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FullChinese at MIT: A Non-Disruptive Integration of Technology for Intermediate Students

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Cover Page Footnote

Collaboration between Gammakite and Massachusetts Institute of Technology (MIT), Global Languages

FullChinese at MIT: A Non-Disruptive Integration of Technology for Intermediate Students

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Abstract

We describe here ten years of development of a Chinese learning technology and five years of practical experience in integrating this technology in MIT classrooms for intermediate-high and advanced-low students. Key results are as follows:

- There is no need to disrupt the classroom experience (both for the teacher and the students);
- Technology provides a sharp increase in learning efficiency and motivation, as confirmed by students; and
- This overall improvement in learning is achieved by focusing on the efficiency of personal study time.

The most salient type of feedback from students falls into two categories: "I wouldn't have been able to take a class at that level without FullChinese," and "The use of technology allowed me to prepare for class two to three times faster." Results were achieved through a slow iterative process during which our learning technology evolved to solve observed needs in acquiring complex new material.

Keywords: SLA, Chinese Studies, Technology in Learning

Technology has transformed every aspect of our life within the past few decades. There has long been an expectation that technology would also profoundly change language learning. It has (Flores, 2015), but, surprisingly, nowhere near the extent most would have imagined. Of course, unlimited access to text, videos, and media content in the target language has made language learning a more engaging experience. In addition, tools like online dictionaries, automatic translation such as Google Translate, and flashcard management software have entered the student's user experience. Also, a new generation of mobile language learning apps, such as Duolingo, has rapidly gained popularity. However, they operate entirely outside of the classroom experience and typically target beginners rather than intermediate and more advanced students. How intermediate-high or advanced-low college students use their time during a semester of language learning has changed only at the periphery. There are many reasons for this phenomenon, but our analysis tells us that technology, to be accepted, needs to achieve two goals simultaneously: (1) integrate smoothly with how teachers conduct their classes rather than claim to upend the way teaching is conducted, and (2) provide clear improvement in learning efficiency. 10% to 20% improvement won't cut it; it needs to reach the level of doubling the efficiency, at least on some dimensions. Achieving these two goals is not easy and requires both patience and humility; it requires patience because the process can only be iterative. Students'

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actual use of the technology needs to be observed and feedback collected. It requires humility because it needs to assume that good teaching, which existed well before the appearance of technology, is complex. Therefore, technology's starting point cannot be the complete redefinition of language teaching but rather an improvement upon it.

While the process of developing language learning technology must be iterative, it would be meaningless without a vision. Our vision assumes that the core of language learning is text and sound input. In other words, input, whether textual or auditory, always comes first, and other aspects of language learning, such as grammar, culture, speaking, and writing practice, come second. For students' learning efficiency to be improved substantially, technology needs to improve that core. It needs to improve how fast a student can acquire a new text and how deeply they can understand it. The increased speed will expose students to a larger part of the target language, and the increased depth of understanding will improve long-term memorization. Both are key ingredients to better motivation. In fact, secondary language learning motivation cannot be improved through more 'fun' or game-like learning activities alone but rather through the feeling that learning itself is happening. Nothing is more rewarding than the certainty of actual progression, and nothing is more destructive than doubts about real progress or questioning whether meaningful goals can indeed be reached. Even in the case of pure games (no learning per se is involved), accumulation of knowledge plays a large role in continued motivation. As Hamari et al. (2016) observed:

"Computer games have been observed to scaffold learning in ways that keep players at the edge of their seats fostering continued interest in the game […] Players hone their skills and build knowledge". (p. 170)

In the case of language learning, "building knowledge" should be understood as building language competency. Taking input as the center of language learning is, of course, not new. The extensive work by Stephen Krashen (1987, 1988) on comprehensive input pushes that principle to its extreme by stating that a large amount of input is all that is needed. We are forcing this trait here, but only a little. To summarize the approach, comprehensive input is the text that is both nearly understandable (the number often mentioned is 98% understandable) and whose content is appealing to the student. Texts need to draw the student in the same way a fascinating novel would. A problem for 'hard' languages like Chinese is that, for intermediate students at least, texts which are both engaging and understandable are tough to come by or, to say it plainly, pretty much impossible to find. A priori, this can be solved in two ways: either create more content or lower than the 98% threshold under which, according to Krashen, input becomes a hassle and loses its appeal. At MIT, we took both approaches at the same time. We used a collection of texts from "Chinese from Different Perspectives" (Chen & Wan, 2021), a recent book discussing contemporary Chinese culture. These texts were more complex than the 98% comprehensible advocated by Krashen. They push students' boundaries and require work on their part. We also allow students to add their own content, which tends to come from webpages, YouTube videos with transcripts, or feeds they find engaging. The challenge that the technology aims to solve is to drastically lower the work required to fully understand these texts and thereby keep them interesting.

Software that provides reading help and helps process complex text is not new either. Many examples come to mind, including the LingQ learning platform (Kaufmann, 2005). For Chinese, software like Wenlin, which leverages John De Francis's extensive dictionaries, is also of great help, especially for students interested in the origin of characters (DeFrancis, 1996). While our developed app FullChinese also took as a starting point to be a reading help, we tried

to push the concept much further by integrating the tool with access to dictionaries, flashcards, sentences, content creation, sound, and, more recently, videos. We tried to provide an efficient all-in-one solution because cutting the number of seconds needed to perform a learning task is not a cosmetic endeavor; on the contrary, it represents the difference between continuing through a text and giving up. Finding the right tools for learning Chinese is even more critical because recent anecdotal evidence suggests a dramatic decline in enrollment in Chinese studies (Mair, 2021). Since students often mention the perceived difficulty of learning Chinese, anything that can alleviate that perception is important.

Related Work

As mentioned, our work follows the tradition of comprehensive input pioneered by Stephen Krashen (1987; 1988). Krashen contrasts the "Comprehension Hypothesis," understanding input, to the "Skill-Building Hypothesis," namely the learning and memorization of vocabulary and grammar rules that then need to be applied consciously (Krashen, 2017). That the first one out-performs the latter has been backed both by formal studies (Stokes, Krashen, & Kartchner, 1998; Lee & Krashen, 2002; Lee, 2005) as well as case histories of highly successful second language learners (Krashen, 2014). Moreover, the comprehension hypothesis appears valid beyond second language acquisition, such as first language literacy development (Krashen, 2004). Highly successful learners have pushed this approach to its extreme outside of the academic world. For Japanese as a second language, both Khatzumoto (2010) and Matt vs. Japan (2020) advocate total input immersion, namely aiming at exposing oneself to audio input as closely as possible as the entire day (with the addition flashcard practice). However, it is unclear to us how this approach translates to situations when that type of time commitment is impossible. We also intuit that Chinese is a more complex language to acquire through pure massive auditory input as the English speaker's ear is unfamiliar with many of its sounds and with its tones.

FullChinese, as we will see below, also uses Spaced Repetition (Pimsleur, 1967; Choe, 2016). We implemented a Flashcard Quiz system that resembles flashcard programs such as ANKI (Elmes, 2015; Nakata & Tatsuya, 2011; Jaya, 2020) with one crucial difference: our Flashcard system exists first within the context of a particular text rather than as a whole. Being able to refer back to a text makes quizzing more natural, as unknown vocabulary can be re-examined in its original context.

Naturally, our application is part of a large ecosystem of language learning applications recently developed for mobile phones. Duolingo, Babbel, and FluentU, among many others, come to mind. One of the largest ones, Duolingo, derives a large part of its success from gamification, an approach that identifies motivation as the core problem (Hamari, Shernoff, Rowe, & Coller, 2016).

The Student Experience

The FullChinese App

FullChinese is a novel app designed specifically to help students learn Chinese. It runs on both major software ecosystems for mobile devices: Apple iPhones and iPads, as well as Android Phones and Android Tablets. The app comes preloaded with a full dictionary (100,000 words and 15,000 sentences) as well as text content ranging from beginner to advanced students (HSK 1

through 6). At MIT and other institutions, it comes preloaded with the "China from Different Perspectives" (Chen & Wan, 2021) book. Recorded sound by native speakers accompanies all texts. More recently, the texts also come with recorded videos that align with the text. This helps keep the student engaged and provides visual information about face and mouth movements which constitute a set of strong phonetic clues missing in pure sound recordings. In addition, students can upload their own content by simply copying and pasting inside the app; this can be used to use any Chinese web page that interests the student as their own study material.

No Forced Change in the Classroom

The use of FullChinese has only a minimal impact on what happens during class time. Teachers only need to mention FullChinese in class once during a fifteen-minute introduction and demo of the app at the beginning of the semester. Support is available to students via email but is typically used to resolve simple access questions to class-specific content. Besides that, class time during the entire semester, goes on as it would without the technology. This is important to note because:

- It removes from the teacher the necessity to allocate time to solve problems unrelated to actual teaching; and
- It allows students to focus fully during class. The last thing technology should do is add distraction rather than focus.

Deep Understanding of Text

More important than speed, depth of understanding is the primary factor conditioning how much of the target language is learned and how much is retained. Depth, however, is difficult to quantify and easily overlooked. We describe here the tools available to the student as well as the process by which they use these tools. Before dwelling on the quantitative aspects, it helps to consider the qualitative intuition behind the depth of understanding. It is usually clear to a student when a sentence is fully understood: there is no unknown left, the meaning of the full sentence is understood as it would in one's native tongue, the meaning of every word, in the context they are used, is also clear as well as the syntactic construction. In other words, after a sentence in the target language is fully understood, there should be little difference, in the brain of the student, with a sentence from their own language.

To describe what it means to understand fully a sentence, we will use a vertical metaphor. A sentence needs to be "understood up" and it needs to be "understood down." By "understanding up," we mean that a student should be able to zoom out from the meaning of an individual word to the meaning of the sentence fragment in which it is used, to the meaning of gradually larger fragments up to the meaning of the whole sentence. By "understanding down," we mean that a sentence needs to be understood by "drilling down" on the meaning of every unknown or unfamiliar world. Namely, the student will need to fully understand why a world has a particular meaning in that context. That meaning needs to be contrasted with other meanings of the same world. Figure 1 gives a summary of what we just described in the following particular sentence in Chinese:

二十世纪七十年代末，为了控制人口过快增长，缓解人口给社会带来的压力，中国政府实行了计划生育政策，即一对夫妻只生一个孩子。

The amount of information needed to fully understand any sentence is substantive and cannot be reduced to a few dictionary lookups. The app allows the student to access the information displayed in that Figure in under two minutes (time may vary, of course). Dedicated learners were always able to achieve the same level of understanding but with more significant time commitments and extraordinary levels of motivation. Technology can make that process accessible to all.

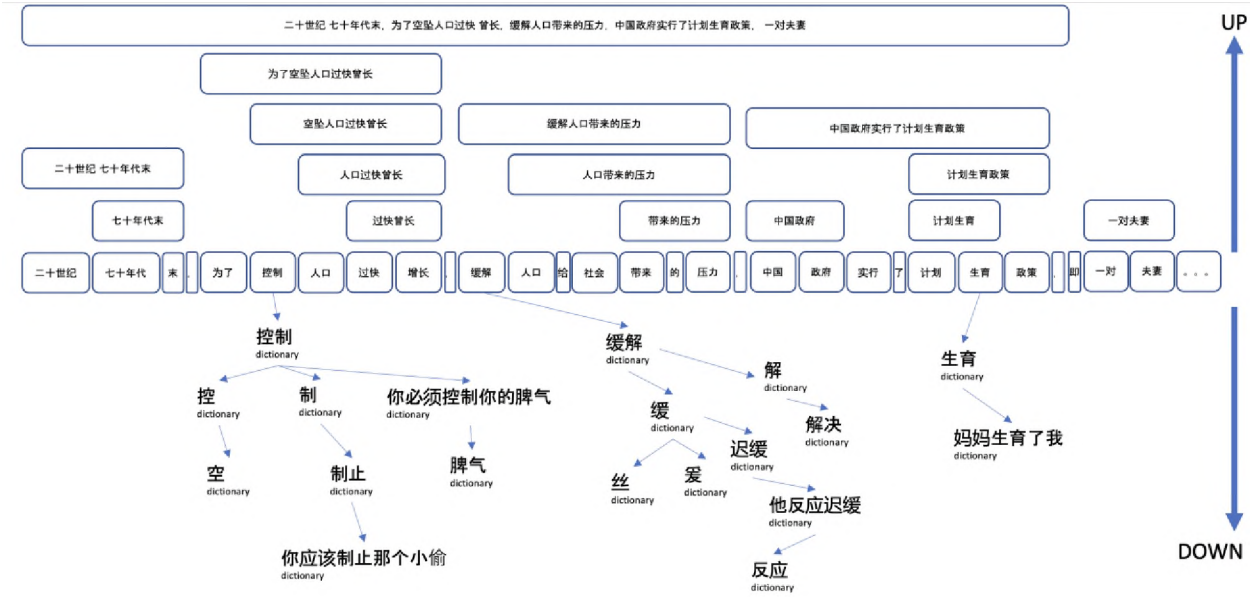

Figure 1. Information Accessed to Understand a Sentence in Chinese

Understanding "Up:" From Words to Contexts

To illustrate how a student would move from words to contexts that are wider and wider, let us consider the following portion of the sentence:

为了控制人口过快增长

Besides understanding how these characters are combined into words (ten characters and five words in this case) and looking up the meaning of each word, the student also needs to understand the syntax of this sentence fragment. Many textbooks will attempt to solve that problem by explaining how to use 为了+V +B, but these explanations are often ignored because they are perceived as too complex.

The solution taken by FullChinese is to provide the student with the information in Figure 2 below. This information is accessed by clicking a "zoom-out" or "zoom-in" button, as shown in Figure 3. The fact that navigating is achieved through the click of a button may sound trivial; however, as already mentioned, the speed and ease of the actions conditions whether they will be performed or not and hence whether the sentence will be fully understood.

Going back to understanding 为了, within that sentence, no explicit grammatical explanation is provided. The student will understand the syntax of the fragment, and thereby the grammatical usage of that word (at least within that context), by quick zooming-out and

zooming-in action. The student will be able to see how 为了 modifies the sentence fragment to which it is applied. The translation of each fragment helps the student understand how different meanings interact with each other.

In addition to understanding 为了 in that particular context, clicking on the word opens its dictionary entry and provides a list of very short sample sentences using that construction. These sample sentences usually provide a more natural way to understand the syntax of 为了 than an explanation could. In some instances, a full grammatical description remains necessary, but it is our observation that this happens extremely rarely (once every few texts).

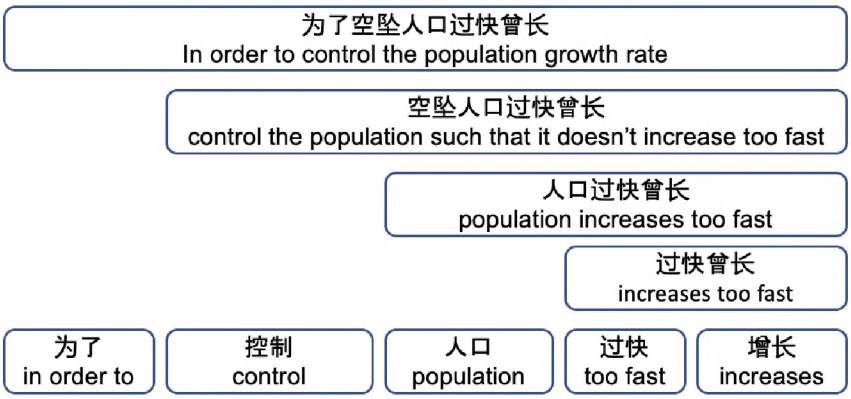

Figure 2. Understanding "为了" by "Zooming Out"

Figure 3. How Students "Zoom Out"

"Understanding Down:" From Words in Context to Related Words and Sentences

Navigating words and sentence fragments, as described in the previous section, gives students a complete understanding of the sentence and of the syntax. However, this is not sufficient to get the feeling that the sentence is indeed fully understood. Words can stay confusing, and the student can be far from having the confidence to reuse the same words in different contexts.

Figure 4 shows a sequence of actions that helped a student get a better grasp on the word 控制. Figure 5 shows the sequence of screens as seen by this student during the same sequence of actions. The sequence of action performed is highly subjective as it depends on the student, time constraints, and a multitude of other factors. Hence, the app should provide a space that can be navigated rather than a predefined set of steps that an ideal student would have to go through. In the example given, the steps respond to a particular set of needs:

(1) Look up the dictionary entry for the word 控制. This helps the student see all the possible meanings of that word.
(2) Open the dictionary entry of the character 控, which gives the meaning of that character as well as how the character can be decomposed.
(3) Drill down to the sub-character 空 to get a better grasp on how the character was built.
(4) Open the dictionary entry for 制 to see the meaning of that character in isolation.
(5) Open the dictionary entry of another sample word containing 制, namely 制止, to get a better feel for the original meaning of 制. This is important because just reading a definition in English is insufficient to get a grasp on the full meaning.
(6) Open the dictionary entry for the sample sentence 你应该制止那个小偷.
(7) Go back up to the original dictionary entry of 控制 and open the dictionary entry of the sample sentence 你必须控制你的脾气. This clarifies the semantic scope of the verb by giving this simple sentence.
(8) Open the dictionary page of 脾气 to clarify the meaning of the last sample sentence. This is interesting because the word 脾气 itself is not in the original text. While it only clarifies the original text very indirectly (namely by clarifying a sentence that itself clarifies the word 控制), we should never lose track of the fact that the ultimate goal of the app was not to increase the understanding of the text but to help the student progress in their mastery of the target language. In this example, the student may have felt the need to clarify the meaning of a word already seen or to learn something new; whatever the case, it does contribute to their learning process.

Flashcards and Quizzes: Always in Context and Curating Personal Dictionaries

Flashcards and quizzes have a long-standing tradition as effective learning methods (Anki, 2023), and they have demonstrated their value; up to a point. One of the problems with flashcards is that it can be difficult to retain the context from which the information was originally derived. Having lost the original context, it is easy to develop the artificial skill of being able to remember the back of the flashcard without really understanding the meaning or being able to use that word.

To alleviate this problem, flashcard decks are built within the context of a particular text. Each time a user flags a particular word within a text, this word will be added to the deck associated with that text. Consequently, when the student is quizzing themselves, the app can

provide a backlink to the original text. This provides a full syntactic, semantic, and cultural context to the word in the context of the quiz. Trying to replicate this functionality while building flashcard decks independently of any particular text is difficult as it often involves inserting too much information on that card.

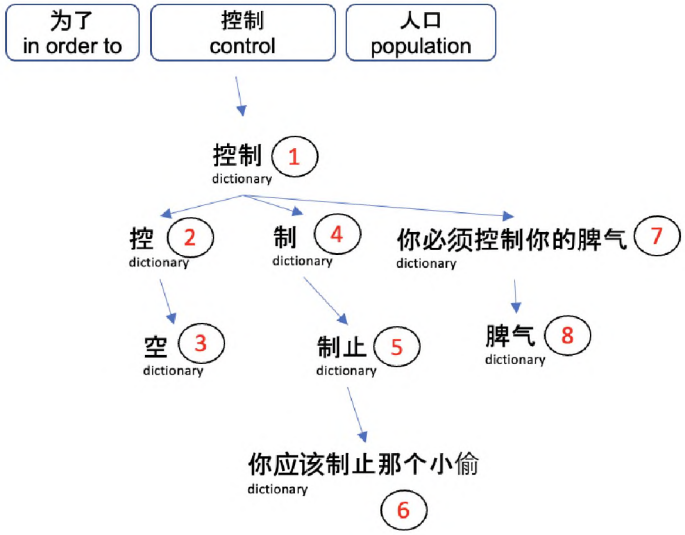

Figure 4. Drilling Down on the Word 控制

Figure 5. Sequence of App Screen Seen by the Student

In addition to this flashcard-and-quiz-in-context functionality, students are able to curate their own active dictionary (the list of words that the student would like to be able to produce). Curating one's dictionary is valuable, but it should be achieved without an inordinate amount of effort.

Sounds

We have so far only discussed textual input. Sound input is obviously critical and extremely challenging because, contrary to textual input, sounds define not only what information needs to be processed but also the rate at which this needs to happen. It is easy for a student to be thrown off-track on a particular word and lose the ability to follow the rest of the sentence.

For texts that stretch the student's current level, we found that the optimal path is to first understand the written text, fully and only then pivot to understanding the sound input. In fact, direct exposure to the sound input is demoralizing as none of the text is understood. This is even

true for heritage speakers despite their higher capacity for oral understanding and sound recognition.

Once the written text is fully understood, and usually after the student has performed a few quizzes to solidify the new vocabulary, the student transitions to a screen focused on listening and repetition (see Figure 6). On that screen, the student can first slow down the sound until they can understand it at natural speed. The same screen can be used to repeat one sentence at a time. It is our experience that one of the final milestones of acquiring a given text is to understand it spoken at natural speed.

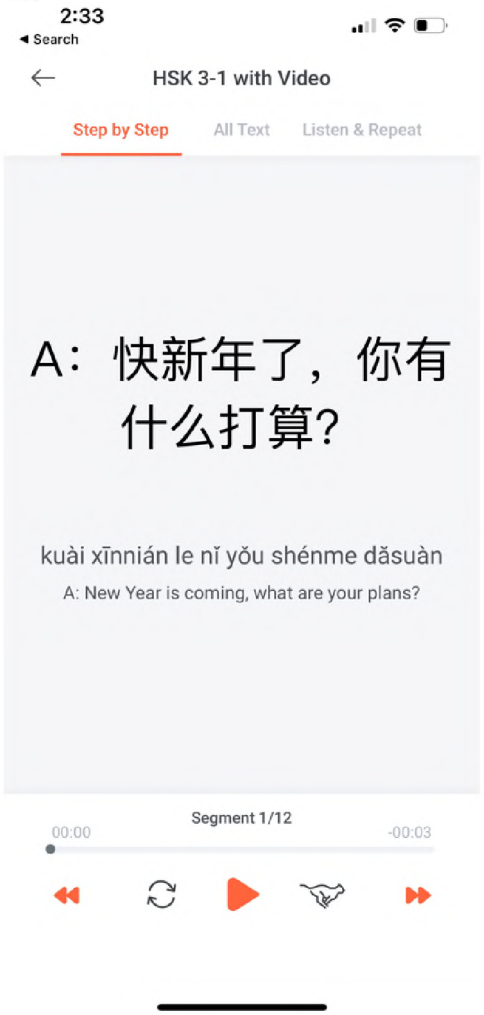

Figure 6. Dedicated Sound Screen

Remembering All Studied Material at the End of the Semester

Success in learning Chinese can only be achieved by sustained long-term motivation. Few things can destroy it faster than the feeling that the material learned and mastered at the time of a class test will be largely forgotten once the semester is over. Conversely, the feeling of having secured that knowledge provides a tremendous confidence booster.

The advantage of understanding a text fully is that maintaining that level of understanding of a given text is several orders of magnitude less expensive than acquiring it in

the first place. Concretely, when a student may have had to perform a deep dive on one hundred words the first time around, the same student will only have to read the text aloud once and listen to it once (with maybe one or two lookups for words still forgotten), to maintain an understanding of that text.

This allows the student, at the end of the semester and anytime thereafter, to simply perform these simple tasks on the relatively small number of texts studied during the semester (typically about six texts).

Multi-Track Input

Intermediate-high and advanced-low students were found to benefit from studying texts at different levels and with various levels of engagement. Our app refers to each level at which a given student will work a "track."

The hard work track. This involves choosing texts that challenge the limits of the student's current understanding abilities. This is the track we have described so far.

The easy work track. This below-level work means studying texts one or two levels below the texts at the current level. For instance, an intermediate student at an HSK 5 level would study HSK 3 level texts. This is useful for different reasons:

- It allows students to make sure that they know all tones at that level, whereas it could be too overwhelming to do that for the hard texts that are also longer.
- It allows students to improve their level of listening understanding. Often, after a "hard work track" text has been fully understood as reading input, the natural speed at which a native speaker will read it is still faster than the current listening capabilities of the student, even if this is less the case for heritage speakers. To improve listening comprehension, it is often helpful to go down one level or two.
- It reinforces frequent vocabulary or sentence structures that are still misunderstood.

The light work track. This goes somewhat against the deep understanding principles presented so far, but we recognize that not all texts can be studied deeply and that there is value in looking at input that will only be partially understood. Studying each text in depth is too mentally taxing. Light work, however, cannot be the core of a study plan. While it can help keep motivation up, it provides reinforcement of already acquired material but does not help expand one's language abilities.

Because teachers do not have time to follow these three tracks, they typically must focus on the "hard work track" elements in the classroom. Meanwhile, a software solution, such as FullChinese, can help provide the content for the other tracks to students. This is particularly the case for the "easy work track," as the app is pre-loaded with complete study books at all levels (HSK 1 through 6), which are accompanied by prerecorded sounds and videos. The "easy work track" also helps with the following problem: teachers have the natural tendency to overestimate their student's abilities and "overshoot" the difficulty of the texts they chose.

Importing YouTube Videos with Transcripts and Other Content

It is impossible to produce enough curated content to satisfy the varied interests of all students, nor is it possible to produce enough content for the "easy work track" described above. The internet offers abundant resources on various subjects and at different levels. However,

intermediate learners often find it challenging to understand content that they find engaging as this content exceeds their current level.

Our approach to solving this challenge is to import outside content inside the learning app such that it can be studied as any other text. We have done so for any YouTube video with a transcript (also called closed captioning or CC). The transcript is imported, translated (through automatic translation), and fully analyzed. All of that happens automatically as the user selects a URL to import. Figure 7 shows the result of one imported video. The video can be played from any point of the text, and it is synchronized with the text. In turn, the text can be studied as any other preloaded text.

Some of these videos can be quite long (up to an hour or more of playing time), so the expectation is not that the student will study the entirety of the content but rather feels free to explore without pressure.

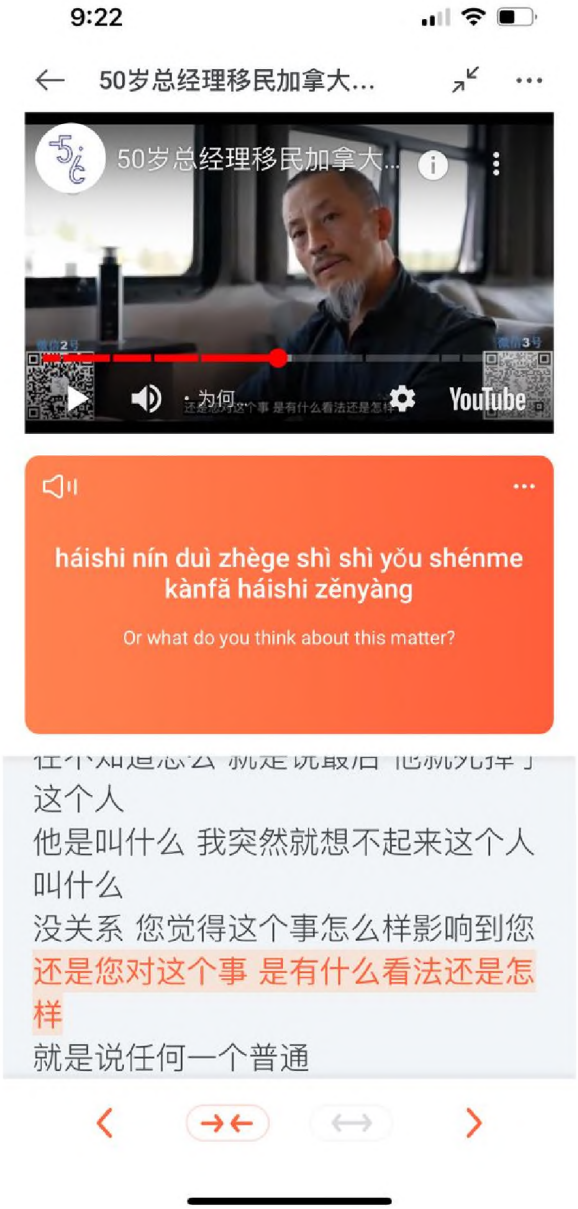

Figure 7. YouTube Video with Transcript Imported into FullChinese

The Teacher Experience

We looked at the teacher experience as carefully as the student's one but from a different angle: we wanted to interfere as little as possible with the pedagogical goals of the teacher and make sure we would not add any additional burden. As a result, students typically use the app only during their personal time, with few exceptions. The class is conducted as it would without the app. The difference is that the teacher can observe students coming better prepared as they have been able to digest more material. Also, the class drop-out rate is lower because students that might have felt new texts to be too complex, now find them manageable with the app.

In practical terms, the teacher does not have to worry about managing any technology as the app support team will help with technical questions.

At a more fundamental level, our aim is to assist teachers in doing what they do best: engaging with their students and guiding them through the most complex aspects of language learning. By providing a tool that helps students acquire basic vocabulary on their own time, teachers can focus on teaching more advanced concepts without the need to spend time going over individual words. This approach also minimizes the frustration and potential disengagement that can occur when students encounter sentences containing too many unfamiliar words at a time.

Furthermore, acquiring new vocabulary during class time while the teacher is speaking can be extremely challenging. By using the app during personal time, students can separate the task of acquiring basic vocabulary from the more advanced concepts that are covered during class. This approach allows for more effective use of class time, as students are better equipped to engage in higher-level discussions.

Guided Teaching vs. Free-Form Exploration

Language learning software applications can be designed in one of the following two ways:

- Guided Teaching: This is a design choice made by apps such as Duolingo. This design requires an app to direct the user to one task and one exercise at a time. This approach is better at engaging students who do not know how to proceed and makes gamification more natural than the free-form design choice, as the user must overcome multiple hurdles to pass a level and progress on a directed development path.
- Free Form Exploration: This is the choice that we have taken with FullChinese. Following this design, the user is provided with an environment in which they can decide at any point what to study and what activity to engage with. This approach is more natural for intermediate to advanced learners who have already formed their own learning styles. It is also the only approach that can be fully integrated with the college learning experience without interfering with the current pedagogical process.

This choice is similar to the choice teachers must make when deciding on a teaching style in the classroom: to either present students with precise activities or provide an open learning space they can explore on their own.

Limitations

The deployment of FullChinese at MIT is not, at this point, the complete study of a research question. Research questions would most likely be related to user engagement. Engagement can

be separated into behavioral, cognitive, and emotional engagements (Fredricks, Blumenfeld, & Paris, 2004), but these are correlated, as shown by Pellas (2014). There is an array of solutions related to improving engagement, for instance, MixPanel (2023). We have hypothesized that engagement closely correlates with the efficiency of the app, as students will only use aspects of the app that they find most useful. This correlation, however, would need to be closely tested, and clear research questions would need to be defined. This remains part of our future work.

Research in gamification in the context of learning (Hamari, Shernoff, Rowe, & Coller, 2016) that follows the theory of flow experience (Csikszentmihalyi, 1990, 1996) hypothesizes that engagement and immersion are good predictors of perceived learning. Contrary to Hamari et al. (2016), we hypothesized that perceived learning itself can increases engagement and immersion (rather than only the other way around). This hypothesis, however, still needs to be carefully tested. It is possible that increased gamification would increase engagement and, thereby, perceived learning. Lack of gamification means that our application, in its current form, cannot address the full potential of students for whom motivation remains a challenge.

Future Work

In future studies, we plan to reconcile our free-form exploration approach with aspects of the directed app approach. This includes adding typical gamification features. This can be achieved by non-intrusive observation of students interacting with the app to suggest a next task to the student if they fail to intentionally progress to the next task by themselves. Even for well-motivated students with their own learning philosophy, it is pleasant to simply open the app and have something suggested immediately and be immersed in a game-like environment. The challenge consists in making sure that these suggestions do not interfere with the ability to choose one's path in the app.

Acknowledgments

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Conclusion

We show how the FullChinese language learning app can be utilized within an undergraduate college class, for upper-intermediate and lower-advanced students, by providing content that is both challenging and manageable. The app, and how it is integrated with the full learning experience within one semester, has evolved through an iterative process over the past seven years. Student feedback gives a glimpse of what aspect of the app are found the most engaging:

- Student 1 (Tufts University): "FullChinese takes all the moving parts of learning a language (i.e., texts, a bilingual Chinese-English dictionary, flashcards), puts it in one place […]."
- Student 2 (MIT): "This app saved me so much time. Before that, studying new text used to be a grind; now I go three times faster."

- Student 3 (Wellesley College): "FullChinese completely transformed the way I engaged with my Chinese language development. I was so impressed by the fact that the app contains everything I need to study […]. Now I can practice reading, writing, listening, and speaking at the touch of a button."

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