions highlight the need for a shift in teachers' and students' mindsets and priorities regarding educational outcomes.

Table 4: Main contradictions of students' and teachers' on FCM

Student	Teacher
Heavier workload	Heavier workload to design a flipped class.
Accessibility of technology/ technological issues	Lack of digital competence.
Inability to provide constructive feedback during peer-assessment	Accessibility of technology/ technological issues (students).
No access to immediate feedback during out-of-class activities.	Lack of current pedagogical knowledge
Preference for teacher-made video lectures instead of YouTube videos.	Lack understanding of FCM
Need for specific instructions when assigning out-of-class activities	Exam-oriented mentality
Inability to meet higher demand in self-discipline and structure to prepare for in-class active learning	
Focus on procedural learning for exam preparation contrary to teacher's desire to elicit conceptual learning	

Discursive Manifestations of Contradictions

Conducting a discursive manifestation analysis and classifying interview excerpts of contradictions into dilemmas, critical conflicts, or conflicts involves a systematic approach to understanding the contradictions and tensions within the discourse. In this study, the discursive manifestation of contradictions that unfold can be categorised into either dilemma, critical conflict or conflict.

When asked if the FCM is suitable for A-Level subjects, it became apparent that both students and teachers were skeptical of its appropriateness. Here are some excerpts of teachers and students' responses to FCM that indicate contradictions that exist in FCM activity system:

- In response to question (*What do you think of the FCM preparation?*)

> "*It's time consuming, because you have to figure out the topic, content and then the script (for the lecture videos) and then you have to figure out the in-class activities." –* Teacher A

> "*Sometimes we would be assigned more a lot of videos, which were mostly short videos, and the deadlines are on the same day, so sometimes, I'll get overwhelmed. After school, I may also have other priorities, or I may not be home at the moment. And at times, the videos are assigned quite late*." – Student B

"*Selecting the right video, with the right topic and duration is very tough and takes up time but I also get support from my departmental PD.”* – Teacher D

"*It'll be easier for the, to prepare notes for the traditional compared to the flip classroom because for the flip classroom, you don't want to tell everything. You don't want to give all the content because you want to use the content during the flip classroom*." – Teacher C

"*A-levels are rigorous and time-bound. There's not much room for experimentation and implementing FCM effectively while meeting the curriculum's demands can be a real challenge."* – Teacher E

“Sometimes I procrastinate so the work piles up. Also I have essay-based subjects so it does pile up and I do get overwhelmed to do everything so like I couldn't do some of the subjects.” – Student H

- In response to question *("Some people do not like to work with technology. Do you have this kind of feeling? Did you encounter any problems using the technology")*

"*It depends on the teacher also, if they are not innovative or tech-savvy so they will not use ICT.*" – Teacher C

“Lack of knowledge of the use of the apps, perhaps. 'cause not, not all of the teachers are knowledgeable to use one particular app. I myself have to teach my, my colleagues as well to use the Class Point app.” – Teacher A

“One of the challenges I faced was the internet connection or maybe not enough data.” – Student L

- In response to question *("Do you think the FCM aligns with the teaching approach expected of the A-level curriculum?")*

"*I don’t believe so, yeah. I, I, because I believe, I believe in chalk and talk and, and once the syllabus is done, like over the past few years we've been doing this over the past, I've been doing this for the past few years. Once the finish of the syllabus, uh, is completed, um, we do a drilling method. Okay. Yeah. Meaning we, we, we really drill the students, we do the past papers, and it works. It works and it helps the students, uh, the lower operator students to, um, to at least get a pass. Okay. At least get a pass*." – Teacher A

“*I prefer using traditional methods because it allows me to complete as some time, uh, which gives, which gives me more time to do, um, to do more of the past papers with, uh, to do revision with the students. So, when you finish the syllabus on time or even before that, you have more time to do past papers with the students*.” – Teacher D

Interview transcripts offer rich insights into conflicts, dilemmas, and critical conflicts. Participants express inner conflicts and uncertainties through spoken words, revealing dilemmas as they weigh pros and cons and critical conflicts when deep contradictions emerge. Both overt and subtle conflicts are discernible from their language, tone, and non-

verbal cues, showcasing differing viewpoints. These transcripts capture nuances, offering insights into decision-making, disagreement, and conflict resolution. Table 5 outlines the verbal expressions evident in discussions with students and teachers, showcasing emerging discursive manifestations.

Table 5: Main contradictions of students' and teachers' on FCM

Issue/contradiction	**Manifestation**
Disagreement over pedagogy	Dilemma A
Desire for autonomy over teaching preference	Dilemma B
Preference for teacher-made video lectures instead of YouTube videos.	Dilemma C
Different expectation over the division of labour between teachers and students (students' autonomy vs teachers' guidance during out-of-class)	Critical conflict A
Unwilling to see beyond the exam and spending time on FCM	Critical conflict B
Inadequate instructions to facilitate students' completing the out-of-class tasks autonomously	Conflict A
The nature of A-level course	Conflict B

Mapping contradictions into the triangular activity system of AT can help visualise how these tensions affect different components of the activity system (Figure 3).

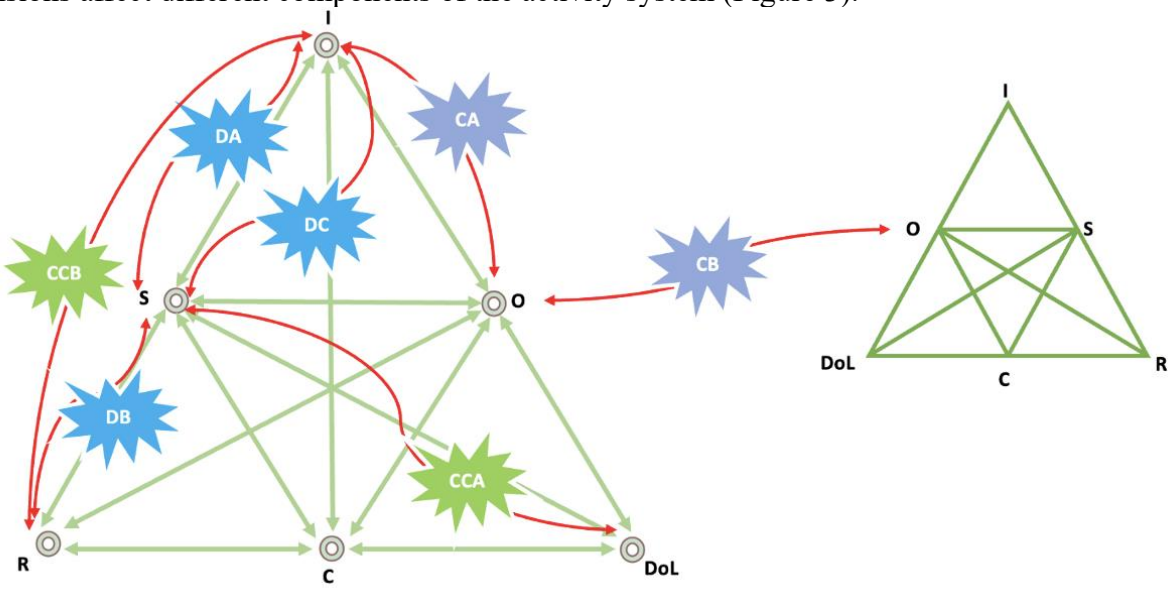

Figure 3: Mapped contradictions in the FCM activity system. Dilemma A (DA), Dilemma B (DB), Dilemma C (DC), Critical Conflict A (CCA), Critical Conflict B (CCB), Conflict A (CA), Conflict B (CB)

Mapping contradictions into the triangular activity system can provide a structured way to visualise and analyse the complex interplay of tensions within the FCM context. It can gain

insights into how these contradictions affect different aspects of the teaching and learning process and inform strategies for resolving or managing them effectively. This framework offers a visual representation of the interplay between various elements involved in teaching and learning, including the subject (teachers and students), the object (learning objectives), and the mediating tools and rules (technology, curriculum, pedagogical approaches). When contradictions emerge, they often involve these elements, and mapping them onto the triangular activity system elucidates their interactions.

By doing so, it becomes possible to identify the specific areas within the FCM environment that are most affected by these tensions. For example, if a contradiction relates to students' self-regulation, it may primarily impact the subject (students) and their capacity to manage independent learning. Conversely, contradictions concerning technology access may directly influence both the subject (teachers and students) and the tools (technology). This visual representation helps educators and researchers understand the focal points of each contradiction, facilitating targeted interventions and solutions.

Understanding how contradictions manifest within this framework informs the development of strategies to effectively address or manage these tensions. For instance, if a contradiction is rooted in students' difficulties with self-discipline during out-of-class activities, educators can use this insight to design interventions that support students in developing better self-regulation skills. Likewise, if technological access poses a challenge, educators can explore ways to enhance accessibility or provide alternative resources. Mapping contradictions into the triangular activity system encourages a holistic perspective of the educational ecosystem. It underscores that tensions within one element of the system can have ripple effects throughout the entire FCM, impacting other components. This holistic viewpoint encourages comprehensive and integrated solutions, moving away from isolated fixes for individual issues.

Ultimately, this approach supports continuous improvement within FCM. By identifying and addressing these tensions, institutions and educators can adapt and enhance their FCM implementations over time, making it a more effective and responsive approach to teaching and learning. These discursive manifestations reflect the nuanced interactions and perspectives within the FCM context, highlighting the need for a comprehensive understanding of these contradictions to develop effective strategies and solutions. Addressing these tensions might facilitate a more unified and efficient assimilation of FCM within the pre-university institution, mirroring the successful practices adopted by this establishment. Consequently, this approach has shown promising outcomes in students' learning achievements, attitudes, and teachers' professional practices. This is evident from the positive outcomes within the activity system following the completion of three full terms of comprehensive whole-school implementation of FCM at the institution.

Conclusion

In summary, this research strongly supports the positive impact of FCM on students' learning attitudes and essential 21st-century skills. FCM fosters self-regulation, collaboration, independence, and heightened engagement, contributing to successful educational experiences. It encourages active participation, critical thinking, and aligns with modern learning approaches. However, it reveals contradictions at student and teacher levels, necessitating collaborative efforts to address these challenges. Contradictions within FCM should guide a more effective, student-centered approach rather than being seen as barriers.

This study provides insights for refining FCM implementation, leveraging AT to address diverse elements like students, teachers, technology, and socio-cultural contexts. AT's adaptability for longitudinal studies aids in tracking changes and interventions, making it vital for educational research and reform efforts. Overall, these findings endorse FCM as a transformative teaching method amid evolving educational landscapes.

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