ICCCM-JOURNAL OF SOCIAL SCIENCES AND HUMANITIES
2026; 5(5): 35-42
Published online 17 11 2026 (https://icccmjssh.com/)
doi: https://doi.org/10.53797/icccmjssh.v5i5.5.2026
e-ISSN 2811-4469

Three Modernisations, Five Commons and Three Progressive Stages: A Case Study of School–Enterprise Collaborative Training of Field Engineers in a Chinese Higher Vocational College

Guo, X.

Xi'an Vocational and Technical College,
Xi'an City, Shaanxi Province, 710077, CHINA

*Corresponding Author: 331019994@qq.com

To Cite This Article:
Guo, X. (2026). Three Modernisations, Five Commons and Three Progressive Stages: A Case Study of School–Enterprise Collaborative Training of Field Engineers in a Chinese Higher Vocational College. *ICCCM Journal of Social Sciences and Humanities*, 5(5), 35–42.
https://doi.org/10.53797/icccmjssh.v5i5.5.2026

Abstract: Graduates of vocational programmes in the new-generation information technology industry often match employers' job requirements poorly, and the transition from classroom practice to real work remains difficult. In response to China's national special training plan for field engineers, Xi'an Vocational and Technical College and Beijing New World Times Science and Technology Co., Ltd. established a joint field-engineer programme for Java development and technical support posts. This article presents a qualitative case study of that programme, based on documentary analysis of project records and institutional reports interpreted through research on workplace learning and boundary crossing. The programme rests on three supports (a substantive governance organisation, a digital industry-data platform and institutionalised standards), a five-part closed loop in which school and enterprise jointly select entrants, teach, build learning resources, manage the process and evaluate results, and a three-stage practical sequence that moves students from post recognition on campus, through project rotation in the enterprise, to certified post-holding. Reported outputs include donated training equipment, jointly developed digital teaching resources, competition awards and high first-destination employment, although these figures come from the programme's own records and have not been independently verified. The analysis suggests that institutionalised rights and responsibilities, deliberate support for crossing the boundary between school and work, and continuous feedback from industry data are the features most likely to transfer to other colleges. Limitations and directions for outcome-focused research are discussed.

Keywords: Field engineer, school–enterprise cooperation, work-based learning, boundary crossing, vocational education, case study

1. Introduction

The new-generation information technology industry changes faster than most vocational curricula can follow. Programming frameworks, cloud and data platforms, and the job roles built around them are revised within the lifetime of a three-year diploma, so that a curriculum designed at the start of a cohort's studies may be partly outdated by graduation. Employers report that graduates can complete textbook exercises but struggle with the routines, tools and quality expectations of real projects. This gap between training and employment is often described in Chinese vocational education as the problem of the "last mile".

The gap is not unique to China. Across OECD countries, vocational systems are being asked to respond more quickly to changing skill needs and to support smoother transitions into a changing labour market (OECD, 2023). Comparative research on the international transfer of vocational education shows that models built around close collaboration with employers, such as dual or apprenticeship systems, depend heavily on local institutions and on the willingness of firms to share responsibility for training (Li & Pilz, 2023).

In China, the policy response has included a national special training plan for field engineers. Issued in 2022 by the Ministry of Education together with four other departments, the plan asks vocational colleges and enterprises to train, through an apprenticeship model with Chinese characteristics, technicians who can operate precisely, understand

*Corresponding author: 331019994@qq.com
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processes, manage well, collaborate and innovate in digital and intelligent posts that are in short supply (Ministry of Education of the People's Republic of China, 2022). A follow-up notice launched the first batch of national projects in advanced manufacturing and set out requirements for joint school–enterprise implementation, reform of admission and assessment, and dual-qualified teaching teams (Ministry of Education of the People's Republic of China, 2023).

Policy alone, however, does not explain how a college and an enterprise turn these requirements into a working programme. Research on workplace learning has long shown that learning at work depends on the guidance, participation and affordances that the workplace offers (Billett, 2001), and that learners must be helped to connect what they learn in different settings (Guile & Griffiths, 2001). Reviews of vocational education find that students often experience school-based and workplace learning as separate worlds, and that integration of knowledge, skills and attitudes across them needs deliberate support (Schaap et al., 2012).

The concept of boundary crossing offers a useful lens on this problem. Akkerman and Bakker (2011) describe boundaries as sociocultural differences that cause discontinuity in action or interaction, and identify identification, coordination, reflection and transformation as mechanisms through which learning can occur at boundaries. In a study of apprenticeships, the same authors showed that school and work can feed each other when apprentices are supported to move between them (Akkerman & Bakker, 2012).

Two further strands of theory are relevant. Situated learning theory treats learning as increasing participation in a community of practice, beginning with legitimate peripheral participation (Lave & Wenger, 1991), and communities of practice develop shared repertoires through mutual engagement (Wenger, 1998). Experiential learning theory describes learning as a cycle of concrete experience, reflection, conceptualisation and active experimentation (Kolb, 2015), echoing Dewey's (1938) argument that experience educates only when it is structured and reflected upon.

Project-based learning provides a further point of reference, since many school–enterprise programmes reorganise curricula around real or realistic projects. A review of the literature concluded that project-based learning can support engagement and skill development, but that its effects depend on scaffolding, group processes and well-aligned assessment, and that causal evidence remains limited (Kokotsaki et al., 2016). This caution matters for any account, including the present one, that attributes improved outcomes to a redesigned curriculum.

The regional context adds to the problem. Western China has a smaller concentration of leading technology firms than the eastern coastal provinces, so colleges in cities such as Xi'an often depend on partnerships with enterprises headquartered elsewhere, and graduates may face a choice between local employment and migration. Programmes that link a regional college with a national enterprise must therefore manage distance as well as differences between educational and workplace practice.

Chinese accounts of field-engineer programmes are numerous but mostly descriptive. They tend to present a college's own model and achievements without stating how evidence was gathered, and rarely connect practice to the international literature on workplace learning. As a result, it is difficult to judge which features of a given programme are distinctive and which might transfer to other settings.

This article addresses that gap through a case study of the field-engineer programme jointly run by Xi'an Vocational and Technical College and Beijing New World Times Science and Technology Co., Ltd. It asks three questions: (1) How is the programme organised and governed? (2) How does it structure students' movement between school and enterprise? (3) Which of its features appear transferable, and what are the limits of the evidence? The study describes the programme as documented by its participants; it does not measure learning outcomes against a comparison group.

2. Literature Review

2.1 Workplace Learning and Boundary Crossing in Vocational Education

Research on vocational learning distinguishes between learning in educational institutions and learning in workplaces, and increasingly treats the relationship between them as the central design problem. Billett (2001) argued that workplaces are legitimate learning environments, but that the quality of learning depends on how work is organised and on the guidance available. Guile and Griffiths (2001) proposed a connective model of work experience in which learners are supported to relate formal knowledge to the contexts in which it is used.

Empirical work confirms the difficulty of integration. Schaap et al. (2012) reviewed studies of students' learning processes in school and workplace settings and found that students act as novices with different learning styles in each, and that enhancing their learning requires adaptive and differentiated support. Akkerman and Bakker (2012) showed that apprentices can act as brokers between school and work, and that institutions can deliberately create boundary objects and practices, such as shared assignments and joint assessment, that connect the two settings.

Situated perspectives add that newcomers become competent practitioners by moving from peripheral to fuller participation in a community of practice (Lave & Wenger, 1991). For vocational programmes, this implies a staged progression in which students take on increasingly authentic and responsible tasks, guided by experienced practitioners. It also implies that teachers and enterprise engineers who teach together form a community of practice of their own, whose shared repertoire shapes what students learn (Wenger, 1998).

2.2 Field Engineers and School–Enterprise Cooperation in China

The field-engineer plan builds on earlier Chinese reforms, including modern apprenticeship pilots and the integration of industry and education. The 2022 notice sets a target of training field engineers in digital and intelligent posts through joint school–enterprise programmes, while the 2023 notice specifies that projects should be jointly applied for by a college and an enterprise, reform admission and assessment, and build dual-structure teaching teams (Ministry of Education of the People's Republic of China, 2022, 2023). These documents define what programmes should achieve but leave the design of governance, curriculum and assessment to the partners.

The international literature suggests that such designs succeed when responsibilities are clearly allocated and when firms see a stable benefit in participation (Li & Pilz, 2023). It also suggests that programme descriptions should be read with care: much of the evidence on school–enterprise cooperation comes from the institutions involved, and few studies compare outcomes with those of similar students who did not take part. The present study therefore treats the programme's reported results as claims to be interpreted rather than as established effects.

3. Case Study Method

3.1 Research Design

The study adopted a qualitative, single-case design that is descriptive and interpretive in purpose (Yin, 2018). The unit of analysis is the field-engineer programme understood as a school–enterprise system: its governance, its joint teaching and assessment processes, and the sequence through which students move between college and enterprise. The case is bounded by the three cohorts of orientation classes reported by the programme. A case design was chosen because the aim is to describe how such a programme is organised and to interpret its features through theory, not to estimate its effects; the design therefore makes no causal claims about the outcomes reported in Section 4.4.

The evidence is documentary (Bowen, 2009), consisting of records produced in the ordinary course of running the programme, and is complemented by the authors' practitioner knowledge as staff involved in its delivery. This combination is common in practitioner case studies: documents provide a stable and checkable record of what was planned and done, while practitioner knowledge helps to interpret how documented arrangements operate.

3.2 Case and Context

Xi'an Vocational and Technical College is a higher vocational college in Shaanxi Province. The field-engineer programme is located in its computer application technology and computer network technology programmes, which belong to the college's animation production technology programme group, and targets two posts: Java development engineer and technical support engineer. The enterprise partner is Beijing New World Times Science and Technology Co., Ltd. According to the college, the programme was selected among Shaanxi Province's first batch of provincial field-engineer projects and has enrolled orientation classes for three consecutive cohorts.

3.3 Evidence Base

Four types of document were used, each linked to particular findings (Table 1). Governance documents, including the measures for the construction and operation of the field-engineer workshop and the council's division of responsibilities, inform the analysis of organisational supports. Curriculum and assessment documents, including the selection criteria, revised curriculum and post competence standards, class management rules and stage assessment rules, inform the analysis of the joint processes and practical stages. Project records and the college's enrolment, scholarship and graduate employment records supply the reported outputs.

Table 1 - Evidence Base Mapped to the Findings

Finding area	Main evidence	What the evidence can show	What it cannot show
Organisational supports (4.1)	Governance structure, workshop measures, partnership agreement, platform documentation	Formal structures, roles and allocated responsibilities	How often structures meet or how decisions are made in practice
Joint processes (4.2)	Selection criteria, curriculum and competence standards, class rules, assessment rules	Designed procedures and who takes part in them	Consistency of implementation across cohorts
Practical stages (4.3)	Training scheme, stage arrangements, P2 to P4 assessment rules	Sequence, duration and settings of practical learning	Students' experience of the stages
Reported outputs (4.4)	Project records, competition results, employment records	Activity and outputs recorded by the programme	Effects relative to comparable students

3.4 Analytic Framework and Procedure

The analysis proceeded in three steps. First, documents were organised deductively under the programme's own three-part model of organisational supports, joint processes and practical stages. Second, within each part, statements were coded thematically for structures, actors, activities and forms of assessment (Braun & Clarke, 2006). Third, the coded material was interpreted through three concepts from the literature: boundary crossing between school and work (Akkerman & Bakker, 2011), staged participation in a community of practice (Lave & Wenger, 1991), and competence-based assessment as a shared standard. A feature was reported only when it appeared in at least two documents, and designed arrangements were kept distinct from reported results. Outcome figures were tabulated without inferential claims.

3.5 Positionality and Limitations of the Evidence

The authors work at the college whose programme is described. This position provides detailed knowledge but also creates a risk of favourable interpretation, which the separation of designed features from reported outcomes is intended to limit. Most of the evidence was produced by the programme itself, students' and enterprise staff's views were not collected independently, and there is no comparison group. The findings should therefore be read as a description of how the programme is designed and reported, not as evidence of its effects.

4. Findings

The programme describes itself as a model of "three modernisations, five commons and three progressive stages", summarised in Fig. 1. The three modernisations are organisational supports; the five commons are joint school–enterprise processes; and the three stages structure students' practical learning across the programme.

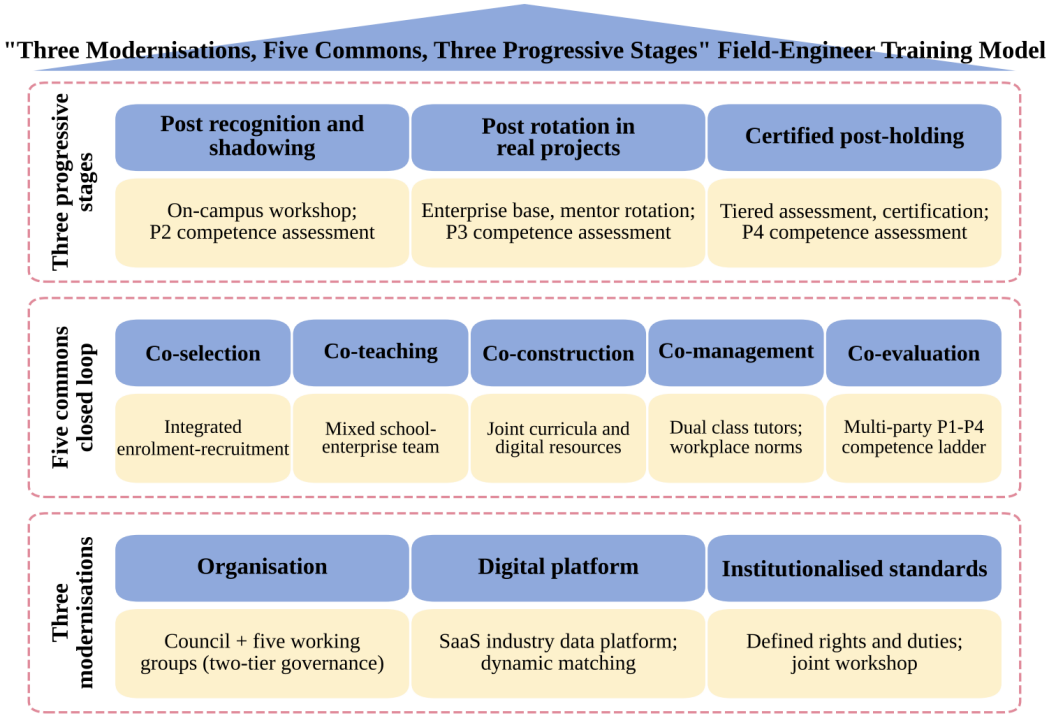


Fig. 1 - The "Three Modernisations, Five Commons, Three Progressive Stages" Field-Engineer Training Model

4.1 Three Modernisations: Organisational Supports

The first support is a substantive organisation. The programme is governed by a two-tier structure consisting of a project management council, formed by leaders of the college and the enterprise and responsible for top-level design, resource coordination, major decisions and supervision, and five working groups for teaching guidance, teaching implementation, recruitment and employment, student management, and research and demonstration. This structure links strategic decisions to front-line teaching. Its practical significance is that responsibility for the programme does not rest with a single department or a single enterprise contact, which reduces the dependence of the partnership on particular individuals.

The second support is a digital platform. The partners built an industry big-data platform on a software-as-a-service architecture, used for job-demand research and competence mapping. According to the project documents, the platform synchronises industry job standards, technology trends and changes in enterprise demand, and is used to revise the training scheme, curriculum content and practical projects.

The third support is a set of institutionalised standards. The partners jointly built a field-engineer workshop and clarified their respective rights and responsibilities for resource input, teacher assignment, project supply, training and the sharing of results. Supporting measures cover the whole process of enrolment, teaching, management and evaluation.

4.2 Five Commons: A Closed Loop of Joint Processes

The programme organises school–enterprise collaboration as a closed loop of five joint processes (Fig. 2). Co-selection integrates enrolment with recruitment: school and enterprise jointly set four-dimensional criteria (literacy potential, logical thinking, technical foundation and career adaptability) and select students for the two target posts. Co-teaching establishes a two-way flow of teachers, with senior enterprise engineers teaching on campus and college teachers training in the enterprise and joining research and development projects in a mixed teaching and research team.

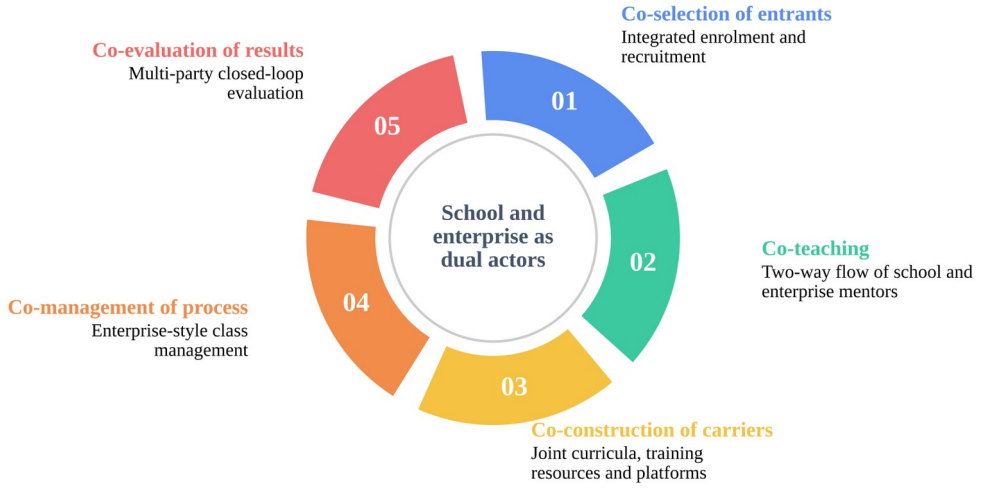


Fig. 2 - The "Five Commons" Closed Loop of School–Enterprise Collaboration

Co-construction of carriers refers to the joint revision of curriculum standards, the reorganisation of courses into project-based modules, and the development of online courses, textbooks and other digital resources that incorporate technologies such as generative artificial intelligence, big data and blockchain. Co-management introduces enterprise-style management into the class through a dual class-tutor system, workplace norms and a dedicated scholarship. Co-evaluation uses jointly revised post competence standards and COMET-based assessment rules to place students on a four-level competence ladder (P1 to P4), with evidence drawn from classroom learning, project work, enterprise training, competitions, vocational certificates and project delivery, and with school, enterprise and third parties as assessors.

4.3 Three Progressive Stages of Practical Learning

Practical learning is organised in three stages that move students from college learners to junior technicians and then to qualified field engineers. The stages are summarised in Table 2.

Table 2 - The Three Progressive Stages of Practical Learning

Stage	Duration	Setting and activities	Assessment
Post recognition and shadowing	Two years	Standardised on-campus workshop and training platforms simulating real development scenarios; project-based modules covering foundation, core, career-direction and elective courses	P2 post-competence assessment
Post rotation in real projects	Half a year	Off-campus industrial park and project base; integrated theory and practice; small-group rotation with one-to-one enterprise mentors; dynamic selection	P3 post-competence assessment

Stage	Duration	Setting and activities	Assessment
Certified post-holding	Half a year	Dynamic rotation and layered assessment; flexible adjustment of posts; extended multi-post training for strong students	P4 assessment by enterprise staff; qualification to work independently

Read through the lens of situated learning, the sequence resembles a structured path from peripheral to fuller participation: students first practise in a simulated environment, then work on real projects under close mentoring, and finally take responsibility for a post (Lave & Wenger, 1991). The rotation stage includes a mechanism of elimination and dynamic replacement, which the programme presents as a spur to effort. Its effects on motivation and equity were not examined in the available documents.

4.4 Reported Outputs

The programme records list outputs in three areas, summarised in Table 3. These figures are reported by the project team and have not been independently verified; several of them describe activity (resources produced, visits received) rather than learning outcomes.

Table 3 - Outputs Reported by the Programme

Area	Reported output
Industry–education platforms	Lead role in a Xi'an industry–education consortium for new-generation information technology and a Shaanxi digital film and animation industry–education community; approval of a provincial industry–education integration practice centre; enterprise donation of training hardware and software worth RMB 821,000; five provincial or ministerial education reform projects; more than 30 visits from other institutions; selection as a provincial typical case of industry–education integration
Students and graduates	Nearly 100 apprentices over three years; scholarships of RMB 89,100; 2 national and 13 provincial competition awards; first-destination employment rate of about 95% and job-relevance rate of about 90%
Teaching resources and technology	5 project-based digital textbooks; 6 online courses; 5 curriculum standards; 16 sets of courseware; 18 teaching plans; 300 standardised test items; 3 software copyrights and 2 utility-model patents; a Java and big-data training package; 8 industry lectures and 3 digital-skills upgrading courses

Note. Source: programme records covering three cohorts; employment figures are taken from the college's graduate employment records. No comparison data for students outside the programme were available.

5. Discussion

5.1 Institutionalised Rights and Responsibilities

The clearest feature of the case is the effort to institutionalise collaboration. The two-tier governance structure, written measures and the explicit allocation of responsibilities for equipment, teachers, projects and results address a weakness that the comparative literature identifies in many school–enterprise partnerships: loose, short-term cooperation that depends on individuals (Li & Pilz, 2023). The donation of equipment and the scholarship fund suggest that the enterprise has committed resources, which is consistent with a durable partnership, although the documents do not show what the enterprise gains or how stable that commitment is.

5.2 Structured Boundary Crossing

The five commons and three stages can be read as a deliberate design for boundary crossing. Joint selection, dual tutors and multi-party assessment act as boundary practices that connect the logics of school and enterprise, and the mixed teaching team functions as a community of practice spanning both organisations (Akkerman & Bakker, 2011; Wenger, 1998). The progression from simulated projects to real projects and then to responsibility for a post mirrors the staged participation that situated learning theory associates with the development of competence (Lave & Wenger, 1991).

This interpretation also points to what the programme does not yet document. Research on boundary crossing emphasises reflection and the transformation of practice as learning mechanisms (Akkerman & Bakker, 2011), and reviews of vocational learning stress the need for differentiated support (Schaap et al., 2012). The available records describe structures and outputs but say little about how students reflect on or integrate their experience, or about students who struggle or leave under the elimination mechanism.

5.3 Dynamic Feedback from Industry

The industry data platform is intended to keep curriculum content aligned with changing job requirements, and the inclusion of emerging technologies in courses responds to the rapid change described in the Introduction. This is consistent with the OECD (2023) emphasis on responsiveness, which depends on timely information about skill needs. Whether the platform actually changes curriculum decisions, and how quickly, is not documented; recording the revisions it prompts would make its contribution visible.

5.4 Competence-Based Assessment as a Shared Language

The four-level competence ladder plays a role that goes beyond grading. Because school, enterprise and third parties assess against the same post standards, the ladder gives the partners a shared language for describing progress, which boundary-crossing research identifies as a typical function of boundary objects (Akkerman & Bakker, 2011). It also ties each practical stage to a visible milestone, which may help students understand what is expected of them at each step. The value of the ladder, however, depends on the reliability of the assessments. The documents do not report how assessors are trained, how consistent their judgements are, or how many students reach each level, and these would be natural first indicators for the programme to publish.

5.5 Implications for Other Colleges

For colleges considering similar programmes, the case suggests three practical lessons. First, governance should be designed before curriculum: a joint council with written responsibilities gives the partnership a structure that can survive changes of staff. Second, the movement between school and enterprise should be planned as a sequence with clear entry and exit points, rather than as a single placement at the end of the programme. Third, the information that keeps a programme current, whether from an industry data platform or from regular contact with enterprise mentors, should be linked to a defined process for revising courses. These lessons are consistent with the international literature on work-based learning (Billett, 2001; Guile & Griffiths, 2001), but their value in other contexts will depend on local labour markets and on the commitment of enterprise partners.

5.6 Limitations and Further Research

Four limitations qualify these findings. The evidence is documentary and produced by the programme; there is no comparison group; students' and enterprise staff's perspectives were not collected independently; and the authors' position may have shaped interpretation. Further research could compare the employment and competence outcomes of programme graduates with those of similar students, interview students and enterprise mentors about their experience of crossing between school and work, and track how industry-platform data feed into curriculum revision over several cohorts.

6. Conclusion

This case study described a field-engineer programme in which a higher vocational college and an information technology enterprise share governance, teaching, resources, management and assessment, and in which students progress from simulated practice to real projects and then to certified posts. Read through research on workplace learning, the programme's most transferable features appear to be the institutionalisation of rights and responsibilities, the deliberate design of practices that help students move between school and work, and the use of industry data to keep teaching current.

The programme's reported outputs are encouraging but come from its own records. Its value as a model for other colleges will be clearer once its outcomes are compared with those of similar students and once students' and mentors' experiences are documented independently.

Acknowledgement

The authors thank Beijing New World Times Science and Technology Co., Ltd. for its partnership in the programme described. This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Conflict of Interest

The authors are employed by Xi'an Vocational and Technical College, the institution whose programme is described in this case study. The authors declare no other conflicts of interest.

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