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Analysis of Cognitive Performance and Pragmatic Accuracy of Prospective Mandarin Teachers in an Immersive Virtual Classroom Discourse Simulation

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ABSTRACT

The growing demand for Mandarin language teachers requires teacher education programs to develop not only linguistic proficiency but also pragmatic competence and cognitive readiness for authentic classroom interaction. This study investigates the cognitive performance and pragmatic accuracy of prospective Mandarin teachers participating in an immersive virtual classroom discourse simulation. A quasi-experimental pretest–posttest design was employed involving undergraduate students in a Mandarin Language Education program at Widya Kartika University. Cognitive performance was assessed through executive function measures, including the Stroop task and task-switching paradigm, while perceived cognitive load was measured using the NASA Task Load Index. The virtual classroom simulation was conducted through a Zoom-based teaching scenario designed to replicate authentic classroom communication. Results indicated approximately a 25% improvement in cognitive and pragmatic performance following the intervention. Correlational analysis further revealed a positive relationship between cognitive load indicators and pragmatic accuracy outcomes. These findings suggest that immersive virtual classroom simulations can effectively enhance both executive functioning and pragmatic competence among prospective Mandarin teachers. The study highlights the importance of integrating cognitive and communicative dimensions into language teacher education to better prepare future teachers for the demands of real classroom discourse

INTRODUCTION

The global expansion of Mandarin Chinese as a second language has placed increasing demands on teacher education programs to produce not only linguistically proficient instructors but also pragmatically competent communicators who can navigate the complexities of real classroom discourse (Rose & Kasper, 2001). Pragmatic competence, defined as the ability to produce and interpret language appropriately in accordance with social context, interlocutor relationships, and communicative purpose, has long been recognized as a cornerstone of communicative language teaching (Deda, 2013). Yet, despite its acknowledged importance, the development of pragmatic competence among pre-service language teachers remains insufficiently addressed in many teacher preparation curricula, particularly for languages with distinct sociopragmatics norms such as Mandarin Chinese (Li et al., 2015).

Pragmatic Competence in Language Teacher Education

Second language teacher education (SLTE) has evolved considerably over the past two decades, shifting from behaviorist models of methods training toward frameworks that foreground teacher cognition, reflective practice, and situated professional knowledge (Wright, 2010). Within this landscape, teacher cognition research has demonstrated that what teachers think, know, and believe directly shapes their classroom interactional practices (Borg, 2003). However, while teacher cognition studies have proliferated across grammar instruction, literacy pedagogy, and assessment beliefs, the specific domain of pragmatic competence as both a cognitive resource and a teachable skill in pre-service contexts remains underexplored.

Pragmatic competence encompasses multiple dimensions, including pragmalinguistic knowledge (the linguistic resources available for performing communicative acts), sociopragmatic awareness (understanding how social variables such as power, distance, and imposition shape language choice), and discourse management abilities (Aufa, 2012). For prospective Mandarin teachers, these dimensions are particularly critical because Mandarin pragmatic systems involve intricate honorific usage, indirectness conventions, and context-dependent politeness strategies that differ substantially from many learners' L1 pragmatic norms (Li et al., 2015). Without explicit attention to pragmatic development in teacher education, pre-service teachers may enter classrooms with sufficient grammatical accuracy but limited capacity to model or teach culturally appropriate interaction.

Assessment of pragmatic competence has relied on several methodological approaches, including written discourse completion tasks (WDCTs), multiple-choice pragmatic judgment tests, role-plays, and expert rating of naturalistic discourse (Pan, 2023). While WDCTs and multiple-choice formats offer scalability and standardization, they have been criticized for limited ecological validity, as they elicit decontextualized language production that may not reflect real-time communicative behavior (Ishihara, 2009). Conversely, expert rating of discourse transcripts provides richer, contextually situated data but demands substantial rater training and calibration (Alemi & Tajeddin, 2013). This study employs both approaches to triangulate pragmatic accuracy, combining the standardization of a multiple-choice pragmatic judgment test with the ecological validity of expert-rated discourse produced during a simulated teaching event.

Immersive Simulations in Teacher Preparation

In recent years, simulation-based learning has gained substantial traction as a complement to traditional practicum experiences in teacher education programs worldwide (Ade-Ojo et al., 2022). Simulations allow pre-service teachers to practice instructional decision-making, classroom management, and communicative interaction in low-risk, controlled environments before encountering the unpredictable demands of real classrooms .(Lindberg & Jönsson, 2023) The emergence of virtual classroom platforms, including video-conferencing-based role-play environments, has expanded the accessibility and fidelity of simulation technology for teacher training programs that lack resources for high-immersion VR systems (Spray et al., 2024).

Research has consistently demonstrated that simulation-based teacher training fosters self-efficacy, instructional confidence, and reflective practice among pre-service teachers (Kelleci Alkan et al., 2024). Kelleci and colleagues found that a multi-feedback system integrated with simulation-based training raised self-awareness and improved teaching skills among 70 pre-service teachers, with

participants reporting that the experience facilitated the transfer of acquired skills to real-life contexts (Kelleci Alkan et al., 2024). Similarly, Remacle and colleagues demonstrated that teaching simulations in a virtual classroom helped trainee teachers develop oral communication skills and self-efficacy, although the benefits were modulated by individual differences in anxiety and prior experience (Remacle et al., 2023). For language teacher education specifically, VR-AI assisted simulations have shown promise in supporting content knowledge application among pre-service EFL teachers, suggesting that immersive technologies can scaffold both linguistic and pedagogical competence simultaneously (Pitura et al., 2025).

Despite these advances, a notable gap persists in the literature. Most simulation studies in teacher education have focused on classroom management skills, general instructional competence, or content knowledge application, with comparatively little attention to the pragmatic dimensions of teacher discourse (Nickl et al., 2022). Furthermore, while research on immersive technologies for second language learning has examined vocabulary acquisition and comprehension (Legault et al., 2019), few studies have investigated how simulation-based experiences influence the pragmatic accuracy and cognitive resources of prospective language teachers during discourse production.

Cognitive Performance and Language Teaching

Effective classroom discourse requires more than linguistic and pragmatic knowledge. Teachers must process multiple streams of information simultaneously, manage competing cognitive demands, and adapt their language production in real time based on learner responses. Executive functions, including inhibitory control, working memory, and cognitive flexibility, underpin these processes and are essential for successful language performance in demanding communicative contexts (Diamond, 2006). A meta-analysis by Cortés Pascual and colleagues confirmed a moderate but significant relationship between executive functions and academic performance, with working memory demonstrating the strongest predictive weight (Cortés Pascual et al., 2019).

For pre-service teachers operating in a second language, the cognitive demands of classroom discourse are compounded by the need to simultaneously plan instruction, monitor learner comprehension, manage turn-taking, and produce pragmatically appropriate language in Mandarin. This dual burden of cognitive processing and linguistic production aligns with Cognitive Load Theory, which posits that working memory capacity is finite and that excessive extraneous cognitive load can impair learning and performance (Song et al., 2023). Research on immersive learning environments has further revealed that virtual simulations, while offering authentic contextual scaffolding, can impose additional cognitive demands that may hinder performance, particularly for novice learners (Grecu et al., 2025). A systematic review by Poupard and colleagues found that virtual reality often induces extraneous cognitive load that hinders learning, while augmented reality tends to optimize cognitive load, suggesting that the design and modality of simulation environments significantly shape cognitive outcomes (Poupard et al., 2025).

The relationship between cognitive performance and pragmatic accuracy in language teaching contexts has received limited empirical attention. While studies have examined executive function advantages in bilingual populations (Lehtonen et al., 2018) and the role of working memory in second language oral production (Payne & Whitney, 2003), few investigations have directly examined how cognitive load and executive function interact with pragmatic accuracy during simulated teaching discourse. Understanding this relationship is crucial because cognitive overload may degrade not only the linguistic quality but also the pragmatic appropriateness of teacher talk, with downstream effects on communicative effectiveness in the classroom.

Research Gap and Purpose

Despite growing recognition of the importance of both pragmatic competence and cognitive performance in language teacher education, these two constructs have largely been investigated in isolation. Simulation-based studies in teacher preparation have predominantly addressed general pedagogical skills or cognitive outcomes without examining pragmatic dimensions, while interlanguage pragmatics research has rarely considered the cognitive demands that shape pragmatic production in real-time discourse. This fragmentation limits our understanding of how prospective Mandarin teachers manage the

simultaneous cognitive and pragmatic challenges of classroom interaction.

The present study addresses this gap by investigating the cognitive performance and pragmatic accuracy of prospective Mandarin teachers engaged in an immersive virtual classroom discourse simulation. Specifically, the study examines (a) changes in executive function performance (inhibitory control and cognitive flexibility) before and after the simulation, (b) perceived cognitive load during the simulation, (c) pragmatic accuracy as measured by a multiple-choice pragmatic judgment test and expert-rated discourse transcripts, and (d) the relationship between cognitive performance indicators and pragmatic accuracy outcomes.

By integrating cognitive and pragmatic dimensions within a simulation-based framework, this study aims to contribute to a more holistic understanding of pre-service Mandarin teacher readiness and to inform the design of teacher education programs that support both the cognitive and communicative demands of effective language instruction.

METHODS

Research Design

This study employed a quasi-experimental pretest-posttest design to examine changes in cognitive performance and pragmatic accuracy among prospective Mandarin teachers participating in an immersive virtual classroom discourse simulation. The independent variable was the virtual classroom simulation intervention, while the dependent variables were cognitive performance (measured through executive function tasks and cognitive load scales) and pragmatic accuracy (measured through a multiple-choice pragmatic judgment test and expert-rated discourse transcripts).

A quasi-experimental design was selected because the study involved intact groups of undergraduate education majors rather than randomly assigned participants. This design allows for pre-intervention baseline measurement and post-intervention comparison while acknowledging the practical constraints of recruiting from a single cohort.

Participants

A convenience sample of fewer than 30 undergraduate students majoring in Mandarin language education was recruited from Widya Kartika University. Participants were in their third year of study and had completed coursework in Mandarin linguistics, pragmatics, classroom pedagogy and internship.

Inclusion criteria:

- Enrolled in a Mandarin language education program
- Native or near-native proficiency in Mandarin Chinese
- Basic familiarity with video-conferencing platforms
- No prior experience with immersive virtual classroom simulations (to avoid practice effects)

Exclusion criteria:

- Diagnosed cognitive or attention disorders that could confound executive function measures
- Prior participation in similar simulation-based studies

Prior to data collection, all participants provided informed consent in accordance with the institutional review board protocols provided by research and community service department in Widya Kartika University.

Materials and Instruments

Virtual Classroom Discourse Simulation

The immersive simulation was conducted via Zoom and designed to replicate authentic classroom discourse in a Mandarin-language teaching context. Each simulation session lasted approximately 120 minutes and followed a structured scenario in which participants assumed the role of a Mandarin teacher delivering a lesson to simulated students.

The discourse simulation included the following components:

- Opening routine: Greeting, attendance check, and lesson introduction in Mandarin
- Instructional phase: Presentation of vocabulary/grammar content with comprehension checks
- Interactive phase: Q&A, error correction, and pragmatic functions such as requests, apologies, and politeness strategies

- Closing phase: Lesson summary and homework instructions

All sessions were video-recorded with participant consent for subsequent transcript analysis.

Cognitive Performance Measures

Cognitive performance was assessed through two complementary instruments administered before and after the simulation.

a) Executive Function Tasks

Participants completed a computerized Stroop task and a task-switching paradigm to measure inhibitory control and cognitive flexibility, respectively. These tasks were administered via Zoom Meeting on a standard laptop.

- Stroop Task: Participants responded to the font color of color words (congruent, incongruent, and neutral conditions). The primary dependent variables were response time and accuracy, from which interference scores were derived.
- Task-Switching Paradigm: Participants alternated between two categorization rules (e.g., parity judgment and magnitude judgment). The switch cost (difference in reaction time between switch and non-switch trials) served as the measure of cognitive flexibility.

b) Cognitive Load Scale

Perceived cognitive load was measured using the NASA Task Load Index (NASA-TLX), a validated multidimensional instrument comprising six subscales: mental demand, physical demand, temporal demand, performance, effort, and frustration. Participants rated each subscale on a 100-point scale immediately after completing the simulation. A composite weighted workload score was computed following the standard NASA-TLX protocol.

Pragmatic Accuracy Measures

Pragmatic accuracy was assessed using two instruments targeting different dimensions of pragmatic competence.

a) Multiple-Choice Pragmatic Judgment Test (MC-PJT)

A researcher-developed multiple-choice test presented participants with classroom discourse scenarios requiring knowledge of pragmatic conventions in Mandarin, including:

- Speech act appropriateness (requests, refusals, suggestions)
- Politeness strategy selection (honorifics, mitigators, indirectness)
- Discourse management (turn-taking, topic maintenance, repair strategies)
- Sociopragmatic norms (teacher-student power dynamics, formality registers)

Each item included a situational prompt followed by four response options. The test comprised 30 items and yielded a total accuracy score 80 percent.

b) Expert Rating of Discourse Transcripts

Video-recorded simulation transcripts were independently scored by two trained raters using an analytic rubric. The rubric assessed the following pragmatic dimensions on a 5-point Likert scale is shown on table 1.

Table 1. Assesment Dimension

Dimension	Description
Speech act accuracy	Correct use and formulation of speech acts in context
Politeness and politeness markers	Appropriate deployment of hedging, honorifics, and face-saving strategies
Discourse coherence	Logical flow, cohesive devices, and topic management
Register appropriateness	Matching formality level to the classroom context
Interactional competence	Responsiveness, backchanneling, and repair management

Raters received HSK level 5 (estimated 4316 words) benchmark transcripts before scoring. Inter-rater reliability was assessed using Cohen's kappa or intraclass correlation coefficient (ICC), with a minimum threshold of 0.78 considered acceptable.

4. Procedure

Data collection occurred over a four-week period at Widya Kartika University especially the student for Mandarin Language Education programs. The procedure followed these stages:

1) Pretest session (approximately 40 minutes): Participants provided informed consent, completed demographic questionnaires, and performed the executive function tasks (Stroop and task-switching paradigms) to establish baseline cognitive performance.

2) Virtual classroom simulation (approximately 60 minutes): Participants engaged in the Zoom-based discourse simulation, assuming the role of a Mandarin teacher. Sessions were conducted individually to prevent participant interaction effects.

3) Post-test session (approximately 30 minutes): Immediately following the simulation, participants completed the NASA-TLX cognitive load scale, the multiple-choice pragmatic judgment test, and the post-intervention executive function tasks. A brief semi-structured interview was administered to gather qualitative insights on perceived difficulty and pragmatic strategy use.

All sessions were scheduled at consistent times of day to minimize circadian variability effects on cognitive performance. The data were analyzed using SPSS programs.

RESULTS AND DISCUSSION

Cognitive Performance and Pragmatic Accuracy Outcomes The analysis evaluated the cognitive performance and pragmatic accuracy of prospective Mandarin language education teachers from Widya Kartika University following an immersive virtual classroom discourse simulation. Baseline and post-intervention cognitive performance were quantified through executive function tasks, specifically the Stroop task and task-switching paradigms administered via Zoom. Furthermore, perceived cognitive load during the simulation was measured using the six subscales of the NASA Task Load Index (NASA-TLX), which yielded a composite weighted workload score. Regarding pragmatic competence, accuracy was triangulated using two primary instruments. The Multiple-Choice Pragmatic Judgment Test (MC-PJT) assessed speech act appropriateness and politeness strategy selection, while expert raters evaluated video-recorded simulation transcripts on a Likert scale using HSK level 5 benchmarks. Initial descriptive statistics indicate on pre/post-test differences about 25%, demonstrating the specific impact of the simulation intervention on both the cognitive load and the pragmatic accuracy of the participants.

Correlational Analysis To address the interaction between cognitive resources and communicative output, a correlational analysis was conducted. The data examined the relationship between executive function performance indicators (inhibitory control and cognitive flexibility), the NASA-TLX workload scores, and the combined pragmatic accuracy outcomes derived from the MC-PJT and expert ratings. Results indicated a positive relationship, suggesting that participants who experienced higher extraneous cognitive load during the Zoom-based discourse simulation exhibited higher pragmatic accuracy result.

DISCUSSION

Interpreting the Dual Burden of Classroom Discourse The findings integrate cognitive and pragmatic dimensions within a simulation-based framework, addressing a critical gap in second language teacher education (SLTE). Consistent with Cognitive Load Theory, the results confirm that the working memory capacity of pre-service teachers is finite; the extraneous cognitive load imposed by the immersive virtual simulation environment directly influenced their real-time communicative behavior. For these prospective Mandarin teachers, the necessity to simultaneously plan instruction, manage turn-taking, and produce pragmatically appropriate language such as intricate honorific usage and context-dependent politeness strategies created a substantial dual burden of cognitive processing and linguistic production.

Implications for Teacher Education Curricula While simulation-based learning fosters instructional confidence and provides a low-risk environment for practice, the relationship between executive functions and academic performance observed in this study underscores a vital pedagogical consideration. The data demonstrate that pragmatic competence encompasses more than just pragmalinguistic knowledge; it relies heavily on cognitive flexibility and inhibitory control to manage discourse effectively under pressure. Therefore, teacher preparation curricula must explicitly address pragmatic development not merely as an abstract linguistic concept, but as a cognitively demanding skill. Scaffolding these immersive technologies appropriately will ensure that pre-service teachers

enter actual classrooms equipped to model culturally appropriate interaction without suffering from cognitive overload.

CONCLUSION

This study shows that immersive virtual classroom simulations effectively improve the cognitive and pragmatic skills of prospective Mandarin teachers. After completing the teaching simulation via Zoom, participants from Widya Kartika University achieved an approximate 25 percent improvement in their cognitive and pragmatic performance. Furthermore, the data revealed a positive relationship between cognitive load indicators and pragmatic accuracy. This suggests that the immersive environment successfully captured the complex demands of a real classroom, where the added cognitive effort helped improve communicative accuracy.

These findings highlight a critical need to update language teacher education. Pragmatic competence requires more than just language skills; it depends on executive functions to manage conversations under pressure. Therefore, programs must treat pragmatic development as a cognitive skill that needs structured practice. By thoughtfully integrating immersive technologies, universities can better prepare future educators for the cognitive and communicative demands of actual classroom discourse.

For practical application, future instructional designs should introduce gradual difficulty levels in virtual simulations to help students build working memory. Additionally, future research should explore how well these skills hold up over longer periods in physical classrooms and compare the cognitive impacts of different digital tools like Augmented Reality and Virtual Reality.

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