

E-Learning Design Principles and Methods
Final Report

Beginner Mandarin

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Table of Contents

Introduction	2
Learning Goals	3
Initial Goals	3
Cognitive Task Analysis	3
Final Goals	4
Assessment Design	5
Instructional Design	9
Choice of Platform	11
A/B Test	12
Design	12
Results	12
A/B Comparison	13
Conclusion	14
Challenges	14
Next Steps to Improve Current Module	14

Introduction

This one-hour e-learning module, Beginner Mandarin, was created in response to the observation that many students at Carnegie Mellon are native Mandarin speakers, and students who do not speak Mandarin may be interested in learning the language so many of their classmates speak. However, the relevance of learning Mandarin is not limited to Carnegie Mellon. Approximately 900 million people worldwide speak Mandarin as their native language¹, making Mandarin a useful skill for anyone.

In designing this online module, we applied research-backed principles and conducted an A/B test of one innovative principle.

¹Source: <https://www.ethnologue.com/statistics/size>

Learning Goals

Initial Goals

When we set out to create this e-learning unit on Mandarin, we were inspired by the possibility of METALS students who did not speak Mandarin taking this unit and using the vocabulary they learned in conversations with Mandarin-speaking METALS students. We initially wanted learners to be able to have a short conversation in Mandarin about food because students often eat together. We also wanted students to learn some basics of Chinese culture and learn to apply at least one grammar rule. We spoke informally with friends to help us determine an initial set of learning content and goals:

1. Given a set of words, students will be able to formulate grammatically correct Mandarin questions that will allow them to enquire more about Chinese food culture and interests.
2. Recall that different regions of China have different languages and different food cultures.
3. Recall that there are four tones in Mandarin.
4. Given the audio, students will be able to identify the correct pinyin word.
5. Given a Mandarin statement, apply the 'ma' rule to make a yes/no question from the statement.
6. Recall basic greetings in Mandarin.
7. Given a question in Mandarin, recall an appropriate response-phrase in Mandarin.
8. Given an English food-related word/phrase, recall the equivalent Mandarin word

Cognitive Task Analysis

As none of us speak Mandarin, we were unsure how much was reasonable to include in a short e-learning unit, and what order topics should be taught in so that learning could build on prior knowledge. Realizing we needed some additional input, we decided to conduct an empirical prescriptive cognitive task analysis. We therefore arranged a semi-structured interview with Carnegie Mellon Professor Yu, who teaches the introductory Mandarin course.

Insights from interview with Professor Yu

Recommendations from Prof Yu	Implication for design of unit
Teach pinyin, not characters	Confirmed our goal
Don't learn rules for pronouncing pinyin (not enough time in 1 hour)	Removed speaking goals, focused on recalling meaning of written words
Impossible to get students fluent in speaking with proper inflection and identifying tones in audio in just 1 hour	Recall tones only, don't use them

"We spend 2 weeks focusing on pronunciation only" - Professor Yu

"[If you're learning] survival Chinese - in that case grammar isn't so important, just imitate phrases and words" - Professor Yu

As we started to think about assessment, we also realized that it would be very difficult to assess speaking and pronunciation. We considered several options: hand grading, self-explanation, and crowdsourcing, but eventually the difficulty of grading combined with Professor Yu's recommendations convinced us to remove the speaking and pronunciation goals.

As we began considering instructional design, we realized that focusing only on vocabulary and one grammar rule was already a lot to cover in 1 hour, particularly given how many facts are involved in learning vocabulary. As a result, we removed the culture goals.

Final Goals

After these changes, our final version of the course learning objectives contained four goals created using KC specification and the ABCD (audience, behavior, condition, degree) framework:

1. Given audio of a Mandarin phrase, students will be able to [correctly] write the English equivalent (skill)
2. Given an English phrase, [students will be able to correctly] recall Pinyin for equivalent phrase in Mandarin (fact)
3. [students will be able to] Recall how to modulate your pitch for each of the four tones in Mandarin (fact)
4. Given a Mandarin statement, [students will be able to correctly] apply the 'ma' rule to make a yes/no question from the statement (rule)

*brackets signify additions of audience and degree based on feedback

Assessment Design

In our first assessment draft, we created at least two assessment questions per learning goal. This meant we could assess each learning goal at least once in the pre-test before the instruction and once in the post-test at the end of the instruction.

We conducted a theoretical descriptive CTA to help us think about how learners might approach different types of questions and decide which types of questions would be appropriate. We used a mixture of multiple choice, free response. We hoped to conduct an empirical descriptive CTA to test our assessment questions and improve our models from theoretical CTA, but realized that true novices would only be able to guess, which wouldn't provide us much insight into the thought processes a beginner would use to answer these questions. We therefore decided to look for what we ended up referring to as 'semi novices': people who have already learned a little Mandarin. We were able to find one, and conducted a think aloud of her completing our draft assessment questions.

Our Think aloud participant was a CMU graduate student, native Korean speaker who learned Mandarin for 1 year in middle school and is currently refreshing her Mandarin by learning from Mandarin-speaking classmates.

Insights from Think Aloud

Findings from Think Aloud	Implication for design of unit
She thought the most difficult part of learning Mandarin was tones	Affirmed our decision to give an overview of tones rather than going into depth
Generally answered questions pretty easily	Reassured us that it should be feasible to teach complete beginners this content in a short time
She had a strategy for answering listening questions: play a recording several times and pick out sub phrases that she knew to build up to understanding the whole sentence	Inspired our A/B test



“Nǐ xǐ huān niú ròu ma”

First listen: “Oh I know nǐ xǐ huān means you like”

Second listen: “and it ends with ma so I can tell it's a question...”

Third listen: “I don't know what 'niú ròu' means but I can tell this means 'do you like something?' ”

Example of listening strategy used by think aloud participant

After completing this think aloud, we modified our theoretical CTA model to take into account what we learned about how beginners approach listening tasks:

Initial Theoretical Descriptive CTA

Task: Student listens to audio of a Mandarin phrase and writes the English equivalent

Start state: Listen to Mandarin
Intermediate state: Recognize Mandarin phrase

- Perhaps this is the same as the next state
- Progress

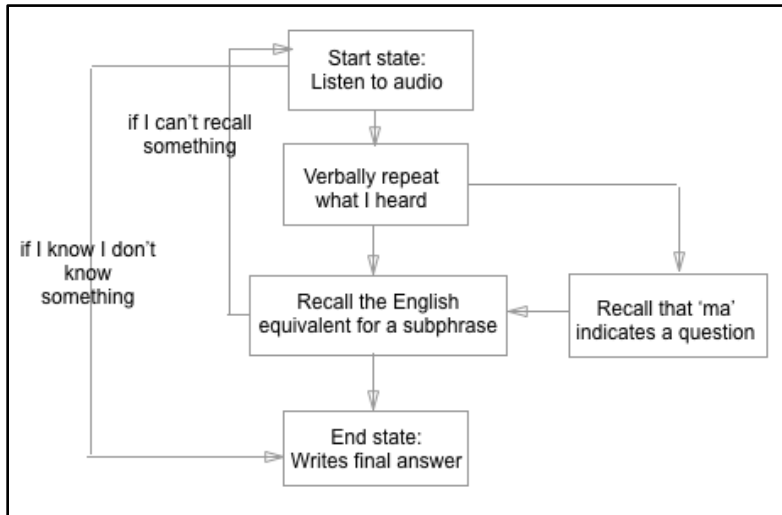
Intermediate state: Recall equivalent English phrase

- KC is a fact. Condition: Mandarin phrase. Response: English phrase.

Intermediate state: Write English phrase
End state: Written English phrase



Final Theoretical Descriptive CTA



Subtasks added after Think Aloud:
-identify a known subphrase
-identify question particle 'ma'
-listen to audio multiple times

Ultimately, we used only multiple choice questions in the summative assessments, and multiple choice and free response (submit and compare) questions in the formative assessments.

Question 2

How do you say this in English?

Select one answer.
1 points

0:00 / 0:01

A. What is this?
B. Good morning
C. Hello
D. Good evening

[Link](#)

Audio multiple choice question targeting Goal 1: “Given audio of a Mandarin phrase, students will be able to write the English equivalent”

How should your pitch change for a letter in fourth tone?

It should fall

Resubmit

✓ Your pitch should fall





Submit-and-compare question targeting Goal 3: “Recall how to modulate your pitch for each of the four tones in Mandarin”

Instructional Design

Evidence-Based e-Learning Principles

Multimedia Principle

The multimedia principle was applied with tables containing printed Mandarin, Mandarin audio, and printed English. In Clark and Mayer’s vocabulary, this table is an organizational graphic that minimizes extraneous processing and makes room for generative processing.

Audio	Mandarin	English
	Wǒ	I
	Link	
	Nǐ	You
	Link	
	Wǒ tǐng hǎo de	I am good
	Link	
	Wǒ xǐ huān	I like

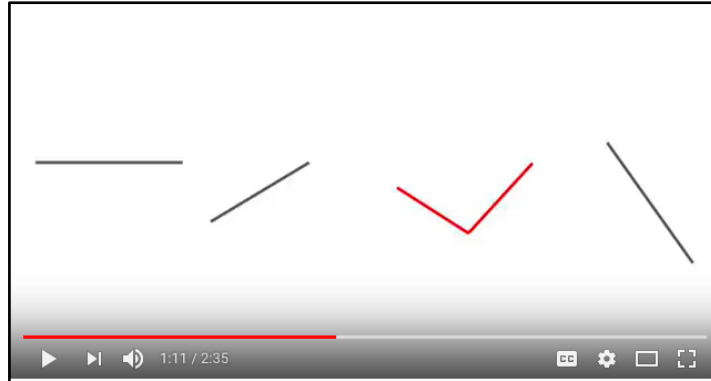
Organizational graphic targeting Goal 2: “Given an English phrase, [students will be able to correctly] recall Pinyin for equivalent phrase in Mandarin”

Although the vocabulary is arranged into a table, we were not able to create true rows and columns separated with lines. Nonetheless, the organization of the vocabulary probably played a factor in learning, which can be inferred from comparing pre-test and post-test scores.

¹Clark, R.C. & Mayer, R.E. (2016). e-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning, Fourth Edition

Modality Principle

We applied the modality principle by using audio narration rather than text narration to describe visuals.



Audio narration: "The third tone is falling and then rising, and sounds like this..."

Redundancy Principle

We applied the redundancy principle by not including redundant text duplicating audio narration. However, we applied boundary conditions of the redundancy principle in a video of two people talking about food. The viewer listens to two actors talking in Mandarin, and sees written Pinyin and written English underneath in subtitles. The greeting vocabulary they use was already covered in instruction, and the food vocabulary they use is introduced through this video. Since the viewers have such minimal exposure, some may not recognize the words for "good morning" and "long time no see" at natural talking speed. We added Pinyin subtitles to support them in doing so. This video is the first instructional event the students encounter for the other food-related words, with the spoken Mandarin, written Mandarin and written English. Without English subtitles, the students would probably not be able to infer the meaning of the Mandarin subtitles or spoken Mandarin.

Personalization Principle

We invoked the personalization principle to prime learners to work harder during the module. For example, in our welcome message, we invited the learner to the unit and then prepared them to take a pre-test on unfamiliar material: "Welcome to our Mandarin course for beginners!... On the next page, you will take a short pre-quiz. Since you're taking this course, we are assuming you do not have much knowledge about Mandarin already. So don't worry if you have to guess!"

In addition, above the vocabulary tables, we wrote messages that used polite speech and spoke directly to the learner: "We think the words and phrases in this table will help you talk with a Mandarin speaker. You may want to listen to the Mandarin words as well as read the Mandarin and English."

What did learners think about the tone of our module? Well, by a stroke of unluckiness, our final changes were not uploaded into the last version of the module, so the learners did not

see them. Instead of the welcoming message we described, they read “This is a Mandarin course.” Without the message, one of the participants said “I assume it's for people who know a bit already?”

Spaced Practice Principle

Since much of the content of our unit involved learning facts, we used the spaced practice principle. To accomplish this, we first segmented the instruction into four categories: tones and pinyin, words for greeting, words about food, and the rule for forming yes/no questions. Then, on each page, we provided learners with formative assessment questions about the content on that page, followed by questions about the content of the pages they had already seen.

Choice of Platform

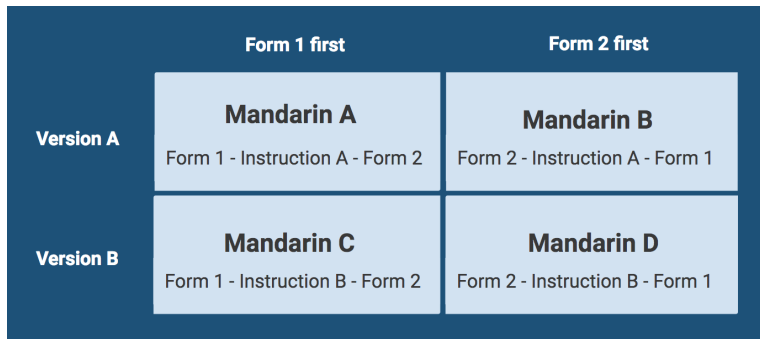
We decided to host our course on Carnegie Mellon’s Open Learning Initiative platform. This decision was influenced by two key factors:

1. Control over instruction layout. OLI offers a lot of flexibility in the layout of instruction which we felt gave us as e-learning designers more control. In particular, instruction can be spread over multiple pages; and videos, slides, and images can be easily incorporated.
2. Data reporting. OLI has excellent data reporting (learning dashboard, ability to export to DataShop) which we thought would help us see what in our module was effective and what we could improve upon in future.

A/B Test

Design

Our A/B test investigated whether explicitly teaching listening strategies (like the ones our think aloud participant used) improve learning outcomes. We also counterbalanced the pre and post-tests to account for possible variance in difficulty in the pre-test and post-test, resulting in four versions of the course.

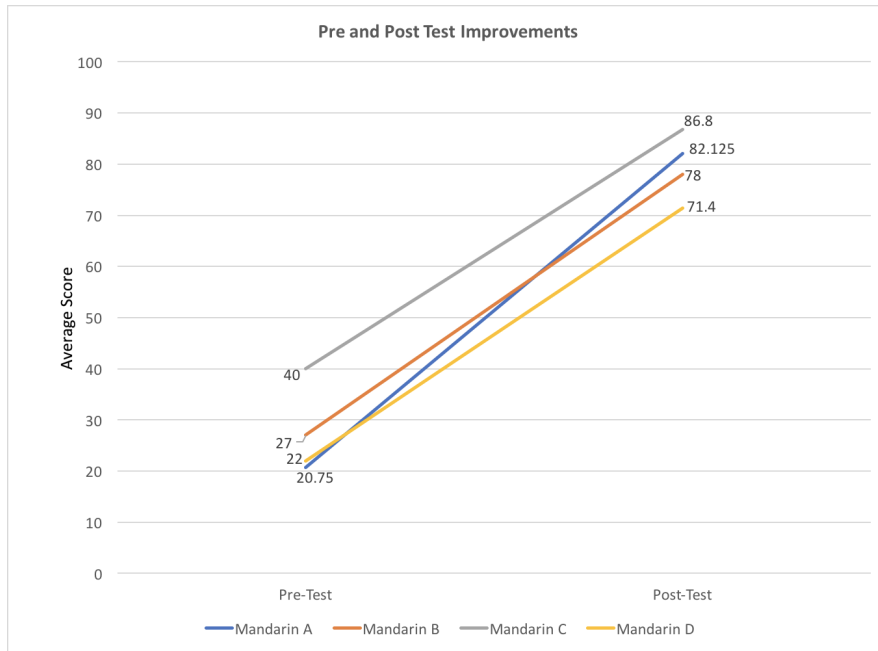


Results

We observed an average gain of 52% on the post-test, when taking into account all four versions of the module. Individually, each version showed an improvement.

Individual Course Version Improvements

Course Version	Pre to Post Gain	Number of Students in Sample
Mandarin A	61%	7
Mandarin B	51%	9
Mandarin C	47%	6
Mandarin D	49%	7



Learning Gains: Pre- and post-test improvement for each course version

A/B Comparison

The modules without the innovative principle (56%) showed greater learning gains than the modules with the innovative principle (48%). The lack of an effect may be due to the low number of student who took the modules with the innovative principle. Also, learners who took the modules with the innovative principle had higher pre-test scores, which made it harder to show larger learning gains. As an alternative hypothesis, perhaps the innovative principle is commonly known and students use listening strategies even when they are not explained.

Conclusion

Challenges

The new OLI authoring tool was in beta mode during the time we were developing our course, which meant there were some technical issues, particularly with using audio. Throughout the process, Kim Larson and the rest of the OLI team helped us resolve issues, for which we are immensely thankful.

Next Steps to Improve Current Module

Assessing learners' speaking accuracy and providing targeted feedback

We would value having the ability to technically automate the assessment of learners pronunciation of Mandarin phrases and then give them targeted feedback. In our current module, we chose OLI as a platform, which currently does not support this functionality. We would like to find a way, or invent one, to be able to assess accuracy of spoken language.

Finding more users for testing

Our modules with the listening strategy - our innovative principle - did not show evidence of leading to better learning. This may be due to not having enough participants in the modules that contained the innovative principle. Moving forward, we would like to have more participants, so we can more definitively understand if presenting learners with a listening strategy causes learning gains or not.

Investigating language strategies

In the post-test data, we found that 75% of students in both the A and B versions correctly translated Mandarin audio phrases that contained a combination of words that were taught and not taught in the module. We hypothesize that students used a listening strategy and then used process of elimination to identify the correct answer. It's possible that they were also inferring words not explicitly taught. For example, they might have inferred "good" in the phrase "good morning" and then were able to recognize a "good afternoon," which was not taught. We would like to do more think alouds to investigate novice, intermediate and advanced learner strategies for tasks such as translation.