

Integrating Information Technology Into Teaching and Learning in Higher Education: Practical Pathways From Shanghai Jiao Tong University

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Integrating information technology into university teaching involves decisions about classroom use, resource organization, staff development, and feedback. This paper examines Shanghai Jiao Tong University (SJTU)'s educational technology work since 2015 through four areas: classroom facilities, digital platforms, teaching resources, and educational data. It traces the emphasis on simple, practical classrooms, the coordination of teaching and support systems, the analysis of recorded content, and the provision of teaching and learning information. It then considers how these developments can inform five pathways for deeper integration: (1) designing connected learning environments around everyday use; (2) reorganizing resources around course knowledge; (3) strengthening digital literacy; (4) developing teaching practices within courses; and (5) linking evaluation to feedback and follow-up. Each pathway relates university experience to a continuing development need and relevant research, with attention to generative AI (artificial intelligence), teacher development, and student participation. Together, the pathways show how technical provision can inform teaching and learning decisions and be refined through teachers' and students' experiences. They also identify teaching practices, student participation, and learning outcomes as priorities for subsequent evaluation.

Keywords: technology integration, higher education, smart classrooms, digital learning platforms, digital literacy, learning analytics

Introduction

Information technology is now part of the environments in which universities organize teaching, distribute resources, and support students. In China, successive policies have encouraged institutions to connect these activities. China's Education Modernisation 2035 identifies information technology as a means of advancing educational modernization (Central Committee of the Communist Party of China & State Council, 2019). The Education Informatization 2.0 Action Plan calls for innovation in educational practices, while the Specifications for Digital Campus Construction in Higher Education Institutions addresses infrastructure, information resources, and application services (Ministry of Education of the People's Republic of China [MOE], 2018; 2021). Universities must translate these ambitions into arrangements that teachers and students can use in everyday learning.

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This remains difficult even where equipment and online content are widely available. Resources may be abundant yet poorly matched to particular courses or learners. Technology can remain peripheral to teaching, reproducing established practices without changing how students participate or how teachers respond to their needs. Sustained integration therefore involves teaching methods, professional capabilities, and institutional coordination as well as technical provision.

Research helps explain these connections. Luo (2019) discusses the limits of deep integration and the need for different forms of technology use. Wang and Tang (2017), writing about school education, identify assessment, management, resources, teacher beliefs, and professional knowledge as parts of a wider support system. Their emphasis on teacher development is also relevant to universities. The technological pedagogical content knowledge (TPACK) framework connects technology with disciplinary content and pedagogy (Mishra & Koehler, 2006), while Ertmer and Ottenbreit-Leftwich (2010) examine the importance of knowledge, confidence, beliefs, and culture. Reviews of higher education address organizational change, institutional strategy, and the conditions under which technologies are implemented (Castro Benavides et al., 2020; Chugh et al., 2023; Fernández, Gómez, Binjaku, & Kajo Meq, 2023).

Drawing on educational technology work at Shanghai Jiao Tong University (SJTU) since 2015, this paper examines developments in classroom facilities, digital platforms, teaching resources, and educational data. It uses the decisions and continuing needs within these areas to develop pathways concerning facilities, resources, digital literacy, teaching innovation, and evaluation. The discussion distinguishes existing provision from proposals for further work and considers how research can inform their implementation.

Connecting Technology With Educational Practice

The expression “deep integration” describes a closer relationship between technology and the organization of teaching. A tool may support an existing task, such as presenting slides or collecting assignments. Deeper integration requires attention to course objectives, learning activities, interaction, and evaluation. It also involves decisions about access, maintenance, and professional support. Installing equipment is therefore only one part of educational change.

Smart classroom research considers social and technical challenges together, including personalization, engagement, interaction, and system integration (Alfoudari, Durugbo, & Aldhmour, 2021). Bond et al. (2020) likewise show that research on technology and student engagement spans different activities, disciplines, and learning contexts. These perspectives direct attention to the circumstances in which technologies are used. A classroom should accommodate the teaching activity; a resource should meet a learning need; and feedback should help its recipient decide what to do next.

This paper examines SJTU’s educational technology provision in four interconnected areas: classroom facilities, digital platforms, teaching resources, and educational data. These areas overlap: A recorded lesson depends on classroom facilities and a digital platform, becomes a teaching resource, and generates educational data. Teachers and students connect these services through their activities, while university management and technical support affect how well they work. The next section describes practice across these areas before considering changes in teaching, learning, and evaluation.

Institutional Context

SJTU has progressively developed its educational technology provision since 2015. This work has supported

the university's Double First-Class development goals and, as national policy evolved, the ambitions of the Education Informatization 2.0 Action Plan. Planning brings together classroom facilities, digital platforms, teaching resources, and educational data, with the aim of connecting teaching, learning, management, and evaluation.

The experience discussed here concerns the university's educational technology development and support work. Classroom refurbishment, platform operation, content production, and data services provide the practical basis for the discussion. Their connections also help explain why continuing maintenance and support for users need to be considered alongside new construction.

Educational Technology Development at SJTU

SJTU's classroom facilities, digital platforms, teaching resources, and educational data services connect through everyday teaching. A scheduled lesson can be recorded automatically, made available as a teaching resource, and reviewed through teaching observation. Figure 1 summarizes these four areas and their relationships.

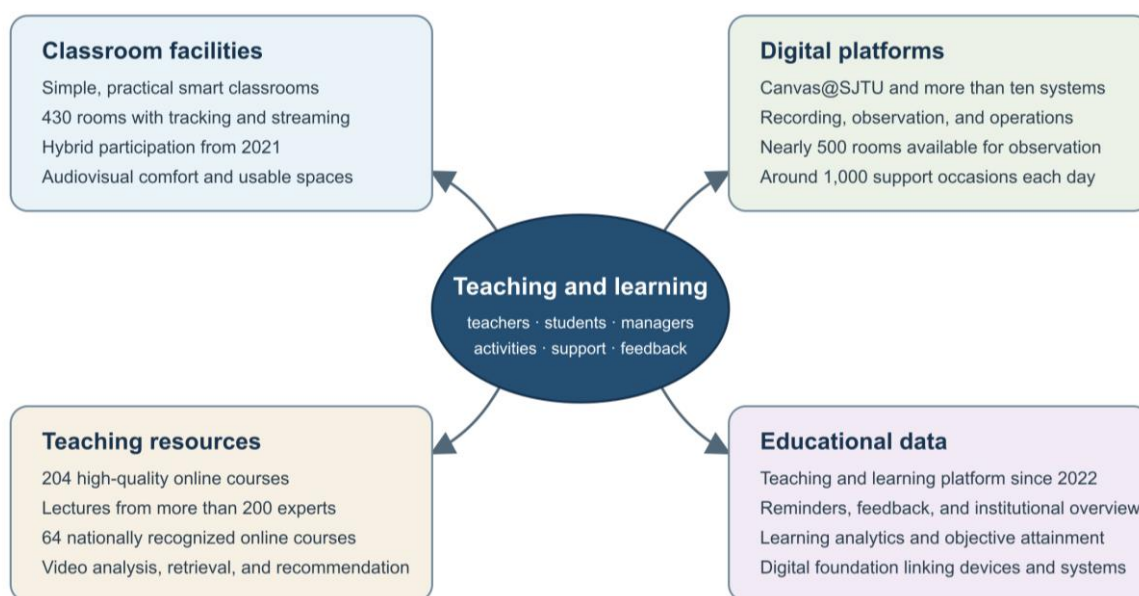


Figure 1. Connections among classroom facilities, digital platforms, teaching resources, and educational data in SJTU's educational technology provision.

Classroom Facilities Designed for Everyday Teaching

SJTU began phased refurbishment of selected classrooms in one teaching area in 2015 and expanded upgrading across public teaching buildings on the Minhang campus from 2018. Departments incorporated cloud computing, data technologies, the Internet of Things (IoT), artificial intelligence (AI), and virtual reality into classroom development. In addressing the problems associated with overly complex facilities and difficulties in their shared use, the Educational Technology Center adopted a simple, practical approach. Ease of use, useful functions, durability and acceptance by teachers and students guided its choices.

Visual and auditory clarity and comfort became concrete design requirements. Connected blackboards in tiered lecture rooms allow writing to be displayed on screens and stored in the cloud; multiple displays and mobile terminals support interaction. Classrooms adapted for hybrid teaching in 2021 enabled students overseas to participate remotely. Corridors, study spaces, terraces, and greenery were also incorporated into the teaching

environment, alongside displays celebrating academicians and distinguished teachers and spaces for students' creative work.

These choices bring everyday teaching and users' experience of the building into classroom development. They also establish a practical criterion for upgrades: New functions must fit the activities they support.

Digital Platforms Connecting Teaching and Support

Built on an open-source foundation, Canvas@SJTU operates alongside more than 10 systems covering classroom resource management, maintenance, information display, cloud recording, and online teaching observation. This arrangement combines a common teaching platform with specialized services.

Smart terminals and sensors support centralized equipment management, automatic activation and shutdown, and early warning and intervention. Operational services support teachers' classroom use on around a thousand occasions each day. Tracking and streaming equipment in 430 classrooms connects to a cloud platform that follows the timetable for automatic live streaming and recording. Teaching video and presentation materials are captured together and available with a single click.

The platforms connect physical classrooms with digital resources and support announcements, discussion, question responses, and attendance recording. The online teaching observation platform covers nearly 500 classrooms, allowing reviewers to observe lessons remotely from multiple viewpoints and provide evaluations. These arrangements bring support and observation closer to routine teaching. Further connections between Canvas, blackboards, and videoconferencing remain priorities, as platform integration is continuing work.

Teaching Resources for Wider Access

SJTU has developed 204 high-quality online courses, assembled lectures from more than 200 leading experts, and received national first-class online course recognition for 64 courses. Materials are available within and beyond the university through the iCourse and SJTU video platforms. These collections provide content for blended teaching and access to the university's wider academic community.

Content production also uses graphics rendering, motion capture, and speech synthesis to create virtual teaching figures and instructional videos. Image and speech recognition support video analysis, slide-level processing, and keyword extraction. User and resource profiles support retrieval and recommendation.

The work extends from producing complete courses to identifying material within recordings. A full lecture serves a different purpose from a short explanation of a concept. Building on existing analysis tools, SJTU plans to connect video segments with electronic textbooks and organize them around knowledge points. The distinction between accessing a collection and finding relevant content informs the resource pathway below.

Educational Data Supporting Teaching and Learning

SJTU collects teaching process and outcome data and uses educational data mining and learning analytics to identify learning difficulties, analyze disciplinary competencies, and assess teaching objective attainment. Since 2022, a teaching and learning information platform has brought data together to provide learning reminders to students, feedback to teachers, and an overview of teaching conditions to managers.

The university has also begun developing an educational digital foundation connecting devices, data, and intelligent applications. Full data transfers and message queues feed a data warehouse, while application programming interfaces make information available to other systems. This work seeks to reduce data silos and duplicated development.

These services establish routes through which information can reach its intended users. Their educational contribution also depends on what happens after a reminder or report is received: Whether a student seeks help, a teacher adjusts an activity or the university changes its support. Such responses require attention alongside data collection.

Lessons for Further Development

Across these areas, SJTU's experience links usable classroom facilities with ongoing support, teaching-resource production with content organization, and educational data collection with differentiated feedback. It also identifies unfinished work in platform connections and resource use. Teacher and student capabilities matter across all four areas, although the provision described here does not establish changes in digital literacy or learning outcomes.

The five pathways address these relationships. Facilities and resources provide direct starting points; digital literacy and course design concern their use; evaluation concerns how information informs subsequent action. Figure 2 maps each pathway to existing provision and the development question it raises. Research helps explain the conditions and limits of their application.

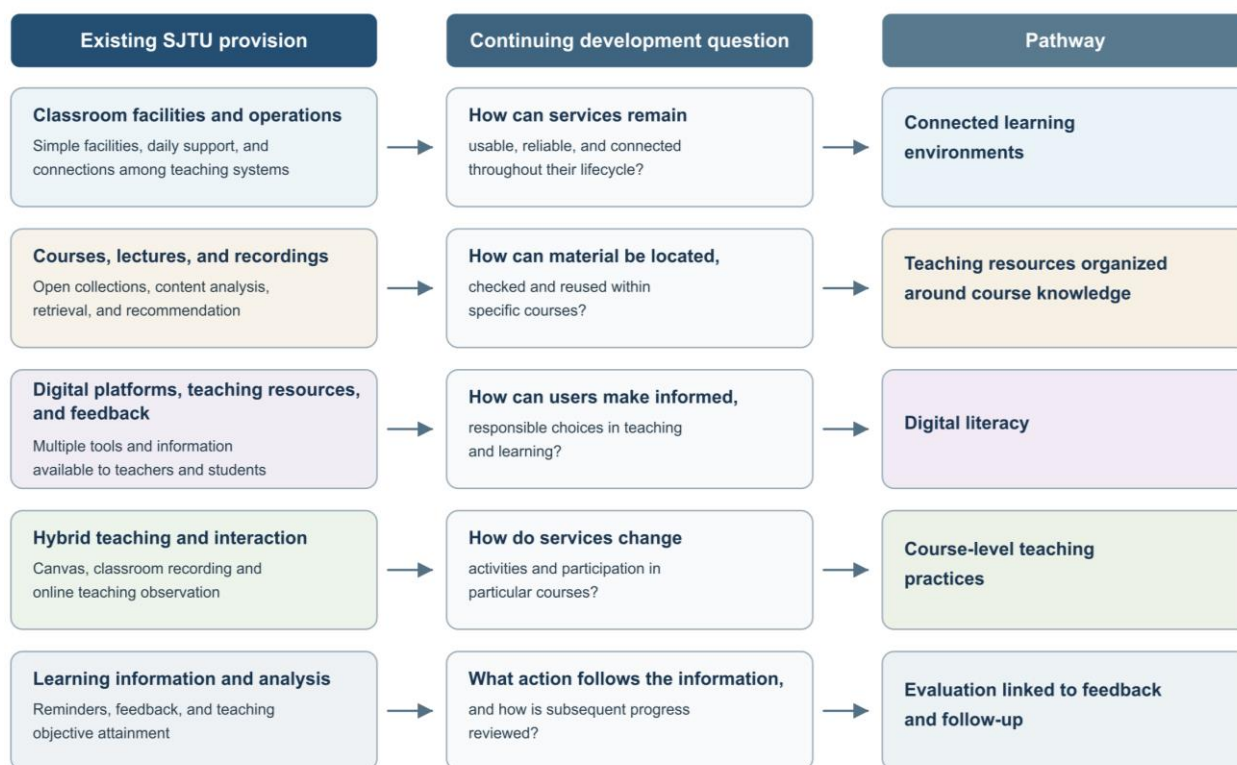


Figure 2. How SJTU's existing provision and continuing needs inform five pathways for deeper integration.

Practical Pathways for Deeper Integration

Designing Connected Learning Environments Around Everyday Use

SJTU's emphasis on simple, practical classrooms makes usability a starting point for further development. Connected blackboards, multiple displays, and hybrid teaching equipment need to work within classroom activities and alongside furniture, lighting, ventilation, and sound systems. Alfoudari et al. (2021) consider the

social and technical challenges of smart classrooms together. In SJTU's case, this perspective helps explain why audiovisual comfort and shared use deserve attention when selecting additional functions.

The university's daily operational workload also places maintenance within the educational task. Lifecycle planning should specify how faults are addressed, equipment replaced, and users supported as classrooms and platforms evolve. Cloud and edge technologies will require suitable system specifications and responsibilities for maintaining connections.

The platform arrangement provides a basis for organizing services around a course. Further links between Canvas, connected blackboards, and videoconferencing could give teachers more direct access to classroom functions and materials, while improvements to mobile learning could help students move between settings. Fernández et al. (2023) emphasize alignment between digital initiatives and institutional strategy. Here, alignment can be pursued through decisions about which teaching activities require shared information and which services must remain available together.

Reorganizing Resources Around Course Knowledge

The online courses, expert lectures, and recordings described in Section 4.3 give SJTU a substantial collection to develop. The next question is how a teacher selects material for an activity or a student locates an explanation. Video analysis, slide-level processing, and keyword extraction provide an existing technical basis for addressing these needs.

SJTU plans to extend its video resource platform through AI speech analysis, automatic translation, and large language models. Recordings would be converted into short videos organized around knowledge points and linked to electronic textbooks and related resources. Tree structures and knowledge graphs could represent relationships between topics, supporting retrieval and helping students understand how a concept relates to earlier and later course content.

Teachers would need to check the accuracy of the segments and their fit with course objectives. Automated processing can identify and label content, but the choice of an explanation for a particular learning activity still requires disciplinary and pedagogical judgement. Student feedback on search results and unclear explanations could inform revisions to the organization of resources. Wider sharing would then be accompanied by work on how materials are selected, combined, and understood. Reuse across courses also requires sufficient context. An expert lecture may offer an explanation beyond a textbook, but a teacher still needs to establish its relationship to the syllabus and students' prior knowledge. Preserving these connections would make shared resources easier to use without assuming that the same material serves every learner equally well.

Connecting Technical Provision With Digital Literacy

Canvas, recording services, and learning feedback give SJTU teachers and students several ways to use technology. Their availability creates a need for guidance on educational choices as well as operation. For example, receiving a learning report requires the ability to interpret it, while selecting video material requires a judgement about its relevance. Digital literacy connects these technical services with decisions in teaching and learning.

For teachers, professional development should connect tool use with disciplinary content, course objectives and teaching methods, as proposed by TPACK (Mishra & Koehler, 2006). China's teacher digital literacy standard also covers awareness, knowledge and skills, application, social responsibility, and professional development (MOE, 2022). At SJTU, a relevant training activity could ask teachers to select a recorded

explanation, design an accompanying discussion, and decide what student responses would tell them. This would connect training with the resources and platform functions already available.

Universities can include integration in professional development expectations and provide differentiated training for managers, teaching administrators, teachers and students. Academic and industry specialists can contribute policy and technical knowledge. Lesson observation, institutional exchanges, and sustained peer discussion would allow teachers to revisit difficulties after trying an approach. Such opportunities matter because beliefs and institutional culture influence changes in practice (Ertmer & Ottenbreit-Leftwich, 2010).

Students also need to judge generated content, understand the limits of generative AI, protect personal information, and respect intellectual property and academic conventions. These issues can be addressed through course tasks and learning support, including discussion of inappropriate dependence. Familiarity with digital devices provides no assurance that these judgements are sound.

Developing Teaching Practices Within Courses

SJTU's hybrid classrooms enabled overseas participation, while Canvas and recording services support interaction and access to teaching materials. Understanding how these changes affect teaching requires closer attention to course design and student participation.

A discussion activity, for example, needs a purposeful question, participation expectations, and a connection to subsequent teaching. Recordings can be selected for preparation or review, with classroom time used to address the difficulties students report. Learning portfolios could bring work from these activities into a continuing record. These are possible uses of SJTU's existing services, whose contribution would need to be examined in the courses concerned. Bond et al. (2020) stress the relevance of pedagogy and context to engagement, while Chugh et al. (2023) connect technology implementation with stakeholder perceptions, disciplines, and evaluation.

A practical next step would be to examine selected courses across disciplines, recording how teachers combine activities, where students encounter difficulties, and what adjustments follow. The observation platform could support discussion of teaching organization, while student feedback would offer a different view of content difficulty, workload, and support needs. Together, these perspectives would give course teams specific questions to address.

Selwyn's (2017) attention to the social and institutional setting is relevant to interpreting such experience. Teachers' workloads, differences among students, and departmental support affect what can be sustained. Students should therefore participate in reviewing course content and delivery, with teachers guiding the process and explaining subsequent decisions.

Linking Evaluation to Feedback and Follow-up

SJTU's teaching and learning information platform already directs reminders, learning feedback and overview information to different users. The university's use of learning analytics to assess teaching objective attainment also provides a basis for considering evidence beyond final marks. Extending evaluation across learning requires specifying how each type of information contributes to a decision and how the response will be followed up.

One possible sequence would use preparation tasks to identify topics needing classroom attention, discussion and question responses to examine understanding, and subsequent assignments to review progress. A teacher could revise an explanation or offer further support, and then check whether the difficulty persists. Students' reports of their difficulties, teacher observations, and platform records would help interpret one another.

This proposed cycle links collection and analysis with feedback, adjustment, and continued review; it is not established simply by making data visible.

Research places useful limits on expectations. Viberg, Hatakka, Bälter, and Mavroudi (2018) found limited evidence of improved learning outcomes in the studies they reviewed. Tsai et al. (2020) identified adoption barriers and limited student involvement in European institutions. These findings support examining whether feedback is understood and used, alongside the technical operation of a service.

Human-centered approaches call for intended users to participate and for careful choices about automation and human control (Alfredo et al., 2024). Consent, privacy, and interpretation also require attention (Slade & Prinsloo, 2013). For SJTU, involving teachers and students in reviewing reminders and reports would help assess their relevance. Evidence of the actions that follow could then inform improvements to the evaluation process. For example, a reminder could point students towards a relevant resource or an opportunity to discuss a difficulty. Follow-up would examine whether that support was accessible and appropriate. This would give teachers information for revising support as well as identifying students who may need it.

Conclusion and Future Directions

SJTU's experience provides practical grounds for connecting classroom facilities, digital platforms, teaching resources, and educational data. Its emphasis on usability responds to the problems of complex facilities; content analysis makes it possible to work within recorded lectures; and the teaching and learning information platform directs feedback to different users. The five pathways extend these arrangements into questions of professional capability, course design, and evaluation.

The next stage requires maintaining equipment and platforms throughout their lifecycle, improving mobile learning and connections among Canvas, blackboards and videoconferencing, and making fuller use of existing videos. Work within courses can show how these services are combined and where they require adjustment. Students' feedback on content and learning experiences should contribute to those decisions alongside teachers' observations.

This paper has examined institutional development and drawn out its implications. Further research is needed to examine how these pathways affect teaching practices, student participation, and learning outcomes. Construction figures and course recognition document the scale of provision but require evidence from course implementation for interpretation. Other universities will need to adapt the proposals to their priorities and support capacity. Sustained integration depends on maintaining the connection between technical decisions and what teachers and students need to do.

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