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Video visualisation of classroom talk in a pre-service teacher-training programme: Design and implementation

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Abstract

Acquiring strong classroom-talk skills is vital to pre-service teachers' future career success. However, they often find this challenging, and their classroom talk tends to be limited to simple phrases that seldom facilitate students' reasoning. One widely used pedagogical approach to developing pre-service teachers' classroom-talk competency is microteaching. Therefore, we designed a training programme that integrated microteaching with video-visualisation technology, peer review, and self-reflection, and implemented it among 67 pre-service teachers. The role of the interactive and process-focused video-visualisation platform, which was also designed by the authors, was to facilitate detailed investigation of classroom discourse and of how teachers and students contributed to dynamic classroom-interaction processes. A mixed-methods approach was adopted, combining quantitative classroom-talk data, survey data, reflection reports, and interviews. Our qualitative results, derived from semi-structured interviews with a randomly selected subsample of 22 participants, showcase variation and common themes in their microteaching discourse. Our questionnaire results, meanwhile, indicate that after the training, the 67 participants improved significantly on multiple measures of teacher self-efficacy. The qualitative results, and reflection reports collected from all 67 teacher candidates, suggest that video visualisation enhanced their perceptions of both classroom talk and of academic productive-talk strategies, while helping them to take holistic and analytical views of classroom talk. In short, the intervention was a valuable part of their preparation for internships.

Keywords Classroom talk · Microteaching · Pre-service teachers · Self-efficacy · Teacher professional development · Video visualisation

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1 Introduction

Structuring and directing classroom talk to encourage learners' engagement and improve their academic performance is a matter of vital importance (Tao & Chen, 2024). Pedagogy-led classroom talk creates a more engaging critical learning environment than can be obtained by relegating students to the peripheral roles of listening to, uncritically accepting, and assimilating information (Teo, 2016). Michaels et al. (2008) established the academically productive talk (APT) framework as a means not only of analysing classroom talk, but also of supporting teachers through a structured approach to understanding and implementing effective classroom discussions. It has subsequently been found to enhance their ability to facilitate meaningful student engagement and learning in the context of language education (e.g. Chen & Wang, 2023).

While previous studies have explored various methods for training teachers in classroom-talk competency (for a review, see Khong et al., 2019), there is a gap in research regarding the use of microteaching in video visualisation-based teacher professional development (TPD) programmes. Video-visualisation technology is well-suited to helping teachers critically assess both teaching strategies and student-teacher interaction patterns. This is because it enables them to identify effective practices and areas for improvement through observation of and reflection on real classroom dynamics in a detailed and concrete manner, and ultimately improves their classroom-talk competency (Chen et al., 2020). Nevertheless, few if any studies have specifically investigated how visualising pre-service teachers' classroom interactions through microteaching can support their reflections on classroom talk and self-efficacy. This absence warrants the present exploration of how TPD programmes can leverage microteaching to further develop pre-service teachers' classroom talk skills and self-efficacy.

Video-based approaches are increasingly popular as a means of promoting teachers' reflections during TPD (Major & Watson, 2018). Integrating teaching videos into TPD programmes allows teachers of almost any subject to pause at any time, play back the recordings, and reflect on their teaching and interactions with students (Gröschner et al., 2018). By watching and analysing teaching designs or classroom discourse in video form, teachers can gain more insights than would ever be possible whilst simultaneously teaching (Blomberg et al., 2013), not least because this approach does not require them to rely on their memories of classroom events, which might or might not be accurate (Sherin & van Es, 2005). The video-analysis tools researchers have developed to facilitate it, include CDA (Chen et al., 2015) and CDAT (Lee & Irving, 2018), offer teachers individualised visualisation support for reflecting on their classroom talk (e.g., Chen et al., 2020; Wang et al., 2025). While these tools have shown promise, current research primarily focuses on two areas: (1) the principles and frameworks used to guide teachers' reflection, and (2) how video-based reflection builds specific skills (Kang & van Es, 2019). Therefore, a gap remains in our understanding of how video-analysis tools influence TPD par-

ticipants' perceptions of classroom talk and self-efficacy throughout their professional development.

The linguistic and cultural dynamics at play in Hong Kong's Chinese-language classrooms give rise to special challenges (Zhang et al., 2025). As in many other East Asian regions, culturally ingrained values of deference to authority and the traditionally passive role of students in the learning process tend to hinder active participation and critical thinking during classroom discussions (Le, 2024). Additionally, high-stakes examinations dominate Hong Kong's educational landscape: teachers there often feel pressured to prioritise syllabus coverage over fostering deeper student engagement (Lo, 2013; Xie, 2009), and their teaching practices often valorise rote memorisation and teacher-centred lecturing, limiting interactive instruction (Abdullah, 2020). These constraints can leave some of Hong Kong's pre-service teachers, particularly those with limited training or exposure to interactive pedagogy, underprepared to facilitate student-centred discussions that promote critical thinking (Fu & Kartal, 2023). As such, interventions that render Hong Kong teachers' classroom talk more effective would tend to support their more confident navigation of the overdue shift from teacher-centred to student-centred instruction, which can be expected to ultimately benefit students' learning outcomes (Tadesse et al., 2023).

The APT framework (Michaels et al., 2008) addresses these gaps by offering structured techniques that help teachers to scaffold discussions, encourage student reasoning, and navigate linguistic and textual challenges. For instance, in Chinese-language classrooms, APT strategies such as *Revoice* and *Say More* allow students to reshape their responses to their comprehension of texts into more elaborative and critical ones, and this can mitigate their reluctance to speak due to cultural norms favouring brevity and deference (Tao & Chen, 2024). Similarly, the *Press for Reasoning* strategy—which encourages students to justify their answers—counters their tendency to provide one-word responses or memorised answers. In short, we expect applications of the APT framework in Hong Kong to foster a shift toward student-centred learning by empowering teachers to create more interactive and cognitively rich discussions within the constraints of their educational and cultural context. Specifically, in our TPD program, APT strategies were both taught explicitly and embedded into video visualisation-supported self-reflection. This helped the sampled pre-service teachers structure their microteaching and self-reflection by equipping them with practical strategies and clear self-reflection structures, in the long run, this can be expected to help them shape classroom environments where students are encouraged to think critically and engage actively, thereby countering rote learning and passive classroom cultures.

Therefore, with the aims of (1) boosting pre-service Chinese-language teachers' awareness of classroom talk, thus reducing their monologuing and increasing productive dialogues between them and their students, and (2) boosting such teachers' self-efficacy, in part by refocusing them on their students' learning engagement, we designed and implemented a TPD programme in Hong Kong that incorporated microteaching, peer review, and video-visualisation technology.

2 Literature review

2.1 Classroom talk and academically productive talk

Teachers play a leading role in setting the conditions for the benefits of classroom talk (Webb et al., 2009), and conversely, their engagement in productive classroom talk is critically important to their teaching practice (Van der Veen & Van Oers, 2017). Nevertheless, many pre-service teachers find it challenging to engage in classroom talk effectively. This may be because the knowledge and skills they need to orchestrate classroom talk in authentic teaching environments are usually limited (Chen, 2020). They may also struggle to manage diverse student behaviours and to maintain a conducive environment for discussions (Chen et al., 2020). The specific outcomes of these challenges tend to include the use of closed-ended questions, simple phrases, and short-sentence responses; the posing of relatively few probing questions; monologic approaches; and poor framing skills (Resnick et al., 2018). These communication practices, in turn, can negatively influence students' reasoning and ability to make reasoned, evidence-based claims about the literature they are reading (e.g., VanDerHeide, 2018). In addition, some teachers are overly reliant on pre-written scripts, making them less responsive to unexpected questions than might otherwise be the case, and/or reluctant to afford their students opportunities to engage in relatively open-ended and meaningful talk (Wells & Arauz, 2006). These gaps in teacher education significantly hinder teachers' ability to implement student-centred, interactive teaching practices effectively (Chen et al., 2020). Therefore, we feel it is crucial that pre-service teachers be provided with the training they need to increase the quality of their classroom talk's framing and implementation (see also Walsh, 2013).

The guiding framework for our exploration of teachers' facilitation of classroom interactions, APT (Michaels et al., 2008), emphasises how intellectually engaged classroom dialogues, thoughtful engagement from students, and fruitful peer interactions can all be facilitated via inspiring discussion norms (Resnick et al., 2010). The versions of APT proposed by Michaels et al. and Resnick et al. can both be divided into four dimensions and eight strategies. With the dimensions numbered, followed by their associated strategies in parentheses, these are: (1) Elaborating (Say more, Revoice); (2) Reasoning (Press for reasoning, Challenge); (3) Listening (Restate); and (4) Thinking with others (Agree or disagree, Add on, and Explain other). Examples of each strategy are presented in Appendix 1.

The APT framework has been used to structure teachers' classroom talk in various domains, including mathematics (Chen, 2020; Chen et al., 2020) and science (Affolter, 2020). However, the present work is believed to be the first empirical study of an APT-based initiative aimed at promoting Chinese-language teachers' classroom-talk competency. As briefly noted above, we regard the incorporation of classroom-talk theories into Chinese-language teachers' TPD programmes as critically important. This is because such theories could encourage them to lead discussions related to Chinese literature, which in turn would tend to help their students develop argumentation skills as they construct, defend, and evaluate varied viewpoints while exploring multiple perspectives in classical poetry, debating moral dilemmas in traditional fables, analysing character motivations in novels, and so forth. Additionally,

it could help their students to develop persuasion skills, along with more advanced language use, e.g., discussions of complicated topics.

2.2 Teachers' perceptions of classroom talk and teacher professional development

Although empirical evidence indicates that interventions can improve teachers' classroom talk (e.g., Alexander, 2018; Chen et al., 2020; Osborne et al., 2019), some studies have argued that modifying teachers' classroom-talk practices is a complex undertaking and basically personal (Wells & Arauz, 2006), i.e., not subject to 'simple process-product logic' (Böheim et al., 2021, p. 3). In other words, changing teachers' classroom-talk competency is not a straightforward, linear process that can be expected to directly produce specific outcomes in the short term. Therefore, instead of seeking major short-term improvements in teachers' classroom talk, we chose to focus on their perceptions of such talk, which are vital to their future teaching competencies (Khany & Malmir, 2017).

Recent research by Ahmed and Montecillo Leider (2024) explored in-service English teachers' beliefs about classroom talk, analysing their reflections on its purpose, quantity, and relevant instructional strategies. However, those reflections were primarily based on video segments of teaching or field notes, which lacked structured analytic support. A key limitation of traditional video use in TPD is that it often relies on unstructured viewing, making reflection highly subjective and dependent on what individual teachers happen to notice or recall (Zhang et al., 2025). Without tools to highlight and revisit key moments, teachers may struggle to maintain reflective focus or become sidetracked, limiting their ability to extract meaningful insights (Chen et al., 2020).

To our knowledge, no prior study has proposed an effective TPD programme for Chinese-language teachers that explicitly integrates video-visualisation technology with structured training modules and explored the participants' pre- and post-intervention perceptions of classroom talk. In any case, more research on tailored TPD programmes that leverage video visualisation to enhance classroom-talk practices in Chinese-language education is clearly warranted.

2.3 Self-efficacy and classroom talk in teacher professional development

Teachers' self-efficacy refers to their belief in their ability to plan, organise, and execute teaching tasks in ways that achieve desired educational outcomes (Tschannen-Moran & Hoy, 2001). It can contribute to many aspects of their performance, including productive classroom talk (Muhonen et al., 2021). Previous studies have shown that teachers' self-efficacy could have positive impacts on both their in-class communication with students and their ability to obtain adequate emotional and instructional support (Perera & John, 2020). Muhonen et al. (2021) found that teachers with divergent levels of self-efficacy also tend to differ in their classroom-talk quantity and quality. Complicating the situation further, pre-service teachers' self-efficacy is usually unstable at first, but is increased and stabilised through their teaching practicum and TPD-programme attendance (Rupp & Becker, 2021). Therefore,

if the quality of classroom talk is to be enhanced, it is important to further support and foster pre-service teachers' self-efficacy through TPD (Chen et al., 2020). Chen (2020) reported that classroom talk-related TPD improved teachers' self-efficacy, but did not present qualitative data on how/why it improved.

2.4 Classroom talk and video-visualisation technology

In contrast to traditional observation or standard peer feedback, which rely on real-time recall and subjective interpretation, video visualisation allows teachers to revisit specific moments, pause, and analyse interactions in depth (Chen et al., 2020). By offering a concrete and re-visitable record of classroom talk, video visualisation can also offer teachers a more nuanced understanding of teacher-student interaction, such as patterns of questioning, waiting time, or student responses being overlooked. Targeted feedback arising from annotation of video segments and discussion of such segments with mentors or peers, meanwhile, helps teachers to refine their classroom-talk strategies and to engage in more precise reflection on both the effective and problematic aspects of their teaching (Chen & Chan, 2022).

Within a TPD programme, Gröschner et al. (2018) designed a classroom-discourse reflection activity based on teachers' classroom videos and found that it improved the participants' self-efficacy and teaching practices. However, because its video-visualisation technology was not self-accessible, and limited to two-minute interactional units, a study that applies more video-visualisation technology to discourse analysis with longer interactional units would be a valuable addition to the literature. Analysing longer units can provide teachers with deeper insights into their teaching's contextual continuity, interaction patterns, and progression toward pedagogical goals. When Chen and Chan (2022) integrated the Classroom Discourse Analyser (CDA; Chen et al., 2015) into a TPD programme aimed at enhancing pre-service teachers' classroom-talk moves, they observed significant improvement both in the subjects' use of productive-talk moves and in their awareness of how to apply the APT framework. However, it is also worth considering shifts over time in pre-service teachers' APT perceptions and self-efficacy. Additionally, it should be noted that most research on teachers' classroom talk has been conducted among mathematics educators. Therefore, other subject areas, notably including language education, warrant further investigation.

The current study therefore adopted CDA (Chen et al., 2015) as its TPD video-visualisation platform and tested how it affected pre-service Chinese-language teachers' classroom-talk perceptions and self-efficacy. We then examined the impact of our training framework, which combined microteaching, peer review, and video visualisation, on the same two outcome variables.

This research was guided by the following three research questions (RQs):

RQ1. How did the sampled pre-service teachers use APT strategies?
RQ2. How did their perceptions of using APT and conducting classroom talk change after the training?
RQ3. How did training in classroom talk via video-visualisation tools affect their self-efficacy?

3 Methods

To address our RQs from multiple angles, and thus arrive at a more nuanced and complete picture of the effects of our TPD programme on the sampled pre-service teachers' use of APT strategies, perceptions of classroom talk, and self-efficacy, we adopted a mixed-methods approach (Creswell & Creswell, 2017). Comprising survey and classroom-talk data analysis on the quantitative side, and semi-structured interviews and reflection-report analysis on the qualitative side, this approach is described in detail below.

3.1 Context

Our training was delivered across 36 sessions, i.e., during 12 meetings of each of three courses—one for juniors, one for seniors, and one for master's students—at a university in Hong Kong. All sessions were taught face-to-face during the first semester of the 2022-23 academic year. The three courses' pre-existing formats comprised seminars, lectures, group activities, discussions, microteaching, and the sharing of teaching experience that had been gained in local schools. Our intervention included modules on (1) pedagogical theories, (2) instructional design, (3) classroom-talk competency, (4) instructional strategies and peer review, and (5) reflection skills as prompted by the video-visualisation platform. The three courses' assessment approaches were similar, all being centred on the students' lesson plans, microteaching performance, peer reviews, and end-of-semester reflection reports. Each course was taught by a different instructor. However, throughout the intervention, the three instructors engaged in peer observations of one another's classes and held regular meetings to discuss their courses and assessment materials, as a means of ensuring both the fidelity of the implementation and consistency in evaluation.

3.2 Participants

Convenience sampling was used to recruit 71 Chinese-language education students enrolled in the three focal courses. There were 25 juniors (hereafter, Class 1), 26 seniors (Class 2), and 20 graduate students (Class 3). All but one of the students consented to participate in our study, and of the remaining 70, 67 completed all the required data-collection instruments, i.e., a pre-test, a post-test, and a reflection report. To ensure a balanced representation of interview participants, we employed stratified random sampling to select approximately 30% of the total participant pool for semi-structured interviews. Prior to this selection, we conducted a one-way analysis of variance (ANOVA; Table S6, Appendix 1) on pre-test self-efficacy scores across the three classes. As no significant differences were found, and our participant pool was also relatively homogeneous in other respects (e.g., all interviewees reported having no full-time teaching experience), we determined that class level would serve as a practical and sufficient basis for stratification. Due to a few altruistic students proactively wanting to be involved in the study, 31.4% (n = 22) accepted, i.e., 10 from Class 1, six from Class 2, and six from Class 3. In the remainder of this paper, to clarify sources of information when discussing qualitative data, participants' iden-

tification numbers are prefixed by 'IN' where data were drawn from interviews, and with 'S' where they were taken from reflection reports.

3.3 Design of the intervention

Before training commenced, a series of online tutorial videos (Table 1) were posted on Moodle to introduce categories of classroom talk and the APT framework; provide instructions for using the video-visualisation platform; and share interactive exercises. Our training model is illustrated in Fig. 1, and a detailed explanation of the key tasks within the training is shown in Fig. 2.

During the intervention, the instructors reviewed the content of the tutorial videos with their respective sets of students; provided them with additional examples of effective classroom talk in practical pedagogical scenarios; introduced classroom activities aimed at boosting the use of classroom talk; initiated group discussions and peer work to provide them with opportunities to practise using classroom talk; and gave their own introductions to the video-visualisation platform. After the training, each student was required to conduct a microteaching session of 15 min or less, which had to incorporate one or more of the classroom-talk strategies they had been taught. Following their microteaching sessions, the presenters engaged in self-reflection as they reviewed the video-visualisation platform's transcription, coding, and analysis of their microteaching. Then, after receiving in-class feedback from their peers and instructors, they were required to submit their self-reflection reports. Lastly, the interviewees participated in individual semi-structured interviews.

3.4 The video-visualisation platform

The platform (Fig. 3) automatically transcribed classroom conversation from the videos uploaded by the trainees. The transcript of each teaching video was manually coded into the different categories of classroom talk and the results were uploaded for visualisation. Each trainee was issued a personal account from which to access the platform, and assigned to one of three platform-user groups, each comprising all the participants from a given course. Within those groups, the members and any course instructor could share teaching videos and curriculum resources, and use comment-

Table 1 Online tutorial-video syllabus

Lesson	Theme
1	Introduction to Classroom Talk
2	The Importance and Challenges of Conducting Classroom Talk
3	Categories of Classroom Talk
4	Introduction to Academically Productive Talk
5	Introduction to Elaborating
6	Introduction to Reasoning
7	Introduction to Listening
8	Introduction to Thinking with Others
9	Summary
10	Manuals for the Video-visualisation Platform and Moodle

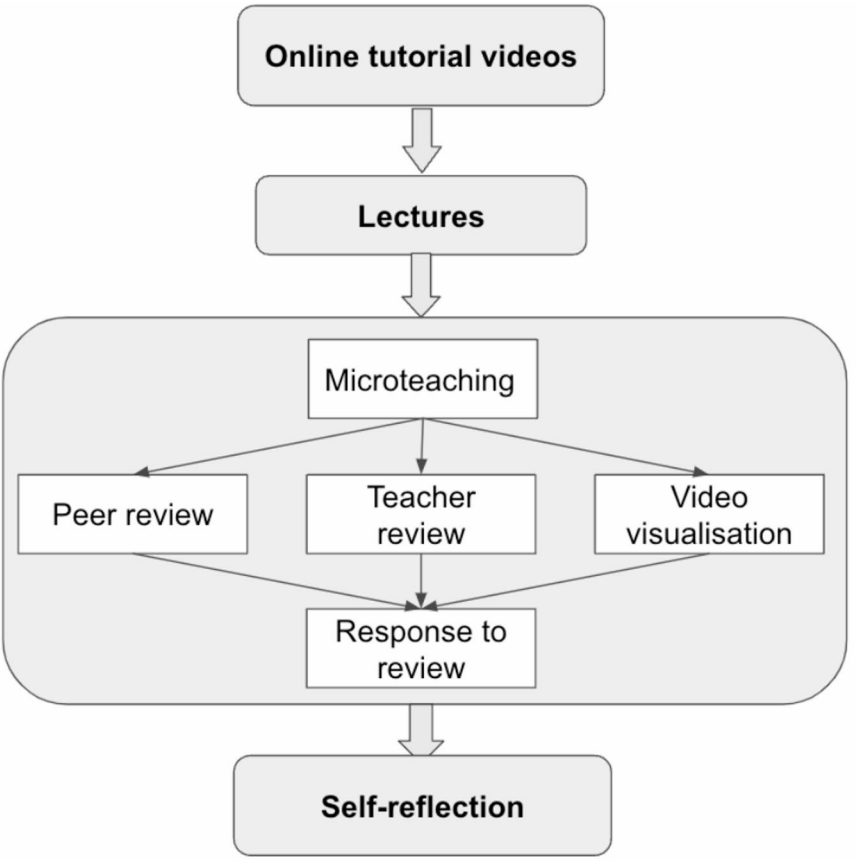

Fig. 1 Model of the training design

ing and annotation functions to engage in collaborative exchanges. Prior to its implementation, a pilot useability test was conducted within the research team to ensure the platform was user-friendly and accessible for those with limited technical expertise.

The platform interface included a video area, a visualisation area, and a dialogue/discussion/exercise area. In the latter, the teachers were able to highlight and annotate classroom dialogue. Figure 4 is a screenshot of the column on the left-hand side of that page. In its upper part, it shows the speakers involved in the teaching process, with students' names provided in abbreviated form. The chart in its lower part, which could be zoomed in and out of using the slider at the bottom, indicates the general distribution of the types of classroom conversations. Clicking on bubbles within it allowed users to quickly locate the corresponding conversation, and their own speech was marked in red. Clicking the interface's 'Display Statistics' button called up statistics on the classroom-talk types, and activating the 'Total Speeches' button caused the distribution of classroom speakers to be displayed. Pressing 'Show Category' revealed all types of conversations contained in the video, and pressing 'By Category' prompted the system to show the various types of classroom talk that

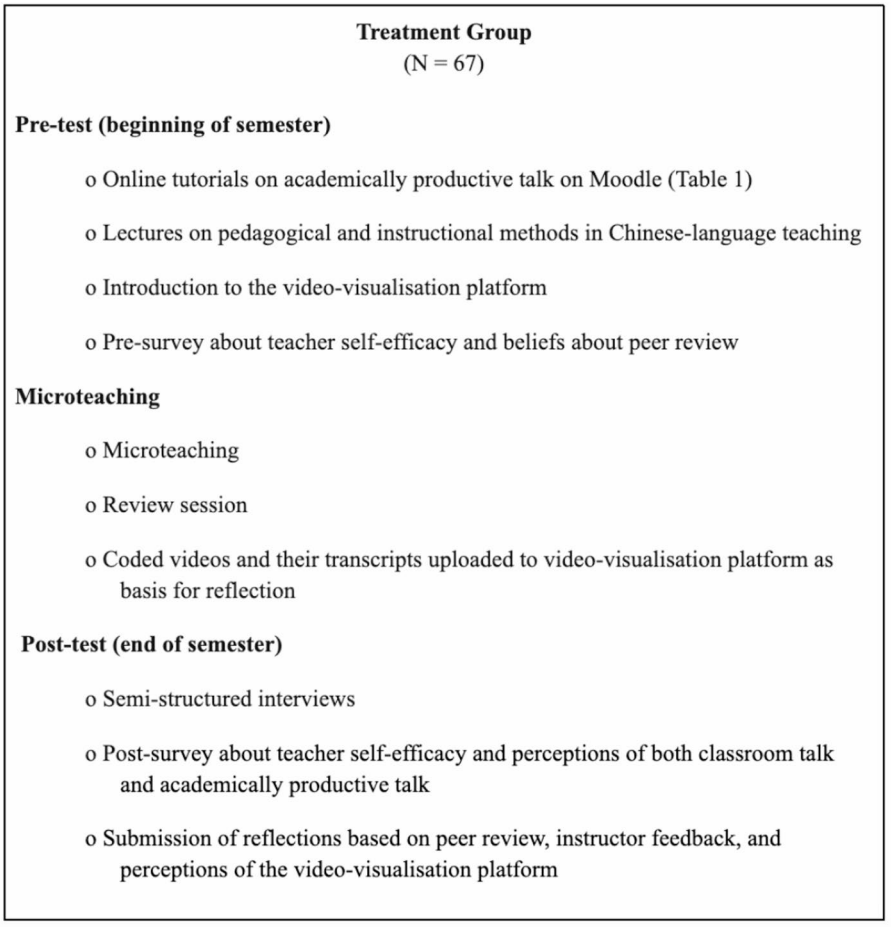

Fig. 2 Training-programme procedure

had occurred. When the user clicked on the arrows on the left-hand side of each type of APT, they were shown how many times it had been used.

3.5 Research procedures

Before the intervention, the research team held regular meetings to discuss the design of the training and tutorial materials, the selection of the classroom-talk framework, the adoption of the platform, and the data that needed to be collected. Informed-consent paperwork was drafted and distributed to the participants in all three classes, and they were informed about the procedure and purpose of the research. One of the specific actions we sought consent for was measurement of the participants' pre-intervention self-efficacy levels.

The pre-test questionnaires were distributed at the beginning of the first class held after consent was obtained. During the remainder of the semester, the three instruc-

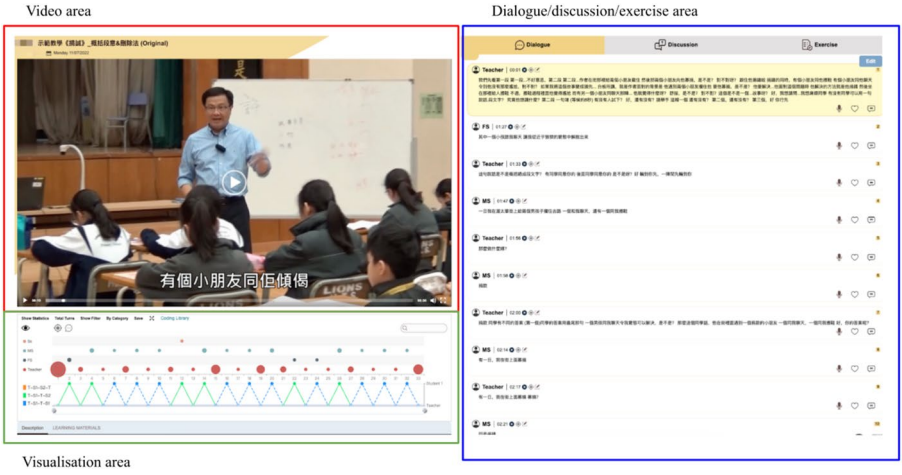

Fig. 3 Screenshot of the video-visualisation platform's interface

tors delivered instruction according to the training design (Figs. 1 and 2), and students' microteaching videos were transcribed and coded within a week after they were recorded. Post-test questionnaires were distributed in the final session of each course, at which time the students were also required to submit their reflection reports.

After the intervention, the collection of these data, and the interview phase, the research team analysed all data using appropriate quantitative and qualitative analysis, and organised the results based on the RQs.

3.6 Instruments

Table 2 is an overview of the data collected, organised according to the variables that were measured.

3.6.1 Classroom-talk data

To obtain a robust quantitative view of the sampled pre-service teachers' classroom talk, we exported data about their conversational turns during microteaching from the video-visualisation platform. These included the frequencies and types of APT strategies deployed in each of the three courses.

3.6.2 Teachers' self-efficacy questionnaire

To better understand changes in the pre-service teachers' self-efficacy, we administered a 12-item questionnaire, adapted from the Teacher's Sense of Efficacy Scale (Tschannen-Moran & Woolfolk Hoy, 2001). The adaptation consisted of translating the questionnaire items into Chinese, the participants' native language, to avoid language obstacles. The translated questionnaire was reviewed and revised by professors specialising in teacher education and Chinese-language education. We chose this instrument, first, because it evaluates a teacher's belief in their ability to effec-

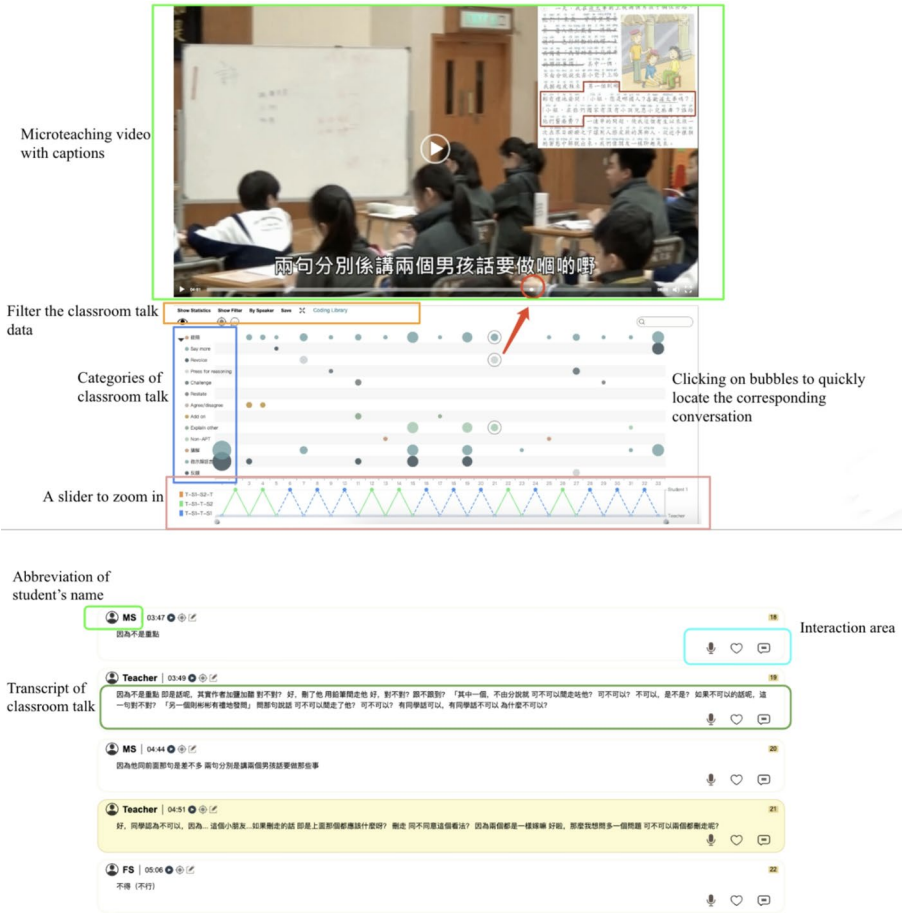

Fig. 4 Screenshot of the dialogue area displaying 'By Category'

Table 2 Overview of the collected data

Variable	Instrument(s)
Classroom-talk Strategy	Classroom-talk Data
Perceptions of Classroom Talk and the Academically Productive Talk framework	Semi-structured Interviews Reflection Reports
Teachers' Self-efficacy	Questionnaires Semi-structured Interviews Reflection Reports

tively employ instructional strategies, manage a classroom, and actively involve all students in the learning process; and second, because it has been utilised globally in research on student teachers, and its reliability and validity have been repeatedly established in various settings (e.g., Bas, 2022; Bosica et al., 2021). Its three subscales, each of four items, are Efficacy in Instructional Strategies (EIS), Efficacy in Classroom Management (ECM), and Efficacy in Student Engagement (ESE). All its

items are responded to on the same five-point Likert scale, ranging from 1='Not at all' to 5='A great deal'. A sample item from EIS is '*To what extent can you craft good questions for your students?*' The overall Cronbach's alphas for its pre-test and post-test administrations were 0.70 and 0.79, respectively.

3.6.3 Reflection reports

Reflection reports can facilitate the development of self-awareness and understanding of one's own perceptions (Hatton & Smith, 1994). To better understand changes in their perceptions of classroom talk and self-efficacy, we required each enrolled student to submit one such report at the end of the training. We asked that it be no more than two pages long and structured in accordance with the 4 F Active Reviewing Cycle (Greenaway, 1992), which entails Facts, Feelings, Findings, and Future. More specifically, the students were encouraged to try to detect their teaching shortcomings and to devise future solutions by reflecting on them.

3.6.4 Semi-structured interviews

We designed our interview questions to capture detailed subjective insights into the interviewees' shifts in self-efficacy and perspectives on classroom talk, along with their thoughts on their own teachers' efficacy, video-visualisation technology, and classroom-talk competency, based on their experiences. The full interview protocol can be found in Appendix 2.

3.7 Data collection and analysis

3.7.1 Quantitative data

Classroom-talk data Classroom-talk data from the video-visualisation platform—including each type of APT that was used by each student—were extracted after the end of the courses, based on the APT coding framework that can be found in Appendix 1's Table S2. Each line from the teachers' conversation was placed into its own category by a member of the research team. This work was reviewed by two other members within 24 h, and before being posted on the platform for the participants to review; and descriptive statistics of these data were calculated to capture the actual use of classroom-talk strategies in microteaching.

The Krippendorff's alpha of each participant's coding document was above 0.967, indicating reasonable inter-rater reliability (Krippendorff, 2011). Disagreements over coding were discussed and resolved during a regular weekly meeting. During that process, the coding references for APT were also modified, to allow teachers' statements and questions in any situation to be coded according to their APT types. Coding and reviewing each 15-minute video took approximately one hour.

Questionnaire Both administrations of the questionnaire were online via Qualtrics. The abovementioned Cronbach's alpha values indicated its reliability, and a one-way ANOVA revealed no meaningful differences among the three courses at the time of

the pre-test. Descriptive statistics were computed for the participants' self-efficacy. Paired-samples *t*-tests were also used to explore whether there were any significant differences in self-efficacy before and after the training, either within or across the three courses. All these analyses were performed with Stata 17 software.

3.7.2 Qualitative data

Reflection reports The reflection reports were collected in the form of either Microsoft Word or PDF documents.

Semi-structured interviews The interviews, each of which lasted around 30 min, were conducted in person or via Zoom and audio-recorded either within Zoom or using a digital voice recorder. The audio files were then manually transcribed verbatim by a research assistant and checked by other members of the research team. MAXQDA software was used to facilitate thematic analysis (Braun & Clarke, 2012) of the interview data and reflection reports. In line with RQ1 and RQ2, the contents of the interview transcripts and reflection reports were coded under three main themes: 'Changes of perception', 'Challenges' and 'Gains'. In addition, some subthemes derived from the main ones were identified and grouped as shown in Table S4, Appendix 1. After coding, the results were analysed with the aim of identifying recurring themes and patterns within the reflection reports, which in turn provided insights into the participants' experiences of and perspectives on classroom talk. More specifically, two researchers read and reread the qualitative data until they were thoroughly familiar with them. Then, they separately coded the same 30% of such data; identified patterns and themes; and discussed their respective coding themes during regular meetings with the rest of the research team. Then, in line with those discussions, they coded the remainder of the data. Final inter-coder agreement was 95.1%, indicating strong reliability. To answer RQ2 and RQ3, the qualitative data were segmented into 573 codes, which in turn were clustered into four major themes: 'Classroom talk and APT', 'Gains in teaching', 'Challenges', and 'Limitations of using APT'. These coding efforts yielded nuanced insights about the benefits preservice teachers may derive from virtual classroom discussions.

4 Results

4.1 RQ1: use of academically productive talk strategies

Table 3 presents data on the extent to which the participants applied and demonstrated their understanding of all eight APT strategies. The number of uses of each such strategy was tallied for each participant, and the table's 'Types of APT Strategies Used' row indicates the number of distinct APTs utilised by each of them. Its 'Total Occurrences of APT Strategy Use' row reflects the overall application of classroom-talk strategies in each microteaching video.

As a group, these pre-service teachers used more than half the APT strategies in their microteaching, and they deployed any one of them an average of 20.6 times per

Table 3 Descriptive statistics, Academically Productive Talk (APT) strategies ($N = 67$)

APT Strategy	Class 1		Class 2		Class 3		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Say More	7.17	5.22	5.36	5.38	3.58	3.19	5.48	4.94
Revoice	9.87	7.74	2.80	3.11	2.37	2.01	5.10	6.06
Press for Reasoning	4.04	3.18	4.08	2.31	1.37	1.16	3.30	2.68
Challenge	2.48	2.17	2.64	2.10	1.11	1.15	2.15	1.99
Restate	0.22	0.67	0.04	0.20	0.42	0.84	0.21	0.62
Agree/Disagree	1.74	1.86	0.92	0.81	0.74	0.93	1.15	1.35
Add On	2.43	2.64	3.12	2.51	3.68	3.70	3.04	2.93
Explain Other	0.87	0.42	0.16	0.47	0.11	0.32	0.12	0.41
Types of APT Strategies Used	5.39	0.89	5.16	1.34	4.89	1.45	5.16	1.24
Total Occur-rences of APT Strategy Use	28.04	13.60	19.12	9.52	13.37	8.00	20.55	2.13

SD standard deviation

presentation (standard deviation [SD] = 12.1). Among all APT strategies, Say more (M = 5.5, SD = 4.9) and Revoice (M = 5.1, SD = 6.1) were the two most used. These two strategies are relatively open-ended and easy to implement on the spot, as they do not require teachers to challenge student ideas or introduce new perspectives, unlike Challenge or Explain other. Their higher frequency may therefore reflect their accessibility for pre-service teachers still developing competency in managing spontaneous classroom talk.

4.2 RQ2: changes in perceptions of classroom talk and academically productive talk

Five main themes arose from the participants' interviews and reflection reports. These were (1) perceptions of classroom talk and the APT framework, (2) perceptions of the role of APT, (3) perceptions of teaching with APT, (4) challenges of guiding classroom talk, and (5) limitations of using APT. Each is explored in its own subsection below.

4.2.1 Perceptions of classroom talk and the academically productive talk framework

Reviewing teaching videos on our video-visualisation platform enabled the participants to gain a clear picture of their teaching, especially (1) how they utilised classroom-talk strategies and (2) the extent to which they applied APT. This process was facilitated by the platform's display of the number of APT-use occurrences. Segmented captions highlighting the conversational turns the participants took during their microteaching also provided insights into how they implemented APT strategies on a case-by-case basis. Replaying the video multiple times could reinforce their memories of classroom events, facilitating reflection even after a considerable period and helping them to recall details they might otherwise have overlooked. Many participants wrote that—specifically due to their use of the video-visualisation platform—they felt they would be more able to design future lessons that made high-quality use of APT.

Although just 10 reflection reports focused on the quantity of APT use, nearly all the participants noted that they wanted to start using APT in their future teaching. Some even named specific types of APT they expected to go on to use. As S4 put it:

> *I didn't use Restate, Agree/Disagree, and Explain Other. All those strategies could help students listen to each other's points of view, and in the process, not only develop their attention spans but also their analytical and thinking skills.*

Though just over a quarter of the participants ($n = 17$) expressed a belief that more APT was better, some ($n = 5$) mentioned wanting to use the Press for reasoning and Challenge strategies more in the future, and a few ($n = 4$) told us that using Restate would foster a more engaging and responsive classroom environment. Also, IN21 said, '*if you probe deeper by asking about the reasons, they may not have thought that much about it. This can help them gain a deeper understanding [of the text].*'

Some ($n = 5$) mentioned the value of strategically adopting lower quantities of specific APT types—not because they opposed the use of APT, but because they were concerned that overuse could dilute its quality. More specifically, they worried that using APT deliberately might involve discussion for its own sake, i.e., that was tangential to the teaching objectives and text, or asking too many shallow questions. Either of those phenomena, they told us, could disrupt the flow of textual comprehension, lead to superficial engagement, or even overwhelm students, while also potentially feeling forced or inauthentic.

Some participants who felt a tension between APT strategy use and lesson pacing told us that our training would be improved if it included advice on how to adjust their teaching dynamically: e.g., to reallocate time if a discussion using APT strategies proves especially valuable, or curtail it if pacing is at risk. One of them, S32, said:

> *I used too many Say more when teaching. […] I asked five to seven students to answer my question and one student to answer about one scene. Asking questions in this way helped the students concentrate […]. But it also slowed down the pace of the lesson.*

Others, however, described how they adapted their strategy use to balance interaction with time constraints. For example, IN9 told us: '*Sometimes after one student answered, I'd ask another to help, like Add on, Explain others. That way, I saved time explaining, and the students interacted with each other too.*' This approach enabled deeper understanding without requiring additional teacher talk, allowing for more efficient use of class time while still fostering rich student discussion.

To ensure effective learning, the design of teaching content must progress in complexity, as suggested by Wickens et al. (2013). Gradual knowledge transfer also crucially depends on such a progression in question design, i.e., that questions match the increasing complexity of content. However, several participants noted that, in their previous microteaching practice, they had not realised this. As S1 explained, '*I didn't deliberately order the shallow and deep questions, and the questions were mainly deep.*' Cognitive-load theory could therefore usefully inform APT implementations,

by emphasising the need to scaffold questions in a way that optimises students' cognitive ability, thereby enhancing their adaptive performance over time. S1 went on to share these insights about future improvement:

> *If I can order the questions by level*, *from shallow to deep*, *and increase the number of shallow questions as appropriate*, *students should be able to grasp the text's content and better understand its deeper meaning.*

In short, it appears that our training and reflection gave the sampled pre-service teachers a sound working knowledge of the APT framework and a desire to use it optimally across varied types of classroom situations.

4.2.2 Perceptions of the role of academically productive talk

Our qualitative data also suggest that most of the participants understood APT as transcending mere classroom talk, to include structured instruction. Here, it is worth noting that their teaching experience was rudimentary, with most having never taught to a whole class prior to the intervention. In their interviews, when asked about challenges or hardships they had experienced at any point in our study, most mentioned having difficulties before their microteaching, including with planning the lesson, choosing a text, and designing talk strategies for moving the class forward. Unsurprisingly, given that the use of APT in their microteaching was compulsory, some reported that they had adopted it to help them pre-outline their talks and to develop funnel questions to better deliver their teaching content. S20 reflected on how APT could make lesson preparation more efficient, describing it as a '*tool*' that supports thoughtful planning. While that respondent's focus on teaching goals and steps to achieve them was typical, other participants also highlighted the difficulty of designing processes for goal realisation, which often felt time-consuming and tedious.

Probably because APT was presented on our platform as a *technique*, our sample of pre-service teachers tended to perceive it through a statistical lens. When they reviewed their teaching performance on the platform, as noted above, APT strategies were coded and embedded in the video with notifications on the sidebar, enabling them to readily notice how many such strategies they had used, and when. Most participants included precise quantitative information about their APT use in their reflective writing. Typically, S6 noted that '*[a]ccording to the platform*, *my questioning strategies took up 43.40%.*' Some participants praised these quantification features: e.g., '*It will quantify all my specifics into data*, *and I'll be able to analyse it better*' (S18). Some ($n = 6$) also commented that the platform helped them reflect on the quality of their classroom talk. For instance, IN18 said: '*If I see a category with a higher percentage of Explanation*, *I'll click on the bubble and it will jump to the content*, *and then I'll examine my discourse against the text to see if it's appropriate.*'

4.2.3 Perceptions of teaching with academically productive talk

Our qualitative data further reflected the participants' diverse perspectives on the advantages of APT, which by its nature includes multiple levels of talk, from giving

an introduction to leading deep discussion. Some of these teachers reported gains in their situational cognition, i.e., that employing APT enabled them to make cognitive advancements in handling specific teaching scenarios. Through the application of APT, these educators enhanced their abilities to navigate, and indeed excel, in diverse classroom situations; and this ultimately enriched their teaching practices and outcomes, as further discussed below.

Two-fifths of the interviewees ($n = 9$) acknowledged that as soon as they utilised APT in their microteaching, they felt more at ease about developing an active and attentive classroom, and/or a more manageable one. As S21 put it,

> *At 3:50, I chose to pose an in-depth question to students who held minority opinions. […] Then, I called on a distracted student to explain why the paragraph couldn't be modified or omitted. All of these fall under Press for reasoning.*

Most interviewees ($n = 18$) noted that APT could also help them co-create a student-centred classroom in which learners master knowledge and develop a capacity for productive higher-order thinking. Students could engage in deeper discussions about a complex text, analyse various viewpoints, discuss themes and character motivations, and evaluate the author's intent and the impact on the reader. As IN19 stated, '*I would turn these strategies into some concrete content, mainly to use them in teaching intentionally, so that I could find out some students' innermost thoughts.*' IN16 told us that APT '*can encourage students to think actively and divergently, while also allowing them to gain a deeper understanding of the entire text.*'

Viewed holistically, diverse intricate and progressively more advanced teaching procedures can be viewed as parts of a single cohesive practice in which pre-service teachers can pragmatically utilise APT to refine their teaching methodologies. So far, as outlined above, we have identified situational cognition as one such refinement. However, this should not rule out future explorations of varied applications of APT that may enable pre-service teachers to adapt flexibly during their teaching endeavours.

4.2.4 Challenges of guiding classroom talk

Monopoly of strategy use and interaction Before their microteaching, most of the interviewees ($n = 12$) had intended or expected to use various APT strategies. One (S34) said, '*I would like to use an approach where the teacher and students ask and answer each other, and the teacher guides the students through answering questions.*' However, contrary to their expectations, it was not easy for them to apply these strategies flexibly. S41 highlighted the unpredictability of students' responses during teaching, noting that over-reliance on lesson plans and scripts can backfire when responses are '*out of expectation*.'

A sizeable minority of the participants ($n = 20$) expressed surprise at the degree of difference between what they saw in their teaching videos and what they remembered happening. For instance, '*The data shows that I used Challenge in the microteaching and not Add-on, but I thought I'd used Add-on more*' (S36).

Three other serious problems came to light through the reflection process. These were (1) a subconscious preference for interacting with a particular group of students (e.g., S18 focused on those on the right-hand side of the classroom and overlooked others) and/or lack of concern about the participation of all students; (2) use of only basic strategies (e.g., Restate, Agree/disagree, and Explain: S20 sacrificed Challenge to maintain pacing); and (3) providing insufficient opportunities for enquiry and limiting students' ideas/thinking (e.g., guiding students to choose the answer the teacher expected: S8 admitted to steering students' responses while rewriting sentences).

When sharing their solutions to these problems, many participants ($n = 20$) said they expected their APT use to become more consistent via real-world classroom teaching, and a few ($n = 4$) stated that APT-based questioning styles would help them incorporate APT into their teaching smoothly. Other participants' reflections on their questioning styles led them to conclude that they should have given students more space to think and answer. One (S29) suggested that open-ended questions and leading questions could help release students' tension that arose from being asked questions, and thus lead to a livelier and more collaborative classroom atmosphere. S43 said: '*Collaborative thinking is an important part of classroom questioning*, *and I think there's still room for improvement in this part of the microteaching*, *especially in the area of Add-on*'. These and other similar data suggest that, in line with APT theory, the sampled pre-service teachers were beginning to develop a reflective mindset.

Limited time to memorise and use the strategies Probably due to the training sessions' fast pace, nearly a fifth of the interviewees ($n = 4$) felt they needed more time to remember and implement specific APT strategies, despite having watched the tutorial videos and lectures. As S38 explained, '*in microteaching*, *I often forgot what the specific ways were and just asked questions as a matter of habit. Developing new and different interaction strategies requires design and constant practice.*' This is common when new skills are not fully internalised: i.e., due to insufficient practice or memorisation, teachers may revert to their habitual responses in familiar contexts, particularly when faced with stress or unexpected situations.

Various participants ($n = 7$) also complained that the 15 min per person allocated to microteaching was too short, and/or that this activity's format led them to feel pressed for time. Some ($n = 5$) expressed a specific fear that they would not have enough time to finish explaining the theories, which would negatively impact group discussions and thus affect their use of APT. S19's reflection included the following comment: '*I set the goal of using more Agree or disagree and Add-on*, *but due to the tight and packed teaching procedures planned before teaching*, *I couldn't leave more time for students to reason step by step.*'

While some participants ($n = 5$) suggested extending the duration of microteaching sessions to allow more flexibility around APT strategy implementation, others ($n = 6$) recommended that we increase the range of opportunities for scaffolded low-stakes practice: e.g., rehearsal sessions in which instructors provide real-time feedback on APT use. S25 remarked, '*It would be useful if we had a practice round before the actual microteaching*, *maybe with mentors or peers pointing out where we could refine our strategies.*' Advocates of both these types of adjustment argued that they

would better support the balancing of content coverage against interactive, student-centred discussion techniques.

Nervousness In part because they lacked teaching experience, many of the participants were nervous, and this also impacted their use of APT strategies, their ability to respond flexibly to unexpected situations, and their teaching more generally. As S8 explained, '*I had not been teaching standing at the podium alone for a long time*, *so I didn't use some classroom-talk strategies I had designed before.*' Fear of losing control in the classroom also led to missed opportunities for fostering deeper interactions. As S19 noted, '*I find myself subconsciously focusing on "teaching" rather than the "learning" of students. I felt uneasy when dealing with strange responses*, *[and] worried that the class would not go as planned.*' In theory, students should have had their comments summarised point by point, and then been guided to discussion in greater depth. However, video evidence reveals that this was seldom achieved by any of the participants. S43 mentioned that she did not instinctively use elaborative feedback: '*I could usually only reply with "very good" and immediately move on to a follow-up question or summary after a student had responded.*'

Moreover, in most scenarios, the participants either suspended the use of APT or targeted it at the most active and high-performing students in their classrooms.

> *Since I'm afraid of nervousness and uncontrollable situations in the classroom*, *I'm not confident in my own questioning and feedback skills. So I have a hidden tendency to avoid interacting with students and asking them questions […But] if I have to*, *I prefer asking the 'good' students.* (S7)

After our intervention, however, the participants' nervousness was largely eliminated, along with the habitual behaviours that most of them had unconsciously been enacting. As S4 said,

> *students' laughter meant that they enjoyed the class*, *and the diversity of their opinions stimulated the imagination and reduced the doubts of other students*, *which enhanced the quality of the discussion. […] I should not fear hearing laughter and 'strange' opinions.*

4.2.5 Limitations of using academically productive talk

While the participants' comments about APT were mostly positive, some ($n = 8$) had negative reactions to its use. For instance, IN7 argued that APT would not be appreciated by Hong Kong primary schools because of cultural barriers between conventional Chinese 'humble learning' culture (Moloney & Xu, 2015) and the more attentive, proactive learning culture implied by this framework. Traditionally, students in Hong Kong are expected to listen attentively, refrain from interrupting the teacher, and avoid assertively voicing their own ideas or challenging the teacher's views. This may make them hesitant about contributing their ideas and opinions in front of their peers, especially if they perceive such behaviours as impolite or disre-

Table 4 Descriptive statistics for self-efficacy, all three courses ($N = 67$)

Factor	Pre-test		Post-test		t-test	
	Mean	SD	Mean	SD	t	*p*
Efficacy in Instructional Strategies	3.46	0.49	3.88	0.57	6.66	0.000***
Efficacy in Classroom Management	3.26	0.50	3.71	0.57	6.63	0.000***
Efficacy in Student Engagement	3.54	0.54	3.85	0.57	4.17	0.000***

SD standard deviation

*$p < 0.05$; ** $p < 0.01$; ***$p < 0.001$

spectful, irrespective of APT's requirement that they engage in them. However, we feel that seeing these practices in action—e.g., via additional successful case studies—and receiving feedback based on expert and peer observation could help alleviate such concerns and promote buy-in. As IN21 noted, '*Peers provide me with feedback from another perspective. They might tell me how to improve or suggest a new way to explain something. I find this very enlightening*'.

Five other participants told us that their microteaching practice had been constrained by APT use, and/or characterised the framework as too rigid. IN22, for example, said that neither her personal teaching style nor the subject, Chinese, suited the use of the Challenge strategy; and IN1 expressed a belief that traditional or conventionally minded teachers who were inclined to conduct teacher-centred lectures rather than student-centred classroom discourse might be critical of the use of APT or over-cautious when applying it.

4.3 RQ3: impact on teachers' Self-efficacy

Table 4 presents descriptive statistics and paired-samples *t*-test results for the sample's self-efficacy. The parallel data broken down by course can be found in Appendix 1.

Prior to their microteaching, the participants' self-efficacy was above the midpoint (i.e., 3) in EIS (M = 3.46, SD = 0.49), ECM (M = 3.26, SD = 0.50), and ESE (M = 3.54, SD = 0.54). After our intervention, these scores improved significantly: by the most in EIS ($t[67] = 6.66$, $p < 0.001$), followed by ECM ($t[67] = 6.63$, $p < 0.001$) and ESE ($t[67] = 4.17$, $p < 0.001$). Within each course, score improvement was also significant across all three dimensions (see Appendix 1).

Regarding EIS, 11 interviewees told us that microteaching and video visualisation helped them acquire multiple assessment strategies, various alternative methods of explaining, creative approaches to crafting questions, and confidence about implementing classroom strategies. When asked about the challenges they faced when preparing and performing their microteaching, nine of the interviewees mentioned nervousness, anxiety, and a general sense of hardship. IN18 noted,

> *When I was designing my microteaching, I lacked information about what the Year 8 students would be like. Thus, I was unsure whether my microteaching design would be well-received in real life […]. Also, I wasn't ready with the on-site emergency responses.*

Later, when asked about gains from the training programme, primarily in EIS, the same interviewee said: '*I gained a much better sense of teaching structure and procedure […This] gave me a chance to practise the teaching strategy*, *and allowed me to think about how much my students would take in.*'

Regarding their ECM improvements, most of the interviewees mentioned that before the training, they could neither handle disruptions in the classroom nor optimally manage their teaching time. IN3 said that, thanks to our intervention, '*I realised the importance of the on-site reaction for emergencies that a teacher should have […and] the problem-solving ability I gained from the microteaching helped me to get the class going*'.

In terms of ESE, most interviewees mentioned struggling to properly deliver knowledge to targeted students and/or to motivate students to pay attention. For example, IN11 stated, '*I have been thinking hard about how to make my students willingly pay attention to my class […] like actually involved and brain-engaged in my class*, *all of them*, *not just sitting there with a blank mind*'. After the training, IN16 said, '*What I learned most through microteaching was how to make the students understand what you were teaching*'. Also, according to some of the interviewees, the classroom-talk strategy that was taught and implemented at the very beginning of the training programme helped them to guide and train their students' higher-order thinking skills: '*[S]ome creative restructuring questions and so on can make students think positively and let them understand the whole chapter in depth*' (IN16).

5 Discussion

5.1 Perceptions of classroom talk

After the intervention, our participants' original perceptions of classroom talk had altered markedly, and we can ascribe these changes chiefly to the structured, systematic nature of the video-visualisation platform as a teaching aid. Our qualitative data suggest that, after fitting APT into their lesson planning in advance of their microteaching, these pre-service teachers had a clearer mindset in terms of both what they taught in the classroom and how they would move forward with their teaching using various APT strategies. By observing themselves in action through the platform, they were provided with unique opportunities to reflect on their teaching practices, identify strengths and areas for improvement, and make informed decisions that would enhance their instructional strategies. This, in turn, had the effect of increasing their confidence about classroom-talk strategies and their sense of competence when implementing them. Video visualisation of the teaching process and its counting of APT occurrences were both key to these novice teachers' reflection and subsequent comprehension (see also van Es et al., 2014).

Our research took place over a relatively short period and at a fast pace. Nevertheless, our quantitative analysis suggests that the participants were able both to integrate classroom-talk strategies into their teaching content and to explicate knowledge while simultaneously building their students' capacity for higher-order thinking. These findings extend Ahmed and Montecillo Leider's (2024) quantitative

ones regarding teachers' perceptions of classroom talk. Like them, we noticed that post-intervention, the sampled teachers not only acknowledged that *more* APT was necessary, but also began to see the importance of the *quality* of APT strategy use. However, we went beyond Ahmed and Montecillo Leider by establishing APT as a classroom-talk framework; by exploring students' perceptions of it qualitatively; and by sampling novice pre-service teachers over the course of a multi-week intervention, as opposed to experienced in-service ones over a period of less than three hours.

5.2 Classroom talk, video-visualisation technology and teacher professional development

Review of and reflection on the APT data presented by the video-visualisation platform signalled to the participants whether their classroom-talk skills were adequate vs. needed to be improved. As such, use of the platform can be deemed to have supported holistic and personalised reflection. Our study has also established an advanced method of situating classroom-talk data on a self-accessible video-visualisation platform that can provide pre-service teachers with ready access to their whole process of teaching. Meanwhile, this platform's interactive design provided more well-rounded and objective feedback than they had previously received from mentors and peers, and also contrasted with previous designs for research on classroom talk, which have tended to lack this technological component (e.g., Gröschner et al., 2018).

Additionally, our results suggest that the participants understood both the concept and the practical application of APT. Accordingly, their gains from our training process included an enhanced capacity for critical reflection, possibly running counter to their original perceptions (e.g., IN1's change of mind about whether he would use APT), and/or a capacity for future personal development (Kimber et al., 2013). Nevertheless, because our training provided instruction and practice before reflective writing commenced, the understandings of each APT strategy expressed in such writing represented the sampled pre-service teachers' overall understanding.

Beyond the above-mentioned benefits, our study contributes to the growing body of research on video visualisation-enhanced TPD by demonstrating how an integrated model combining microteaching, peer review, video visualisation, and structured reflection can enhance teachers' classroom-talk competency. Though previous studies have highlighted the potentially important role of video-based reflection in professional development (e.g., Gröschner et al., 2018), many prevailing approaches to incorporating such reflection rely heavily on passive observation of videos. Our findings demonstrate that embedding video visualisation within structured reflection cycles can provide a more data-driven, self-directed, and interactive learning experience. Our study therefore contributes to discussions on broader educational reforms in Hong Kong, particularly the shift toward student-centred pedagogy and reflective teaching practices, while also addressing educational policy and the need for institutional support for sustainable implementations of technology-enhanced TPD.

In addition to supporting diverse reflection practices, our model addresses specific challenges faced by pre-service teachers in urban settings. Although technological access is rarely an issue in such environments, pre-service teachers often experience intense time constraints due to coursework, teaching practicum, and part-time

employment. The video-visualisation platform's self-paced, modular design enables urban pre-service teachers to engage in focused reflection without requiring large uninterrupted blocks of time. In this way, the model not only enhances flexibility but also responds directly to the practical realities of pre-service teacher preparation in urban educational contexts.

5.3 Pre-service teachers' reflection on classroom talk via video-visualisation technology

Confirming previous research results (Chen, 2020; Gröschner et al., 2018), our findings imply that undergoing a systematic video-assisted reflection process can significantly boost teachers' self-efficacy. However, because Gröschner et al.'s study of video-based reflection was not embedded in a self-accessible video-visualisation platform, their participants could not use it either to reflect on their teaching practices at any time of their own choosing or to interact with peer participants online. Theoretically, then, the present research has crossed the boundary between learning and reflection as part of a community, insofar as our video-visualisation platform can not only enable community-based reflection, i.e., sharing and reviewing the microteaching videos in class, but also individuals' private review of and reflection on their teaching performance whenever they wish to engage in those activities. Previous research (e.g., Zhang et al., 2025) has raised concerns about the outcomes of individual reflection, on the grounds that they may be too subjective. However, in our approach, the quantitative classroom-talk data can be seen as an objective index, tracking the frequency of student interactions and providing concrete numerical data that can complement subjective reflections by mitigating the individual biases that can arise during them. Moreover, individual reflection has the potential to accommodate pre-service teachers' varied levels of willingness to share their reflections publicly. Therefore, our approach can be seen as extending the benefits of individual reflection.

Fundamentally, our training prompted many of the participants to understand that the purpose of questioning in the classroom is not only to lead students to understand content comprehensively, but also to train them in thinking skills. Hence, they also realised that, as teachers, they should not limit themselves to asking closed-ended questions, but rather pay close attention to students' points of view and the logic underlying them, and then follow up initial questions with more challenging ones.

5.4 Teachers' self-efficacy

The self-efficacy of the members of all three courses improved across all three subscales: findings consistent with those previously reported by Velthuis et al. (2014). Crucially, our results confirm that the focal type of TPD can effectively enhance pre-service teachers' self-efficacy regarding their future teaching practices; equip them with practical, detailed strategies for promoting classroom discussion; and boost their confidence about implementing those strategies in their subsequent careers.

The microteaching within our training programme offered the sampled teachers a chance to gain experience of organising and managing classrooms, notably by

maintaining student engagement and using questioning strategies to promote critical thinking. Those two activities, in particular, appeared to boost the microteachers' own confidence in their abilities: a finding that aligns with Mergler and Tangen's (2010) assertion that pre-service teachers' classroom-management abilities positively impact their teaching self-efficacy. Additionally, the peer feedback provided during microteaching sessions allowed participants to refine their strategies, further reinforcing their sense of competence and preparedness for future teaching contexts.

Because the reflection reports we collected were written at the end of the training, most of them linked the recognition of teaching problems to critical actions the writers wished to perform. Some prior research has claimed that teachers' reflective practice leads to efficient corrective feedback (Van Ha & Murray, 2021). Based on the present study's results, we feel that reflection is of the greatest value when part of a wider process: in this case, one that consisted of watching peers' microteaching, noting the peer feedback they gave and received, writing critically about problems, and correctively crafting future solutions to them.

Classroom talk and questioning techniques have been widely discussed in the literature, with most of the relevant studies recognising the importance of developing classroom discourse and questioning skills (e.g., Smart & Marshall, 2013). Most pre-service teachers form their questioning skills in their TPD classrooms. Nevertheless, hearing and delivering teacher-centred lectures cannot give pre-service teachers much experience of the questioning and response skills that an interactive classroom requires.

By using APT-informed microteaching as its core learning activity, our intervention provided pre-service teachers with a four-level, eight-type classroom-talk strategy based on a solid questioning format. The value of APT in microteaching, and of reflection on the use of APT through peer review, were both acknowledged by the majority of the participants, whose questioning skills (as measured by analysis of their peers' feedback) also improved markedly. Some of our interviewees noted that APT provided a clear, structured, and well-designed questioning plan for microteaching; and, aided by reflection-report writing, some participants exhibited abilities not only to identify which types of APT they wished to use more in their future teaching, but sometimes also when to expand their use in specific scenarios. This same subgroup of pre-service teachers also provided reflections on the quality of the APT that they had used.

5.5 Limitations and future research directions

The present study has several limitations. The first is that its design did not allow us to establish quantitatively which training sessions contributed the most to self-efficacy. Future research should therefore include experimental studies or longitudinal assessments, both to clarify this point and to enable comparison of the varied impacts on self-efficacy provided by a range of training components and/or approaches. Second, our training focused on increasing the use of APT, and as a result, participants' classroom-talk competency was assessed solely through quantitative measures, i.e., the frequency and types of APT used. However, feedback from the participants indicated their strong interest in the quality of APT usage, and

specifically, the timing and appropriateness of employing specific APT strategies. Some expressed concerns about using APT strategies merely for the sake of it, i.e., applying them mechanically or superficially without aligning them with a specific instructional context or learning objective. Some were also wary of developing a narrow focus on increasing APT strategies' use-frequency, which they felt could disrupt the flow of classroom discourse. This highlights the importance of ensuring that APT strategies are employed purposefully and thoughtfully, rather than as a checklist to be completed. Future studies should therefore consider balancing both the quantity and quality of APT in teaching, ensuring its alignment with pedagogical goals, and teaching their participants how to select APT strategies that will most effectively foster productive and meaningful interactions in specific contexts.

Second, the duration of our TPD programme was one semester, and as such, our data were inherently unable to capture either longer-term changes in the sampled pre-service teachers' classroom-talk practices or our training's effect on their eventual real-life teaching. More longitudinal research, and/or studies integrating other TPD tools such as collaborative lesson-planning or guided-reflection platforms, should be conducted to fill those gaps.

Third, we utilised convenience sampling and focused on a single subject area. Future studies of our approach's training effects would benefit from including pre-service teachers from across various disciplines.

Lastly, while video visualisation was a key tool in our study, we must acknowledge potential barriers to its adoption such as technical limitations, accessibility issues, and the learning curve for new users. In addition to the asynchronous access provided by the tutorial videos in our study, a more tailored approach could integrate video visualisation with personalised coaching, allowing both pre-service and in-service teachers to analyse their own teaching videos. Hybrid learning models that combine asynchronous video analysis with in-person or virtual mentoring could also be a useful means of providing ongoing support.

Accordingly, future studies should explore strategies that could enhance accessibility and ease of use for teachers in varied contexts. For instance, researchers could test how well mobile-friendly platforms and offline-access options could support users in various environments. In rural settings, these options may help overcome technological barriers. Additionally, structured reflection guides and step-by-step scaffolding could be developed to help reduce beginners' cognitive overload. In any case, future adaptations of our approach should ensure that the TPD model remains accessible, scalable, and responsive to diverse teaching contexts, and thus support sustainable teacher development in both rural and urban settings.

6 Conclusions

In this study, we designed and implemented a series of training tasks for pre-service Chinese-language teachers that combined classroom talk during microteaching, peer review, instructor feedback, and reflection supported by video-visualisation technology. It yielded two key findings. First, the sampled pre-service teachers' self-efficacy had improved significantly after the intervention in terms of instructional-strategy

use, classroom management, and student management. And second, the sampled pre-service teachers started to apply various APT strategies in their microteaching after the intervention, which also drove positive change in their perceptions of classroom talk: notably, by promoting the idea that APT serves wider purposes than the mere facilitation of teachers' effective communication, e.g., pedagogical guidance. The participants acknowledged that video visualisation and peer review were crucial pedagogical elements of teacher training, and developed a positive attitude about reflecting with their peers. That attitude, in turn, allowed them to transcend the traditional (i.e., bilateral and hierarchical) relationship with a teacher-as-expert, and instead to view learning as a shared, collaborative journey. By fostering such an environment of partnership, teachers can create a more inclusive atmosphere in which everyone contributes to knowledge co-construction.

These findings have several important implications for educational practitioners. First, more TPD programmes should prioritise cultivating and strengthening teachers' classroom-talk competency in various subjects. Indeed, such programmes could evolve into sustainable communities of life-long learners (e.g., online professional learning communities: Jin et al., 2025) in which teachers facilitate regular knowledge-sharing through discussions about teaching practices; engage in collaborative lesson-planning tailored to varied classroom contexts; reflect on their practices; receive constructive feedback from peers; and decide how to adapt their methods to improve students' learning outcomes.

Additionally, our findings imply that teacher educators could usefully provide both more detailed lectures about classroom talk and more chances to practise it, and that scholars should explore additional frameworks for classroom talk that might meet teachers' needs in a variety of subject-matter and cultural contexts. In connection with such reforms, our study's findings have important implications for broader educational reform in Hong Kong, particularly the ongoing shift toward student-centred pedagogy. If classroom-talk strategies are integrated into TPD, schools should be able to reap the benefits of more dialogic and enquiry-based learning. Additionally, aligning curriculum frameworks and teacher-appraisal systems with student-centred teaching goals has the potential to drive systemic change. However, addressing cultural and institutional barriers will be essential to ensuring the sustainable implementation and long-term impact of these reforms.

Lastly, artificial intelligence (AI) could in theory be used to develop more advanced, time-efficient, and cost-effective analytic tools for classroom discourse than are currently available. Hurdles such as concerns about data privacy and the risk of AI misinterpreting complex human interactions and cultural nuances would need to be overcome. Nevertheless, future work could utilise promising AI-enhanced tools to facilitate the provision of real-time feedback, curate databases of effective discourse strategies, and enhance the quality of classroom-discourse analysis.

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Declarations

Competing interests There are no conflicts of interest to declare.

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