International Journal of Learning, Teaching and Educational Research
Vol. 25, No. 2, pp. 404-431, February 2026
https://doi.org/10.26803/ijlter.25.2.19
Received Nov 13, 2025; Revised Jan 27, 2026; Accepted Jan 30, 2026

Supporting Complex Educational Transformation in the Fourth Industrial Revolution: A Digital Literacy PBL Case Study

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Abstract. This research investigated educators undergoing simultaneous changes to their disciplinary and pedagogical knowledge to explore supports for teachers undergoing complex transformations to education. This topic is relevant within the context of increasingly rapid educational change. The research fills a gap in the literature in providing detailed accounts of the transformation process, particularly within the context of mainland China. The primary objective was to investigate a job-embedded teacher training in which teachers used action research for the design, implementation and evaluation of a project-based digital literacy programme. The participating teachers did not have previous training in digital literacy and did not typically teach using a project-based approach. The research used a case study methodology. Data sources

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included researcher field notes, artefact analysis and post-programme semi-structured interviews. Analysis indicated that the teachers' use of a modified action-research protocol with job-embedded training provided effective support in applying new pedagogical and content knowledge as well as team management and collaborative processes. Implementation of the target programme for students still faced constraints from systemic pressures, such as conflicting assessment and leadership priorities. The research findings offer insight into practical considerations when helping teachers transition from traditional pedagogy to Project-Based Learning (PBL) or from teaching traditional literacy to digital literacy. The research also generated theoretical implications such as the need for educational leaders to plan tailored support for complex teaching and technological innovations. For this purpose, the Training Support for Educational Transformation (TSET) action-research model is proposed.

Keywords: Educational Transformation; Teacher Professional Development; Action Research; Project-Based Learning; Digital Literacy

1. Introduction

Although many educators are exploring the impact of artificial intelligence on education, this change is better understood within the broader context of the fourth industrial revolution, driven by converging advances in AI, robotics, quantum computing, the Internet of Things, and biological technologies (Schwab, 2017). As these changes increasingly affect education, this research focused on the need to support teachers through major technological, socio-economic, sustainability, and pedagogical transformations in classroom practice.

The overarching purpose of the research was to examine a specific case of complex educational transformation and the process of navigating training and implementation using an action-research, job-embedded training approach. The study is relevant to researchers, school leaders, coaches, and teachers as education shifts from disciplinary knowledge acquisition to the development of complex, real-world competencies, requiring significant changes in policy and teaching practice (OECD, 2018; OECD, 2020; UNESCO, 2017a).

This case study focused on capacity building for simultaneous transformations in teachers' digital literacy and pedagogy through the design, implementation, and evaluation of a Grade 8 English as an Additional Language course using project-based learning in a K–12 bilingual school in Beijing, China. The study is therefore relevant to educators interested in digital literacy, which is becoming an increasingly important goal across all levels of education as digital communication expands (UNESCO, 2017b; UNESCO, 2017c).

Despite digital literacy being an important vehicle for creative expression and human connection, it has become common knowledge that significant problems have emerged in the digital world. Generative AI, alongside more traditional technologies, are increasingly being used to flood information spaces with misinformation, deepfakes and propaganda. Photos, videos, personal information

and other data from social media may be scraped to create pornography, identity theft, phishing attempts and other malevolent attacks. Cyberbullying has led to suicide or other serious outcomes. Message and data interception dangers are present in many open networks, and a wide range of methods have been used to hack into devices ranging from personal, through corporate and even government-level systems.

The importance of digital literacy has resulted in the development of a range of digital literacy competency frameworks and training programmes that are explored in the literature review. Many of these connect conceptually with work done in the new literacies and multiliteracies literature, which enlarges the scope, semiotics, and practices of traditional literacy studies (Gee, 2014). While some institutions have dedicated departments for digital and multimodal studies, in many schools internationally this role falls to English as an Additional or Foreign Language teachers, who have traditionally focused on conventional literacy (Hazard, 2018; Hazard, 2019). As digital literacy is often approached through progressive pedagogies such as PBL (Harris & de Bruin, 2018; Krajcik & Blumenfeld, 2006), this change in content knowledge may also stimulate changes to pedagogy within these departments.

Therefore, this research also fills gaps in the PBL literature as it relates to digital literacy within EAL and training for PBL within EAL departments. It also builds on previous research on simultaneous changes to both content and pedagogy (Hazard & Liu, 2024), which indicate a relatively complex level of educational transformation as compared to minor changes in either content or pedagogy alone. Practical models for undergoing such change are under-described, particularly in K–12 bilingual settings in China. This paper documents a case in which teachers and instructional coaches used action research, framed through project-based learning, to develop content knowledge and pedagogy and to design, implement, analyse, and reflect on a new programme for students.

The overarching purpose of the research is to document the theoretical and practical underpinnings of a capacity-building initiative and isolate what is learned for the benefit of other educators and to stimulate further research in this important area. The research examines key concepts from the literature that informed the study, highlights the method of capacity building through a non-traditional teacher training and job-embedded support programme, details data collection and analysis, and finally presents findings, conclusions and implications. The case-specific implications included support for use of PBL in digital literacy courses, and support for action research as a means for planning, managing and evaluating programming initiatives. Theoretically, this case in combination with other works reviewed, led to the TSET action-research framework.

2. Literature Review

2.1 Literacy and Multiliteracies

Literacy, in its broadest sense, refers to the ability to read, write and engage with written texts in meaningful ways. It encompasses not only the decoding of written

symbols but also the comprehension, interpretation, and critical analysis of texts across various contexts and modalities (Kress, 1997). The concept of literacy has evolved to include multiliteracies, recognising that individuals must navigate and make sense of diverse forms of communication, including print, digital, and multimodal texts (Cope & Kalantzis, 2009).

As such, literacy is a dynamic, socially situated practice that extends beyond basic reading and writing skills to include the capacity to participate effectively in a range of discourses within society (Gee, 2014). Proficiency in literacy skills enable individuals to access information, communicate ideas and engage in lifelong learning, thereby contributing to social inclusion and economic advancement (UNESCO, 2017c). In an increasingly digital and globalised world, literacy serves as a critical tool for navigating complex information environments, fostering critical thinking and promoting informed citizenship (Özel, 2025). Consequently, fostering literacy development is a central goal in national education policies and to international education efforts such as Sustainable Development Goal 4: Quality Education for All (UNESCO, 2015).

In EAL classrooms internationally, English language literacy is taught through explicit instruction in reading and writing, alongside the development of oral language skills. Teachers systematically introduce learners to the conventions of a range informal and formal registers, dialects and genres, by providing example texts of various kinds for decoding, modelling language use, scaffolding text production, and providing opportunities for authentic communication (Gibbons, 2014). Instructional approaches often integrate genre-based pedagogy and functional linguistics, enabling students to understand how language choices vary according to context, purpose, and audience (Derewianka & Jones, 2016). Through such practices, EAL educators support learners in mastering academic and everyday English, equipping them to participate fully in diverse communicative settings and multicultural environments.

2.2 Digital Literacy

The rise of the Internet, social media, mobile devices and other digital platforms radically altered how information is produced, disseminated and consumed, rendering digital competencies essential for effective participation in modern life (Özel, 2025). Gilster (1997) popularised the term "digital literacy," emphasising not just technical skills but also the capacity to critically evaluate digital information. As the concept has evolved, digital literacy also empowers individuals to protect themselves and others online while engaging in digital practices (European Commission, 2022).

Digital literacy thus involves not only knowing how to use digital tools and platforms but also understanding how to critically assess digital content, communicate ethically, and collaborate effectively in virtual spaces (UNESCO, 2017b). Meaning is conveyed through increasingly interconnected modes – written, oral, visual, audio, tactile, gestural, spatial, and personal – which can be combined and recombined through synaesthesia, the fusion of modes and symbols of meaning (Cope & Kalantzis, 2009). Building on this, the New London

Group (1996) advanced a critical multiliteracies perspective that deconstructs power structures and empowers learners and educators to reshape society through authentic, meaningful communication, whether digital or analogue. Digital literacy continues to evolve rapidly as the digital landscape presents new challenges and learning goals, such as understanding AI privacy concerns, developing critical thinking, supporting active citizenship, and developing sustainability competencies in the digital sphere (Özel, 2025). Increasingly, digital academic integrity is also recognised a crucial part of digital literacy in the age of generative AI (Eaton, 2025).

Several widely adopted frameworks have been developed to articulate and categorise the specific competencies associated with digital literacy. Three of the most influential are the Digital Quotient (DQ) Framework, the European Union's Digital Competence Framework for Citizens (DigComp), and the International Society for Technology in Education (ISTE) standards. Digital literacy frameworks intersect with and often include digital citizenship, which has a rich literature pertaining to the digital rights and responsibilities of citizens both within their national boundaries and beyond them in the global digital commons (Isin & Ruppert, 2015).

The DQ digital literacy framework is a model designed to delineate and assess the multifaceted competencies required for effective participation in the digital age. This framework encompasses a range of knowledge, skills, and attitudes that enable individuals to navigate, engage with and contribute to digital environments responsibly and productively. It was developed to incorporate and interact with the OECD Education 2030 Framework (OECD, 2018) and the United Nations Sustainable Development Goals (SDGs). The DQ framework uses a grid of eight zones of digital life which are developed and measured at four levels, resulting in a matrix of thirty-two digital competencies. Levels include connectivity, citizenship, creativity and competitiveness. Zones include (digital) identity, use, safety, security, emotional intelligence, communication, literacy and rights. Programmes utilising the framework are to be customised for various contexts, age levels and objectives.

2.3 English as an Additional Language as a Vehicle for Digital Literacy

The intersection of EAL (including English as a Foreign Language [EFL]) programmes and digital literacy reflects the growing recognition that English language acquisition programmes are a unique site for developing digital competency when utilising English in the international digital global commons (Hafner et al., 2015). As educational contexts become more linguistically and digitally diverse, EAL programmes play an increasingly important role in developing digital literacy, supporting equitable participation and success for multilingual learners across both English-dominant and international settings, as reflected in EAL syllabi (Hazard, 2018).

The integration of digital literacy in EAL programmes is commonly grounded in multiliteracies pedagogy, which recognises multiple communication channels and the need for learners to navigate diverse genres, dialects, modalities, and

digital environments (Cope & Kalantzis, 2015). This situates digital literacy as an extension of traditional language skills, encompassing not only the ability to read and write but also to critically decode or create multimodal and digital texts effectively in local or global contexts (Hafner et al., 2015).

Pedagogical approaches within EAL programmes increasingly leverage digital resources to facilitate combined language learning and digital literacy. Strategies include the authentic use of multimedia texts in context, such as social media, online discussion forums, video games, and other collaborative platforms (Jones, 2023). Studies conducted in primary and secondary schools have shown that digital storytelling, collaborative online projects, and the use of educational technologies support both language development and digital skill acquisition (Hubbard, 2013; Kessler, 2018). These findings underscore the potential of EAL programmes to serve as vehicles for digital inclusion, particularly for students from linguistically and culturally diverse backgrounds.

Despite the promise surrounding digital literacy integration in EAL programmes, several challenges persist. Barriers include unequal access to digital devices and reliable internet, limited teacher training in digital literacy and pedagogy, and the need for culturally and linguistically responsive digital content (Hubbard, 2013; Purmayanti, 2022). Research has identified the need to transform outdated assessment practices, provide ongoing professional development, plan community engagement, and support design of digital materials to ensure relevance and accessibility for all learners (Kessler, 2018). Despite these challenges, the integration of digital literacy into EAL programmes holds significant promise for advancing educational equity and preparing students for participation in digital societies.

2.4 Project-Based Learning, EAL and Digital Literacy

PBL is an instructional approach rooted in constructivist theory, emphasising active, learner-centred engagement through authentic, inquiry-driven projects (Condliffe, 2017). Research suggests well-executed PBL can improve academic learning outcomes while supporting affective and cognitive development (Zhang & Ma, 2023). Within EAL programmes, PBL is theorised to foster meaningful language use, collaboration and critical thinking by situating language learning within relevant, real-world contexts (Beckett & Miller, 2006). Previous research also suggests that PBL can enhance language proficiency and learner engagement among EAL students by providing opportunities for authentic communication, negotiation of meaning, and the development of both oral and writing skills (Beckett & Slater, 2005; Stoller, 2006).

PBL may increase motivation, self-efficacy, collaboration, and 21st century skills particularly when projects are culturally responsive and tailored to learners' linguistic backgrounds (Fragoulis & Tsiplakides, 2009; Guo, 2006; Sah et al., 2024). Pedagogical strategies in PBL-based EAL programmes emphasise the integration of language objectives with content-based learning, the use of cooperative group structures, and the incorporation of multimodal resources (Beckett & Miller, 2006). Teachers employ formative assessment, reflection activities, and peer

feedback to facilitate language development throughout the project cycle (Stoller, 2006). However, challenges persist, including variability in teacher preparedness, time constraints, and the need for alignment with curriculum standards (Beckett & Slater, 2005; Sah et al., 2024). Professional development, institutional support, and collaborative planning are identified as crucial for effective PBL implementation in language classrooms (Fragoulis & Tsiplakides, 2009; Beckett & Miller, 2006; Sah et al., 2024).

PBL has also emerged as an important approach for cultivating digital literacy, leveraging authentic projects to develop students' digital skills in meaningful contexts (Harris & de Bruin, 2018). PBL approaches to digital literacy typically involve collaborative, interdisciplinary tasks that require students to solve real-world problems using digital tools and platforms (Bell, 2010). Empirical studies indicate that PBL supports the development of digital competencies, including information literacy, online communication, and digital content creation (Harris & de Bruin, 2018; Krajcik & Blumenfeld, 2006). Teachers play a pivotal role in modelling digital skills, facilitating collaborative inquiry and providing differentiated support based on students' prior experience and access to technology. However, limited teacher training, the challenge of designing culturally responsive projects, and disparities in digital access are reported constraints (Harris & de Bruin, 2018; Purmayanti, 2022).

Teacher training for interdisciplinary PBL is unique as it often supports the simultaneous acquisition of both content knowledge and pedagogical knowledge and may therefore utilise an action-research approach for modelling PBL pedagogy (Hazard & Liu, 2024). In cases like these in which pedagogical learning is relatively complex, research also suggests that job-embedded learning may be a powerful vehicle for improving teacher learning (Biancarosa et al., 2010; Saunders et al., 2009), particularly when it utilises collaborative learning teams, expert instructional coaching, sustained duration, and sufficient administrative infrastructure (National Institute for Excellence in Teaching [NIET], 2012).

2.5 Current Study

The purpose of the current study is to explore the experiences of a group of EAL educators who received support to co-design and execute a complex project-based digital literacy programme for the first time. The programme was considered complex due to the extensive interdisciplinary digital literacy knowledge required, the need for significant pedagogical shifts away from traditional education, and its extended duration. The teachers used an action-research method to explore the necessary content, pedagogy and implementation, which was framed as a sub form of PBL to support the transfer of skills from their training to their teaching repertoire (Hazard et al., 2025).

This research seeks to better understand and document teacher professional learning within the context of significant transformations to education as well as to investigate the intersection between EAL, digital literacy education and PBL. The research question and sub questions that were formulated to guide this study were:

RQ: What understandings can be uncovered regarding teacher professional development for integrating digital literacy PBL into an English as an Additional Language programme using an action research-based, job-embedded training programme to support design and delivery?

1. How do EAL teachers experience and make sense of the transition to conceptualising digital literacy instruction as a part of their content domain?
2. How does an action research-based, job-embedded, professional development programme shape EAL teachers' capacity to integrate simultaneous content and pedagogy transformation (digital literacy through PBL)?
3. What insight can the findings cast on broader questions of effectively supporting teachers through complex educational transformation?

3. Methodology

3.1 Research Design

The qualitative case study methodology in educational research is characterised by an in-depth, contextually rich examination of a specific phenomenon, group or setting within its natural environment. This approach enables researchers to explore complex processes, practices and interactions as they unfold, thereby generating nuanced insights that are often inaccessible through experimental or survey-based methods (Yin, 2018).

Employing a case study design involves the collection of multiple data sources, including interviews, observations and artefacts, which are triangulated to enhance the validity and reliability of findings (Creswell & Poth, 2018). The method is well-suited to examining the complexity of teacher professional development and instructional innovation in real-world settings, facilitating the identification of emergent themes and patterns relevant to practice. This single case study involved weekly observation of training sessions, meetings and lessons over approximately twelve months, as well as semi-structured interviews, artefact analysis of teacher-made learning exemplars, and teaching materials.

3.2 Context and Participants

The research collected data during and after the design and delivery of a job-embedded PBL training for digital literacy at a bilingual middle school in Beijing, China. The research participants were drawn from a pool of eight middle school EAL teachers who designed and taught a PBL programme. Participation in the research data collection was voluntary and was conducted with informed consent. Seven of the eight teachers agreed to be included in the research. Participant numbers were utilised to anonymise the teachers both in the choice to participate and with regard to their data. The participants were international schoolteachers originating from America, China, South Africa and the United Kingdom. Most of the participants had significant backgrounds in teaching with 2, 8, 8, 9, 15, 16 and 17 years' teaching experience reported.

3.3 Procedure

3.3.1. Teacher Training

The teachers and coaches used an action-research approach to plan, enact, analyse and reflect on the student course. The action research was nestled conceptually into a PBL framework to highlight pedagogical crossover between the training

and the course they delivered (Hazard et al., 2025). Training began two months before the eventual student PBL experience launched to give time for learning the base content and pedagogical knowledge necessary to design the course. Throughout each of the action-research phases, teachers circled back to the driving question: 'What understandings can we, as language teachers, come to about why and how to support student digital literacy through PBL in a Chinese bilingual school context?'

As well as learning to prepare appropriate teaching plans and materials before the student course launch, faculty met weekly throughout the year during and after student course delivery. In these meetings they shared their experiences with peers, gave each other feedback, made individual course adjustments and received ongoing support from professional development coaches. Training meetings occurred for 45 minutes once a week throughout the programme, terminating after a final reflective meeting once the student course finished.

The contents of the training programme can be conceptualised using Shulman's (1986) Pedagogical Content Knowledge (PCK) framework. Pedagogical Knowledge (PK) represents the general teaching techniques teachers need to be effective, such as effective formative assessment. Content Knowledge (CK) represents the subject matter to be studied which teachers must have knowledge of to successfully teach. PCK represents the PK specific to the teaching of a specific programme of study. The more complex Technological Pedagogical Content Knowledge ([TPACK] Koehler & Mishra, 2009) framework was also considered for use but given the relatively low technological demands of the programme it was determined the PCK framework was more suitable for the scenario.

Major targets for the training included the necessary CK for the programme as EAL teachers may not have training in digital literacy. In the case of the teachers who participated, none had digital literacy training. To help develop CK for the student course, the faculty action-research project included a general investigation of the DQ Framework. As well as the framework itself, they studied previous youth training programmes using DQ (Liau et al., 2015). CK development focused on the following topics and subtopics:

- Links between traditional literacy, multiliteracies and digital literacy
- DQ framework overview
- Digital citizen identity and digital academic integrity competency
- Cyberbullying management competency
- Cyber security management competency
- Digital critical thinking competency
- Digital empathy competency
- Privacy management competency
- Digital footprint management competency
- Screen time management competency
- Digital creativity competency

PK was developed implicitly when the teachers experienced learning from the perspective of students undertaking a PBL inquiry and explicitly when receiving

feedback and mentorship from the professional development coaches during training meetings and post-observations. Major areas of PK investigation included:

- Using Sustainable Development Goal 4 set within the wider framework of the SDGs as the overarching context of education.
- Moving from a focus on knowledge acquisition to development of OECD 2030 competencies for student learning goals (OECD, 2018).
- Understanding basic PBL design considerations from the Gold Standard PBL design framework (Larmer et al., 2015) and the Global PBL framework (Hazard, 2023) when developing the programme including:
    - Authenticity, Contexts of Learning, & Sustainability Vision
    - Intellectual Challenge, Depth of Inquiry, & Structure
    - Artefacts of Learning & Meaningful Audience
    - Student Voice, Choice, Diversity, & Inclusion
    - Layers of Collaboration & Assessment Plan
    - Technology, Digital Citizenship, & Digital Academic Integrity
    - Revision, Reflection, Criticality, and Reflexivity
    - Project, School, and Community Impact

- Using big ideas (Wiggins & McTighe, 2005) to build meaningful links between lessons.
- Utilising a student inquiry question and facilitating the ongoing generation of subquestions.
- Understanding common workflows for PBL workshops.
- Understanding active learning and making thinking visible (Ritchhart et al., 2011) in the PBL classroom.
- Embedded formative assessment (Wiliam, 2011) in the PBL classroom.
- Coaching for performance with student teams and individuals.
- Effective PBL team meeting protocols and principles.
- Developing metrics for post-programme evaluation and improvement.

As part of the process of planning, the programme teachers were asked to create an exemplar of the video artefact in pairs to mirror the students' learning journey and understand potential areas of challenge. This, and other PCK for the programme included:

- Differentiated, just-in-time language instruction procedures to be used once a week during the artefact production lesson.
- Multimodal literacy in short form viral videos.
- Summative assessment criteria.
- Video production and specific challenges students might face in their learning artefact development.

3.3.2. Teacher Production and Execution of Student Digital Literacy Course

After their initial investigation of the content and PK required, the teaching faculty developed a fifteen-week student digital literacy course for 79 grade eight EAL students spread across four separate classes. The course utilised a PBL teaching design and had three forty-five-minute lessons a week. The three weekly lessons followed a consistent structure. The first lesson focused on an initial

investigation of a key concept, such as a DQ competency. The second lesson involved deeper practical exploration using age-relevant case studies, initially selected by teachers and later generated by students. The final lesson centred on artefact production, where students synthesised their findings, engaged in discussion, conducted further individual investigation, and created learning artefacts with supportive coaching and just-in-time differentiated language support.

Student learning artefacts consisted of a 5–6-minute paired video script that explained the importance of digital literacy for young people, outlined the DQ framework, examined the component each student considered most important, and presented a call to action for responsible digital citizenship. The second artefact was a video utilising the script that demonstrated awareness of both traditional and multimodal literacy highlighting the students' unique strategies for conveying meaning in the short video medium. Each class had a foreign and a Chinese teacher. The foreign teacher typically led the initial investigation and case study lessons, while the Chinese teacher led the production lesson.

The overlapping artefacts were developed with the mission of generating awareness of digital literacy issues among students' friends and family by sending their finished work to this authentic audience. At the start of the programme, students selected a vulnerable person in their lives, such as a younger sibling or grandparent, and dedicated their artefacts to them to enhance personalisation, meaning, and protective intent. The programme provided for students was guided by the student research question: 'How can we, as concerned young citizens, use our knowledge and skills in digital literacy to educate friends and family on this important issue?'

Several case studies were used to initiate discussion, including youth affected by financial and immigration scams involving criminals impersonating police, immigration officers, or family members; academic integrity and plagiarism breaches; romance scams; and cyberbullying. Further cases explored hacking, phishing, sock puppets and meat puppets, misinformation and fake news, facial recognition, data scraping from social and other media, AI deepfakes, digital addiction, and information interception via open networks. Positive examples were also included, highlighting digital 'heroes' who challenged bullying or harm and young people who used creativity and digital competence to generate positive social impact. Students also generated authentic cases from their own lives and their research for these and other content areas.

3.4. Data Collection and Analysis

Qualitative researcher notes were gathered throughout the year-long process. A second data source was artefact analysis, which included two artefacts. As part of the training, participants developed exemplar student deliverables, including a content-learning video, which were also used to help students understand course success criteria through assessment of the teacher exemplars. The second set of artefacts were the digital teaching materials produced by the teaching team, as these reflected their understanding of target content and pedagogy. A third source

of data was post-programme semi-structured qualitative interviews. Interviews were recorded verbatim and transcribed.
Sample interview questions include:

a) What are your reflections about incorporating digital literacy in your English programme?
b) What, if anything, did you learn from the job-embedded training and how was it different from standard Professional Development (PD) courses?
c) What challenges have you encountered in implementing the PBL for digital literacy programme, and how have you addressed them?

Audio files were compared to the transcriptions to check accuracy. Braun & Clarke's (2006) six-phase thematic analysis was utilised to build consensus on themes for all qualitative data. Qualitative codes were produced from the raw data and built into themes. Themes were built out of the codes and then discussed for possible variations in naming, opportunities to combine or break overarching themes into multiple themes. Once consensus was reached on the themes, they were given final definitions and written into the findings. Then codes and themes from all sources were finally examined for any new insights or reorganisation. Video artefacts were examined using checklists for the target knowledge. Learning materials produced for the course were analysed using the programme learning goals which are detailed in section 3.3.1.

4. Results

4.1. Theme 1: Transition from Traditional EAL to Digital/Multiliteracies

Participating faculty noted the benefit and importance of being provided explicit links between EAL practice, literacy studies and digital literacy frameworks both for themselves and for their students. Participant 3 had identified as an English teacher and had not previously identified with literacy teaching. They described making connections between concepts themselves and with their students:

> *"We mentioned, what is literacy? I realised that, you know, it's like reading, writing… Then I asked them [students], what is digital literacy? They didn't know. But I'm like, you guys do this every day… It's kind of interesting how they wouldn't know what it is until you explain it."*

Participant 1 articulated the connections they made as such:

> *"I know where they [literacy and digital literacy] blend together in my class. I teach students writings skills and, like, sentence structure. But we also have students practice speaking by recording videos or using some apps. So, traditional [literacy] teaching and digital literacy are not opposites. They work hand in hand."*

Overall, both students and teachers found links between traditional literacy studies in the EAL classroom and digital literacy clear once they were introduced to the concepts explicitly. Participant 2 described connecting to tacit student knowledge of digital literacy:

> *"I think the thing is that they might not see it as literacy of a different kind, but you can show them with this [course]. That they're actually transferring skills".*

Participant 4 gave their perspective on integrating digital literacy into EAL in the following manner:

> *"So traditionally, it's basically just traditional reading and writing in English courses, right? That's what we teach in English courses to students. But now… in this programme… we are making digital literacy a huge part of the traditional reading and writing English course… I think traditional methods, they're not, students don't find them very engaging. And I think it's difficult in the classroom to teach if students don't want to interact. I think moving in this manner towards having students interact digitally is the way that we should be going as far as educators."*

4.2. Theme 2: Complex Transformation of CK, PK, and PCK

The programme facilitated the development of CK, PK and PCK—the unique blend of knowing what to teach and how to teach a specific programme effectively in context.

4.2.1 Content Knowledge

Acquisition of CK was initially identified through the analysis of the learning artefact exemplars made as part of the training process. Artefact production required mastery of core digital literacy content, effective multimodal composition using features common to short online videos, such as emojis and sound effects, and the ability to align quality with a specified rubric performance band.

Previous to the teacher training, none of the research participants had prior background in digital literacy or multiliteracy studies, though many were aware of some of the issues from news stories. For example, Participant 4 stated that:

> *"I've had no formal training. I follow the news. So, I'm aware of the concept and I think it's really important, but yeah, no training…I watch a lot of YouTube videos talking about AI, and its impact on society, especially politically and economically. I mean, in the US, that's a big thing… There's a lot of, like, misinformation, and deepfakes and fake news."*

Evidence of deeper content knowledge acquisition was noted later in the lesson content the teachers designed. The first lesson in a week would typically require an investigation of a concept, framework or competency followed by examination of relevant case studies. Analysis of lesson and materials fidelity was completed using the programme learning goals on an ongoing basis and observed performance demonstrated significant content knowledge acquisition that matched or exceeded the level necessary for the course depth.

This evidence was enriched during researcher notes of observation of team meetings and lessons. Combined data from these courses demonstrated that the faculty involved acquired a robust understanding of the DQ framework and how digital literacy overlaps with traditional literacy studies. It was expressed numerous times that the use of a digital literacy framework was particularly helpful, with Participant 1 saying:

> *"As a teacher, also as an adult, I know some digital literacy knowledge. But I didn't learn [study] anything about it. I had some prior knowledge, but I lack a clear framework. The training gave me a really clear framework".*

While understanding of multiliteracies and semiotic theory was basic, teachers demonstrated functional competence through their effective use of colour, emojis, effects, humour, editing, and sound, drawing on prior experience with the medium and insider knowledge of age- and culture-specific signifiers.

4.2.2 Pedagogical Knowledge

Initial PK checks were completed through the learning materials artefact analysis. As well as checking these for content knowledge, it was possible to check for the appropriateness of the learning activities and assessment for PBL pedagogy. There was a sufficient degree of demonstrated PK demonstrated benchmarked to the design frameworks that were used. Notes from observation of the team meetings and lessons indicated that the activities developed in the lesson plans were also well-articulated in the classrooms overall.

There was also self-assessed consensus among the participants that they learned relevant PK throughout the programme. Participants identified the use of milestones with clear deliverables as a particularly effective pedagogical strategy for managing learning and supporting students' metacognitive awareness. It was also noted that good PBL pedagogy includes flexibility with the individual needs of different teams and classes supported by differentiated instruction depending on the results of formative assessment. Milestones interacted with differentiation as they helped keep track of differences between student teams within classes and across classes. Participant 2 described this interaction the following way:

> *"The milestone system really helped. Once we had that, we knew where we wanted to be each week. What we needed to have gone through with students. But I think it's about flexibility… because you can't stick to it [schedule of work], and we talked about that in the meetings. You can't be rigid, because you have different levels, different learners, all of these sorts of things going on. Also, some of the concepts they're really familiar with. You know, cyberbullying. My students knew about it, but then not something else. So, you had to take maybe take a little bit of time out of this competency and then spend more time on that one. I think, yeah, that was a challenge. But we just approached it on a week-by-week basis. Just not being rigid and allowing ourselves to go back to something or go forward to something. We kind of just moved it around."*

There was strong consensus that PBL was an effective teaching approach for the digital literacy content. The most common reasoning for this was that the learning goal for the content was about real-world comprehension, action, and impact and therefore using a pedagogy rooted in authentic inquiry and an authentic audience was realistic, thought provoking and engaging. For example, Participant 4 stated that:

> *"I think PBL is really good because they get real-world experience. They're actually doing it rather than just reading about it in a book or*

> *passively, you know, watching a video and learning passively. So, I'd say the benefit is they're engaging with it. It's active. It's interesting. And I think this topic is probably one of the most important for students to learn… they're interacting with AI and the fact that people don't read newspapers or get their information from traditional news sources. So, I think something like this is critical for student's learning."*

Grounding the student inquiry in problem solving how to help their own friends and family using their learning was seen to give emotional purpose as well as authenticity. Participant 2 described it as:

> *"I think PBL is a chance for them to really explore it [digital literacy] without being lectured in a traditional way… maybe they felt they're in control because we did it from the point of view of helping someone. They need to find out how they can help. Not your teacher is just going to tell you what digital literacy is."*

Participant 5 noted the dimensions of voice and choice demonstrated respect for the students, stating:

> *"Compared to traditional ways of teaching digital literacy, PBL will give students… voice and choice. So, we respect the students to express their ideas rather than push them to absorb the knowledge that we want to cover".*

Participant 7 noted the engagement that came from developing English language capacity centred on a topic and problem that was authentic and personally meaningful, noting:

> *"When we actually sat down and had discussions in my office and groups of students, they would actually be able to articulate what they were doing and why they thought it was important… Academically, some were really, really good, but some were lower. And even the ones that were lower academically or from a literacy point of view… They were engaged. So, I like that."*

Participant 6 noted the pedagogy's ability to support learning between students:

> *"PBL makes it a bit more active for the learners… for them just to have more input from themselves rather than the communication flowing in one direction. So, they might [normally] learn about something and then they regurgitate what they learn… or they can have a project where they can show their own ideas and understanding of what we've learned. So, it becomes more active in terms of the learning and the output as well."*

The opening and closing activities, which brought all the students involved together and mixed them across classes for initial inquiry and case study activities and then the sharing of final reflections was noted as useful pedagogically by participants. Participant 1 noted:

> "*The trainings, opening and closing ceremonies impressed me a lot. The opening ceremony stimulated students interests and the closing ceremony gives students a sense of recognition and their contributions and their videos are shared with everyone*."

Participants highlighted the value of the cooperative programme development model, in which the team collaboratively contributed content ideas, shared experiences, and exchanged feedback while implementing the pedagogy and content. Participant 1 described the process as:

> "*Our team built together. I didn't develop it by myself. We, you know, we have the same goals and structure first and then split tasks. Some teachers wrote content, made PowerPoints and others, you know, plan activities*".

Observational notes confirm that significant negotiation and revision happened as the teachers made their way through the programme, allowing them to adjust content and learning activities as necessary.

4.2.3 Pedagogical Content Knowledge

The production and use of an exemplar of the final student artefact (a video) was an important component of the training model, serving multiple functions such as ensuring foundational CK. The exemplars also supported course specific PCK such as understanding the technical video production requirements, multimodal discourse symbols for the genre, success criteria for grading and common areas of difficulty or confusion. Artefact analysis of the faculty produced exemplar videos demonstrated not only content knowledge, but also many multimodal meaning-making strategies such as use of colour, music, emojis, memes and other signifiers from new literacies.

The participants also went through a training activity in which they graded the various exemplars and negotiated their results to better build inter-rater reliability as well as understand problems students might have when completing the same process later. This experience translated into enhanced PCK when supporting students during throughout the course as artefact production occurred every week. Participant 2 found it "*really valuable*" to be asked to do what the students would do, helping them understand the challenges and processes involved, thereby building empathy and practical understanding. Participant 1 stated:

> "*Producing the exemplar was an interesting part of the course because, actually, that was the first time I've been asked to do what the students will be asked to do. So that part, I think, is really valuable because we've done it. Then by the time you get round to asking the students, what to do, you have firsthand knowledge.*"

The combination of CK, PK, and PCK in this programme led to an overall consensus the combination of content and pedagogy was meaningful for both teachers and students. Participant 4 noted:

> "*I feel more knowledgeable about digital literacy just from having participated in this project. And I would also say the end results watching the student videos… They were better than I was expecting. And I feel like most of the groups put a lot of effort into it, even the one that was not as good as the others. I can still see the students put effort in. So, I was happy with the end result. The fact that the students took it seriously and… tried to do a good job versus just submitting something and not caring.*"

Several of the participants mentioned the fact that the experience helped create mutual understanding and deepened the bonds between teachers and students. For example, Participant 3 stated:

> *"Through the PBL I just wanna mention my most rewarding part was definitely just hearing those stories and having the interactions with the students. It was more personal. So, I really enjoyed that. I… would also then add the fact that I could just bond better with my students. Yeah, I enjoyed that. And I enjoyed seeing the little quirky things that added to their videos. It's applicable to their daily lives, and it's also kind of nice learning more about your students that way. I think it kind of helps with the student-teacher bond as well because they're sharing some more personal things."*

The participants universally described a sense of learning together through this process of inquiry and problem solving. Participant 1 exemplified this, saying:

> *"The rewarding part is the growing together with my students. I know they made some mistakes online and they faced some consequences. It's really happening in real life. But through this… our shared learning, I understand them better. And you know, we can solve the problems together because we have been through the same lessons. We have the same background."*

4.3. Theme 3: Value of Sustained, Job-Embedded Training

A dominant finding was the contrast participants drew between the job-embedded training and standard intensive professional development courses. The extended duration and embedded support were consistently highlighted as critical to success. Participant 7 stated:

> "*It was a whole lot more depth than a standard PD course… completely different to, like, if you do a course for two days at the beginning of a semester… having that support over the year, like, made a big difference".*

Having the training integrated with instruction was specifically noted by Participant 5, who stated:

> *"We [previously] did a lot of training, but this time I work as an instructor or a teacher. So, it gave me more context about the real situation we are facing".*

Rooting the training in teacher inquiry was seen as valuable as it modelled the process the students were going through with their own inquiry question. For example, Participant 4 indicated:

> *"I mean as far as the training… having an overarching question was valuable and also trying to have students have their thinking around that".*

The inquiry-orientation also appeared to deepen understanding of self-directed learning. The development of self-directed learning is typically one of the goals of PBL but may be lost if inquiry is diluted too much (Hazard et al., 2025). Participant 2 noted:

> *"I personally learned quite a lot in how to approach the project as opposed to what I've done in the past. I think a lot of what I had seen and done with projects in teaching didn't feel like there was something that, I suppose, was geared towards making the students learn by themselves. I think a lot of what this showed me was the idea is that we're giving them tools to learn about this topic as opposed to just teaching."*

The ongoing format of the training was also impactful as it modelled how teaching teams can interact, give feedback and make changes throughout learning experiences, particularly for interdisciplinary PBL programmes that run across departments. Participant 3 described this facet in some detail:

> *"I think the way we approached it was a lot different, because it was a lot of content that would be unfamiliar to some of the teachers, and also the students. So, the fact that we got together to discuss it before teaching it to the students, I think was really helpful. And then also the feedback afterwards. It would help us to adapt to how to approach even the next class in the content coming next. This was, like, a nice consolidation of how to teach PBL in a new fresh way. And also, you'd hear feedback from your peers. So then obviously, I formed the way of how I would teach it in my head, but then I heard other people saying how they would approach it. And that would also form how, and change how, I would approach it."*

This balance between pre-course training and the ongoing support was exemplified by Participant 2:

> *"The pre-course training was really good, because for me personally, that was the first time at this school that I had training specifically on how to put together and run a PBL, which kind of highlighted a lot of things that I thought in the past, that maybe were wrong or needed to be kind of updated. So that I really understood what I was trying to do. The meetings helped, because I think as a team, we were all sort of new to this thing. It was a new project for us. So, coming together and being able to talk about where people are in the project, what challenges they've had, what things they've done that worked was helpful to kind of anchor us… And if we had problems, we were able to ask other people."*

This ongoing problem solving was particularly important also because of the necessary change in student mindset that came with the pedagogy, which Participant 5 described as:

> *"The biggest challenge for us was most of the students, when they first took this course, they thought it should be kind of a traditional course. So, they pretend, or they always want to know 'the answer' for the questions, or the case studies. However, that's not what we want… we have to shift their minds like to think creatively… to guide them, to enlighten them how to answer the question by themselves."*

4.4. Theme 4: Navigating Systemic and Practical Implementation Hurdles

Despite the positive outcomes, the analysis revealed significant challenges that impacted the programme's delivery. The most reported issue was keeping students on task while using devices for extended durations. Participant 3 noted:

> *"I feel like I don't have enough eyes to make sure that they stay on topic. And that's what I mean when they use the devices. When it comes to teaching the content… it's just the normal challenges of, like, attention. The kids being tired because they're probably staying up late doom scrolling or something like that."*

Strategies included using tools such as Apple Classroom, continuous movement and observation, and explicitly teaching feedback, revision, and self-directed improvement, for example through the video *Austin's Butterfly* (EL Education, 2017), to support sustained incremental improvement.

Another challenge was balancing the many demands on teacher time with the need to engage in professional learning and a new curricular style, which was exemplified by Participant 1's statement that:

> "*The challenge is to balance my time, my teaching time, my learning time, and I think it's… a little overwhelming, finishing daily teaching tasks and PBL is also a heavy time demand and requires really careful time planning".*

Some teachers noted that conflicting priorities meant they or their team members could not always engage as deeply as would be optimal, such as Participant 4 who noted:

> *"My co-teacher couldn't always go to the meetings, because she had tutorials".*

Participant 7 called the hectic school duty structure a limiting factor, feeling

> "*Hostage to different things at different times*",

particularly noting competing pressures due to standardised English exams and suggesting a shorter duration might be more feasible. Participant 1 and Participant 3 also recommended a tighter timeline to maintain student focus.

These issues resulted in a description of the importance of top-down support for teachers. Participant 6 explained the necessity to

> "*Have the whole backing of people around you*,"

revealing that conflicting time and assessment priorities from higher management were de-motivating.

5. Discussion

There are several significant findings for discussion. The first is that EAL teachers in the field can benefit from explicit training linking traditional literacy, multiliteracies and digital literacy frameworks to help them conceptualise these as extensions of their previous content knowledge. Once these links are formed, digital literacy studies may become a natural extension of traditional EAL content and pedagogy.

Participating teachers demonstrated strong practical multiliteracy knowledge through their use of contemporary short-video conventions, including editing styles, emojis, memes, text, sound effects, colour, and other multimodal elements. They also adopted a casual, adolescent register in their exemplars, implicitly

validating student self-expression while still modelling the use of target competency vocabulary.

Similarly, students utilised a wide variety of creative elements and humour to enhance meaning in their video work, using both casual register and slang appropriate for their target audience, which was friends and family. Notions of bottom-up citizenship and community as discussed by Cope & Kalantzis (2009) did come to the fore both within the context of the final learning artefact to educate and protect friends, family and the online community of the students. Several of the teachers relayed that the student's genuineness in this regard, especially in working against cyberbullying. However, although the teachers and students demonstrated criticality toward digital media content and users, there was no evidence that they used the programme to critique major power structures for emancipatory purposes as recommended by the New London Group (1996).

An important consideration that emerged from this work was explicit instruction in the concept of signals and semiotics for meaning making in multimodal composition. Such instruction should allow students to reflect upon similarities and differences in their own semiotic dialects. Cope and Kalantzis (2009) state that we increasingly exist with a variety of identities that function in a multitude of spheres of experience and therefore the conventions by which we make meaning need to be addressed in a bottom-up fashion. In this case study, we found that students need to have enough instruction to allow them to take over the process of identifying variables that create our unique multiliteracy dialects.

These include culture, age and affinity groups, among other factors. This is important because the teacher cannot know the semiotics of all multimodal dialects. The teacher's role is to make multimodal dialects explicit, model examples from their own dialect, and invite alternative interpretations. For instance, discussing emoji use can highlight how meanings vary across ages and cultures, such as the smile emoji differing in Western and younger Asian contexts. These examples provide a starting point for reflecting on, comparing, and applying meaning markers effectively across dialects.

A second area of findings was that an action research-based inquiry approach was found to be an effective vehicle for preparing teaching teams to design and execute interdisciplinary PBL. This finding is congruent with other work on teacher capacity building for simultaneous interdisciplinary CK, PK, and PCK for PBL (Hazard & Liu, 2024). Regarding PK for digital literacy, the participating teachers unanimously found a PBL approach to be an effective vehicle for acquiring knowledge, skills and attitudes that could be used to affect real-world digital empowerment. Utilising authentic learning artefacts is recommended in PBL design (Larmer et al., 2015). This authenticity was enhanced by levering the meaningful audience dimension by including families and peer groups, but also by specifically targeting a loved one to dedicate the project to and thereby protect from harm.

A third area of findings was that the participants unanimously found added value in the long-duration, work embedded professional development. However, despite the high level of professional development support, the teachers faced systemic and practical hurdles when implementing their programme with students, including competing time demands and curricular pressures. These are consistent with the literature which advocates for consistent leadership support for PBL programmes and an awareness of the need to manage curricular pressures (Sah et al., 2024; Santos et al., 2025).

Another systemic challenge was balancing support for multimodal meaning-making and creative composition with the emphasis on standard English conventions assessed in standardized testing (Cope & Kalantzis, 2009). This is an important consideration and one that will be felt in many educational contexts. As language, particularly multimodal communication, evolves, programmes face difficult choices between prioritizing authentic, relevant communication and focusing on the conventions assessed by standardized tests. This issue could be taken on explicitly to help develop critical language awareness and critical multimodal literacy that interrogates the privileged position of some dialects, languages and media over others. Furthermore, a stronger element of critical pedagogy could question the broader power structures in play, such as the educational system, government policy or international structures.

A final area of findings for discussion is a synthesis of what was learned about supporting teachers through complex educational transformation through this case. Adult learning may be more-or-less structured, including formal, non-formal, and informal learning (Merriam & Baumgartner, 2020). As well as a variable amount of structure, there are also a variety of formats for professional development such as short-duration intensive training and ongoing job-embedded training (NIET, 2012). The research findings suggest that complex teaching innovation programmes can be supported through special projects that bring coaches and practicing teachers together as collaborators to work through the entire cycle of programme design, execution and evaluation together. This research confirmed that even teachers who had previously taken intensive PBL design courses felt strongly that they benefitted from sustained coaching. This finding supports the idea that PBL can be highly effective, but it requires significant and complex changes in pedagogy which take time, practice, and reflection to develop (Condliffe, 2017).

NIET (2012) identifies many benefits of job-embedded training but also highlights the fact that it is more costly than intensive programmes and should be justifiable. This decision-making process should ideally consider duration and complexity of implementation for new content, pedagogy and/or technology. We suggest that if educational transformations are straightforward, such as switching from standard questioning to a question randomiser, a short duration of professional development and classroom implementation may be enough to create measurable impact. However, in cases where the pedagogical practice is complex, such as designing and implementing interdisciplinary PBL or utilising classroom technologies, data analysis evaluating short learning interventions may produce

results that demonstrate little impact, even if the technique has value. This suggests that educational leaders should carefully consider training, supports and the planned duration of complex educational transformation projects.

This situation may become more commonplace as schools increasingly move from teaching for disciplinary knowledge to multifaceted competencies, integrate novel curricula such as PBL, explore emerging technologies such as AI, and respond to other trends of the fourth industrial revolution. Amid staff limitations, financial constraints, and competing priorities, institutional leaders may overlook that setting a transformative vision is only one step in the chain of successful school innovation. Deep transformations to teaching and learning may require substantial time and support for leaders, teaching faculty and students. Offering broad spectrum support that considers the full range of possible formal, non-formal, and informal learning options is an important part of planning transformation. This research supports previous work that indicates intensive training may not be sufficient in all cases (NIET, 2012). Furthermore, it supports the use of teacher action research as a vehicle for teachers to plan, execute, analyse and reflect on changes to their programming, teaching and technology use.

To this end, after tracking educational transformation using action research over a wide variety of cases, we propose the TSET action-research model. This model is designed to help plan and guide programmes involving significant changes in content knowledge, PK, and technological knowledge. This process uses a standard four-step action-research methodology (adapted from McNiff, 2013) to plan, act, analyse and reflect on educational transformations. It is novel in that it builds in an explicit decision-making process to determine necessary training, leadership and institutional supports during the planning phase. Having such a protocol may help to avoid blind spots in order to maximise student, faculty and institutional learning.

Phase 1 begins normally with collaborative problem framing and planning the action-research cycle but adds an explicit step in which leaders, coaches and teachers work together to co-construct what content, pedagogy, and technologies will be targeted for training using a framework such as PCK (Shulman, 1986) or TPACK (Koehler & Mishra, 2009). For example, in cases of interdisciplinary content that teachers are unfamiliar with, the content knowledge to be delivered must be added to the training objectives.

In phase 2 the stakeholders identify the knowledge gaps and consider the relative complexity of the transformation. This includes the refining the specific content, pedagogical and technological knowledge objectives; the anticipated time a new technique or technology will be used for; and potential institutional conflicts or problems that require mitigation planning or ongoing support. In phase 3 the training and support plan is formed to address weaknesses and threats while maximising strengths and opportunities. These could include the level of formality of supports, such as informal, non-formal and formal training. It also includes the format of support, such as short-duration intensive training, full-duration job-embedded coaching, stimulation of a community of practice, cross-

functional management teams or any combination of these depending on the scenario. Planning should ideally include necessary leadership and other institutional support and what criteria will be used to identify when support is no longer necessary. Finally, the research plan can be finalised, including data sources and analysis plans that consider all relevant stakeholders for the scope of study (for example institutional, teacher and student learning outcomes).
In phase 4 the training and educational transformation initiative are executed. Data is gathered and analysed as it comes in to allow for rapid adaptation. In phase 5 the final analysis is performed on the project data. Finally, in phase 6 the overall adoption project, including training and other features identified for inquiry (student learning and satisfaction for example) are evaluated, reflected upon and future actions planned.

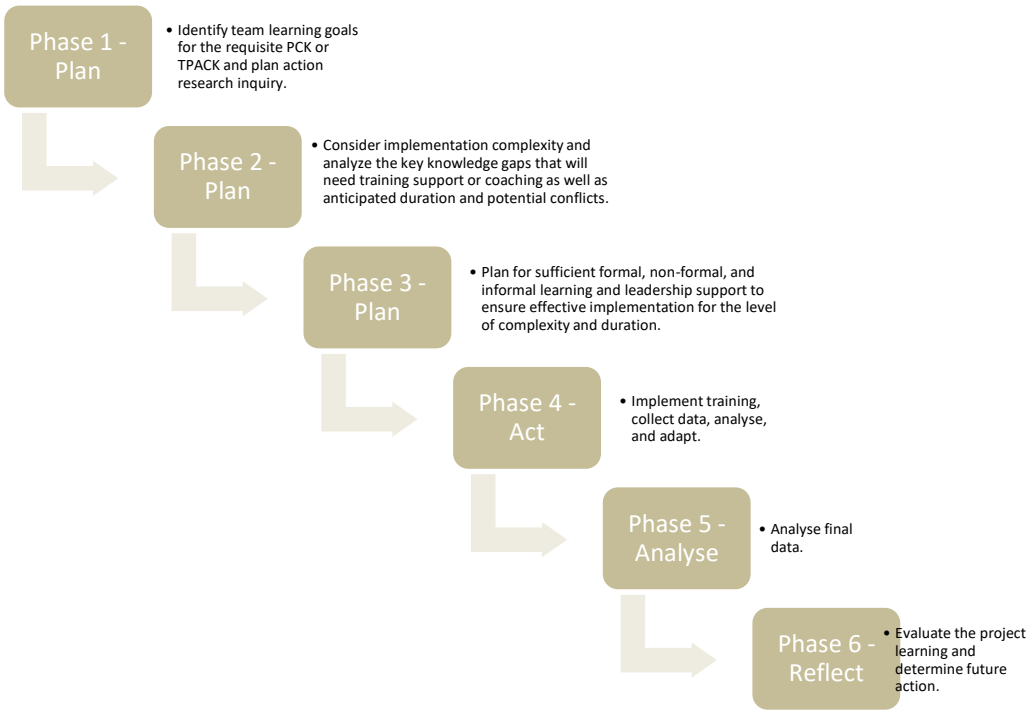

Figure 1: TSET action-research model

This model is explicitly participatory and highlights the methodological benefit of incorporating systematic inquiry, data collection and reflection using action research to guide and evaluate the implementation. It also underscores a number of extra phases in planning to ensure that the training is optimised for the relative complexity of the target PCK or TPACK and the context. It emphasises the reciprocal relationship between teacher inquiry and effective practice, showing that sustained, collaborative, inquiry-based professional learning embedded in real work contexts supports adaptive, ongoing transformation. It also reminds planners to consider leadership and other structural supports to avoid problems such as conflicts between leaders with different priorities and curriculum-assessment disconnect.

A case study approach was undertaken for this research as the goal was to explore the complexity of the phenomena under study. Artefact analysis provided a relatively valid and reliable measure of the CK, PK and PCK that teachers acquired. Additionally, the responses articulated by the participants in qualitative semi-structured interviews show alignment with the research questions. As case study research, the findings are not intended to be reliable across contexts, though they do fit a pattern in the literature.

In this case, the data showed a high level of consensus, which is likely due to the significant support offered from both the coaches and the leadership within the context. It is likely there would be more dissent in cases without such support. The TSET framework emerged after several research projects investigating action research being utilised for educational transformation, such as Hazard and Liu (2024) and Hazard et al. (2025), among others. It is offered as a locally relevant way of supporting educational transformation that requires confirmatory study in other contexts. Future research in different contexts that investigate a range of content, pedagogical and technological transformation would be useful.

6. Conclusions and Implications

This study explored the transition of EAL teachers from traditional literacy to explicit digital literacy in their content and from their current teaching approach to a PBL pedagogical approach. There were several findings with meaningful implications. The first implication is that EAL teachers in the field can benefit from explicit training linking traditional literacy and digital literacy frameworks to help them conceptualise these as extensions of their previous content rather than replacements. When these links are formed, EAL may become a natural discipline for housing digital literacy studies and significant transfer of content and PK may occur. The suggests that EAL faculties that do not already make explicit links between these areas may benefit from doing so.

A second implication is that action research, can be a useful training vehicle for developing knowledge, skills and attitudes for teacher professional development and helping to support institutional learning. Whether institutions commission faculties external professional development or engage in internal learning, they may wish to consider an authentic, inquiry-based approach when developing teachers or planning novel student programmes. In cases where the pedagogical change is PBL related, framing action research as a form of PBL and utilising PBL teaching techniques may assist transfer from training to the classroom.

A third implication is that training for complex transformation to CK, PK, and technological knowledge can be supported through programmes that bring experts and practicing teachers together as collaborators to work through an entire design, execution and evaluation cycle together. This may be seen as an extension of intensive training courses rather than a replacement and, due to the resource requirements, may need to be used sparingly and strategically. However, the use of this technique may be pivotal in the successful adoption of complex teaching or technology innovations.

Deciding on the amount and type of support may be aided by using a systematic process such as the TSET action-research model. As well as avoiding blind spots in the planning phase, this may help create a shared vision and a consistent support plan from leadership that includes all relevant stakeholders. For example, creating clear understanding of how transformations will interact with regular curricula and any standardised assessments and building flexibility into programme design to accommodate unexpected needs is more likely if there is a comprehensive planning process.

Extended coaching and job-embedded training may bring many benefits but is resource intensive. Given this reality, we suggest faculties identify potential coaches among them who can specialise in mentoring for content, teaching techniques or technologies. It may also be beneficial to set up communities of practice or research teams around known transformations to develop sharable expertise and a body of contextualised experience.

7. Statements of Interest

Declaration of interest: The authors declared that there were no potential conflicts of interest.

Data availability: The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request provided that such requests will not compromise anonymity of participants.

Authorship and contributions: All authors contributed significantly.

Ethical declaration: This research was conducted in compliance with ethical guidelines, ensuring voluntary participation, informed consent and the confidentiality and anonymity of all data.

Funding: The authors received no financial support for this article's research and/or authorship.

8. Acknowledgements

The authors wish to acknowledge the use of Microsoft Copilot to improve the readability of the document. This tool was used to help improve the language and grammar in the paper. The paper remains an accurate representation of the authors' work and intellectual contributions.

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