Demonstrating Rationale

Summary report

Turtle Learn

Kucirkova, N., Schechter, R.L. & Forestan-Barnes, E.
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Report prepared by Drs Natalia Kucirkova and Elisa Forestan-Barnes, on behalf of WiKIT, AS and Rachel Schechter, on behalf of LXD Research.

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@ info@wikit.no

www.wikit.no

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Why is evidence necessary?

Prioritising evidence of efficacy and positive impact is essential for K-12 EdTech companies, particularly in the context of online learning platforms. By doing so, companies can ensure that their platforms are not only effective in improving target skills, but also engage teachers and/or students, personalise learning experiences, inform decision-making, and build trust among educators, administrators, and parents. By prioritising evidence-based practices, EdTech companies can make a meaningful and lasting impact in education.

How WiKIT supports companies on their evidence journey?

WiKIT has a vision for research and innovation driven technologies that address educational inequities and support high-quality, science-based learning outcomes for all children. WiKIT's mission is to ensure that technologies developed for children are based on science and are therefore well positioned to positively advance children's learning and development[1]. We enable the integration of science with EdTech design and implementation by empowering partnerships between EdTech developers, scientists, and practitioners, and by supporting the necessary policy infrastructure to mobilise these partnerships. We operate through a nationally oriented head-office for EdTech Evidence evaluations in Norway, and an international network of EdTech Evidence research consultancy services offered globally.

In 2024, WiKIT was commissioned by Turtle Learn to deliver the "ESSA IV-aligned" Evidence Ready service, which consists of a systematic approach to evidence, with a review of product and services, the Evidence Ready Audit, possible usability and feasibility studies conducted by Turtle Learn and three main deliverables: 1, Logic Model; 2, Theory of Change And 3, Theory of Action, individualised to the company's needs and strategy, supported with relevant scientific research studies and summarised in a short, written report.

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1 Kucirkova, N. (2022) *Understanding Evidence: A Brief Guide for EdTech Producers,* Report for WiKIT, AS, https://doi.org/10.1007/s10643-022-01415-1 , Available under Creative Commons Attribution 4.0 International, https://creativecommons.org/licenses/by/4.0/.

WiKIT's Evidence-Ready approach includes:

1. Developing a logic model in the form of inputs, outputs, activities, and impact statements that summarise the company's mission.
2. Developing a theory of change supported by relevant scientific papers that underpin the outcome and impact statement in the EdTech's logic.
3. Developing a theory of action with the scientific pillars of the EdTech's current work, as well as the gaps, capabilities, challenges, and strategies for future development.

Together, these essential monitoring and evaluation tools feed into mutually reinforcing steps that embed evidence priorities and realistic execution within an EdTech. They represent a vital first building block in every EdTech company's evidence portfolio, and are aligned with the ESSA IV standards of evidence recommended by the Office of Educational Technology and other international bodies concerned with EdTech impact.*

This report summarises selected outputs from this process, as agreed with Turtle Learn.

*Kucirkova, N., Campbell, J., Lindroos Cermakova, A. (2023): EdTech ImpactEvaluation Frameworks: Summary 2023 , Report for WiKIT AS, DOI:10.13140/RG.2.2.21563.59681

About Turtle Learn

Turtle Learn is an innovative learning and teaching tool designed to enhance Chinese language skills in primary students in Hong Kong. Commissioned by Kazoo Technology in 2023, WiKIT supported the evidence journey for Turtle Learn, aligning its research with the ESSA Tier IV standard of evidence.

The international edition, "Touring Turtle," offers interactive exercises with three avatars – the "adventuring turtle," "princeling dino," and "the sweet unicorn". Available in bundles or through subscription, the product includes cards, a physical cube, and a software app.

Kazoo Technology, founded in 2016, emphasizes multi-sensory stimulation in early education. The product underwent rigorous user testing, gaining recognition for its Chinese-learning series developed in collaboration with the Education University of Hong Kong. Additionally, the Cookie Kiddle line targets younger learners, stimulating English vocabulary and coordination through a smart tactile learning cube. The product line up extends to tailored Chinese language classes using AI for interactive real-time lessons, designed for teachers and parents alike.

User base

Over 15% of schools in Hong Kong already use the product and the company is currently considering expansion to the USA.

Turtle Learn collaborates with various schools in Hong Kong, falling into three categories:

a) Schools equipped with devices and trained teachers who independently utilize the Turtle Learn software for classes with self-created content.

b) Schools providing raw pedagogical materials but lacking time for content creation; Turtle Learn's education professionals digitize and curate the materials (with additional fees), allowing teachers to preview and approve the content for subsequent class use through the Turtle Teach platform.

c) Schools facing shortages in both teacher count and devices; Turtle Learn supports them by performing content digitization, lending devices, and connecting them with trained Chinese teaching professionals from affiliated universities to conduct classes. This category typically includes smaller schools with limited resources or charity groups lacking qualified Chinese teachers.

Mission:

Turtle Learn leverages technology to transform learning into an effective and joyful journey, embodying the steady, delightful progress of a turtle.

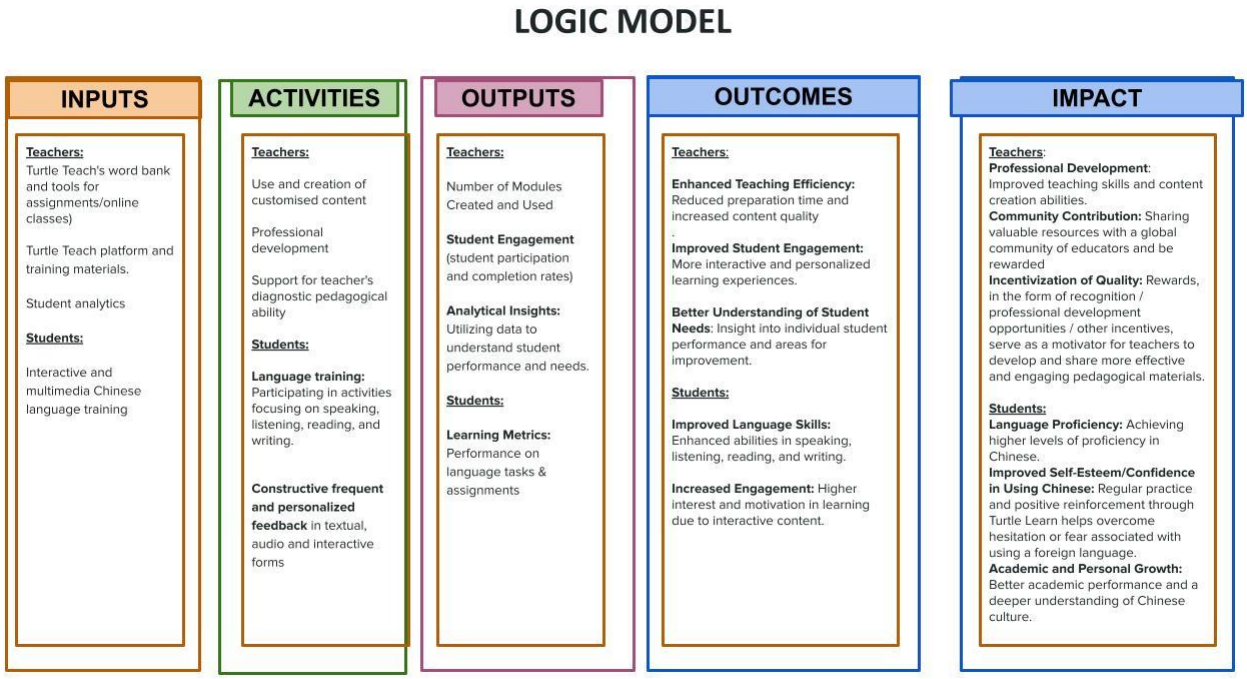
Vision:

We envision a world where technology connects every dot in a learner's journey, crafting a comprehensive learning portfolio that guides them to become informed, culturally connected global citizens.

Logic model

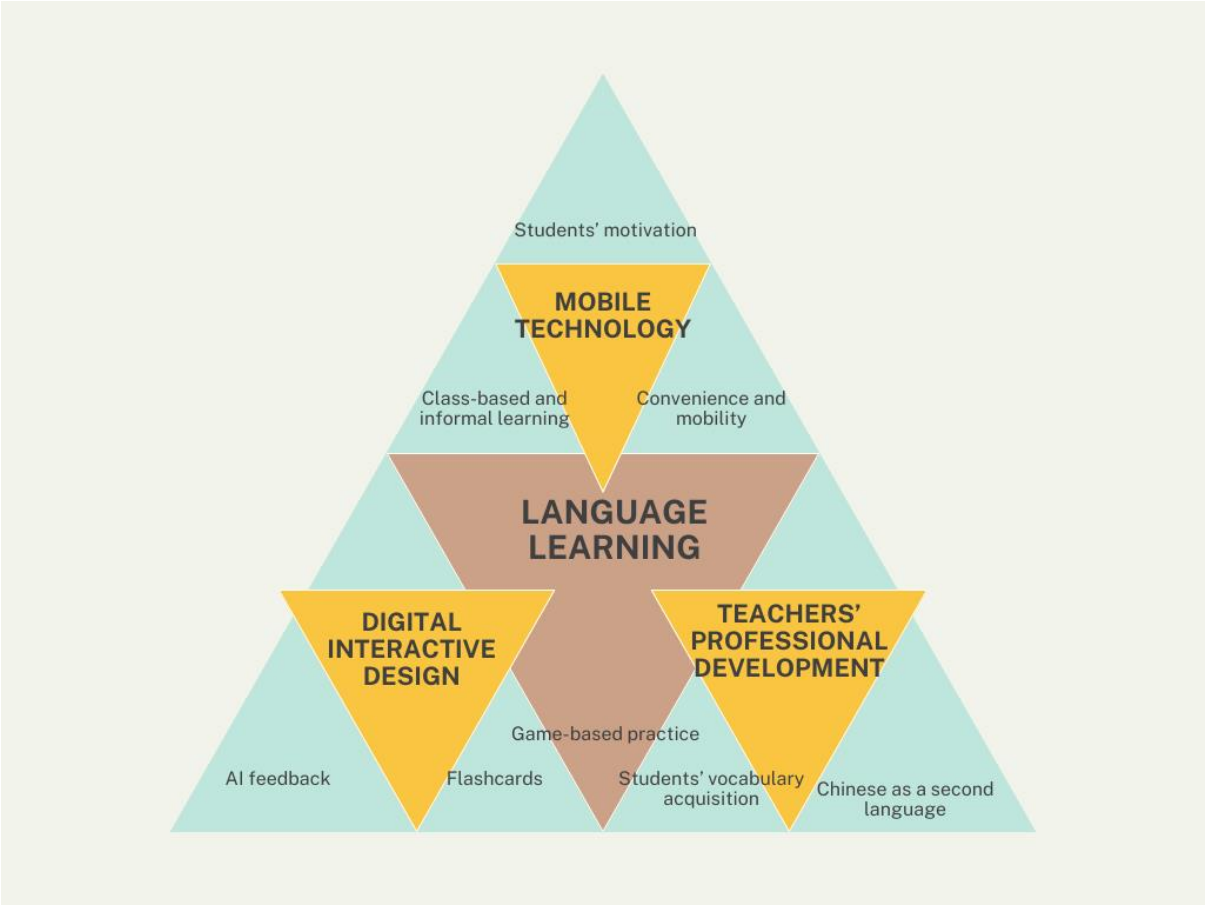
The Logic Model for Turtle Learn is illustrated in a simplified form in Figure 1. The Logic Model outlines how the use of the products by children independently or together with their teachers, parents or peers, guides them towards Chinese language practice, resulting into higher language outcomes over time.

Figure 1. Simplified logic model for Turtle Learn



Theory of Change

Figure 2. Theory of change for Turtle Learn, based on relevant literature



Turtle Learn's Theory of Change is captured in Figure 2. The key premise in the Theory of Change is the correlation between students' multisensory learning with language learning.

Digital interactive design and language test scores

There is some research support for the assumption that tailored multisensory interactive Chinese language classes can improve students' language test scores. Hwa et al. (2012) showed that a blended learning approach, including an interactive multimedia e-book, can enhance students' achievement in learning Chinese as a second language, at tertiary level. The research conducted with students in Taiwan reinforces the idea that effective Chinese learning outcomes can be achieved through the integration of well-designed texts, audio, graphics, animation, and hands-on practice (Lee et al., 2008). The similarity in context and approach between these studies and Turtle Learn indicates a good alignment between published research and Turtle Learn's approach.

As for the connection between Turtle Learn's use of digital language-learning scaffolds and published literature, there is some supportive evidence. For example, positive outcomes of using technology for language learning were found in the use of different colours to show the strokes of Chinese characters (Hulls, 2005). A study by Feng and Wang (2023), on the challenges encountered by primary school students (particularly left- behind and migrant children), has shown that utilising technology in the form of an educational Robot, as the reading tool, Al human-machine interaction and use of interactive picture books, can improve students' engagement in the language teaching, as well as the bilingual pronunciation (English/Chinese), based on the robot's scoring corrections. The study consisted of a 6-month comparative experiment, comparing the effects of bilingual reading using educational robots with Al assistance and conventional paper books. The design of Turtle Learn aligns with this study's findings, especially in the positive effects of human - AI robot interaction, which shows to enhance the interest and motivation of Chinese elementary school students in reading comprehension, independent learning ability and academic achievement.

Mobile technology and students' outcomes

More broadly, the literature indicates a relationship between the use of mobile technology and students' outcomes: for instance, a study by Ling et al. (2020), tested selected mobile applications (MA), similar in characteristics, on a sample of non- Chinese students enrolled in the Foundation Mandarin (level 2), at Universiti Teknologi MARA (Saraswat). The students were using the MA for 3 weeks, against the control group, who were instead learning using the traditional rote learning method. The results showed a significant positive effect of that in learning Chinese character stroke order, with lower failures in the post-test, compared to the traditional learning method.

Wang and Leland's (2011) study on first time learners' perception of Chinese character learning highlighted the importance of orthographic features (radicals and rules of character) in learning Chinese characters. Based on those premises, research by Soleimani et al. (2014), and Chung (2013), underscored that assistance of mobile applications (MA), and especially use of iPads to learn character writing in Chinese language, showed higher achievement in terms of character writing and writing order and higher motivation among students. This, again, is in line with Turtle Learn design, as in learners would become more engaged with the use of iPads, for ease and convenience, which

facilitates the integration of Chinese learning into their daily lives, in class as well as outside the classroom.

When it comes to chosen or preferable Chinese characters learning strategies among learners, Ke (1998) found that paying attention to character component (radicals, character stroke sequence), reproducing, and focusing on the graphic structure and semantic of the characters are perceived as an effective learning strategy by most participants. The study was conducted with learners who had just completed one year of study in Chinese language course, thus a similar target group as the students enrolling in classes with Turtle Learn.

Vocabulary acquisition and game-based practice

Research by several authors has indicated the efficacy of using graphic organisers for learning vocabulary, impacting on comprehension and retention of words meaning much more effectively than the traditional method of looking up a definition. Acquisition of an adequate vocabulary is crucial to convey our basic communication with others and it is the main difficulty for all Chinese language learners at different levels. A study by Fah (2015) showed the positive effects of game- based practice on year three pupils' vocabulary acquisition in Chinese language classroom in Malaysia. The study consisted in an experiment where the treatment group was using games (flash cards), while the control group was using the traditional method. Results showed that the experiment group performed better than the control group in terms of vocabulary acquisition when game - based practice was used in the classroom. Furthermore, research by McLaren and Bettinson (2016), highlighted the potential of digital tools in enhancing student engagement and allow for a broader range of strategies in the learning of Chinese character script. However, the authors noted some limitations in adapting digital learning based on space repetition to the typical classroom schedule.

Research suggests that digital flashcards with Chinese characters can enhance vocabulary learning and attitudes towards learning (Li and Tong, 2019). E-flashcards are an effective pedagogical approach for novice Chinese language learners. In the study by Li and Tong (2019), students using E-flashcards outperformed those using paper flashcards in Chinese word learning and demonstrated more positive learning attitudes. Collectively, these studies point to the need for Turtle Learn to empirically test and build on the findings with previous, similar, approaches.

Technology use and teachers' professional development:

In terms of positive impact of technology on teachers' skills and professional development, a study by Ottenbreit-Leftwich et al. (2010), showed that teachers' attitudes towards students, classrooms and academic material to be taught are crucial in their instructional practices and integration of technology within them. In order for teachers to integrate a new technology in their practice, they need to believe it will be valuable to achieve their instructional goals and facilitate their work, therefore support for them to learn to use the technology and the presence of a wider user community. Professional development programs are more effective when they align with teachers' value beliefs, so their training and development specific programs can be tailored to better support teachers. The study shows that teachers who are more confident in the use of technology are also more open to broaden the integration of technology use in their classroom. They also become more confident in student-centred practices, motivating students and building their pedagogical approaches to include more and

more innovative practices (Ottenbreit- Leftwich et al., 2010). Once these features are implemented in Turtle Learn, the platform could have an impact on teacher professional development.

Ten relevant studies from this literature review are available as full-texts, shared with the company.

Overall, the literature supports the assumption that tailored Chinese language classes using AI and interactive features, and delivered through mobile technology with trained teachers, can improve students' Chinese language scores. To identify how Turtle Learn might add value to existing classroom practice and demonstrate a positive impact on students' Chinese language learning, a series of studies will need to be conducted. The WiKIT team discussed the plan for these studies with the Turtle Learn's leadership team in light of the company's current priorities and future aspirations. Based on the discussions and the ESSA Tier standards, a research plan for the next five years was put together and is reproduced in Table 1.

Research roadmap

The research plan is based on a combination of guidance provided by the Office for Educational Technology on the ESSA standards https://tech.ed.gov/, the WiKIT researchers' own evaluation of an optimal research plan for the company and the CEO's input into what might constitute a realistic and feasible research approach.

Building on the study conducted in 2022/23, there is an indication of effectiveness of Turtle Learn in improving students' abilities in Chinese language learning. The study, conducted over four months in three primary schools in Hong Kong (Primary 1 to Primary 3 levels), showed significant increase in Chinese language advancement in students who have learned using the tool in the classroom. The positive outcome was especially observable in students in the lower ability groups (based on pretest scores), in particular the first and second quartile, where the increase in test score results were the highest and most significant, respectively 28% increase in the 1st quartile (the lowest ability group), and 15% increase in the 2nd quartile group. These results are very promising in terms of the impact Turtle Learn can have on students' performance in Chinese language learning, in particular underperforming students, who need to be stimulated in different ways compared to the highest performing students.

Given that the initial study was not peer-reviewed or publicly published, it would need to be reviewed in detail to be evaluated for its weight of evidence and scientific rigour. WiKIT considers the study as an important "proof of concept" study that can feed into a robust "Evidence Portfolio" of Turtle Learn's impact over time. To facilitate the evidence-building, WiKIT researchers put together a roadmap for Turtle Learn's research. This was discussed with Turtle Learn's leadership team to anchor the plan in the company's strategy.

Table 1 outlines the research plan over the next 5 years. The focus will be on five main domains, involving both students and teachers' experience in the use of Turtle Learn. Concerning students, in particular, the research will focus on engagement, language proficiency, confidence in the use of Chinese language and the development of a growth mindset.

Starting from later this year (2024), the first step was to have a research-based theory and logic model. This document contains the theory of change and logic model, which can be deployed to conduct analysis on existing data on student performance scores. As essential tools for decision-making, the logic model and theory of change can be also used to guide the analyses of responses to use of personalised AI feedback provided by Turtle Learn and survey data about teachers' attitude towards the use of the tool. The following stages, in the next few years, will focus on correlational and causal studies with the help of continuous data collection, through partnerships with more schools (students and teachers), and institutions which would collaborate to undertake more complex research. The CEO is committed to this research plan and envisage that Turtle Learn will be able to expand their offer to different type of learners, including children with ADHD and SEN. Ongoing research will be key to achieve these ambitious goals.

Figure 3: Research Roadmap for Turtle Learn

Domain	Spring 2024	Summer 2024	Fall 2024	2025	2026-2030
Students' engagement Teachers' professional development Students' language proficiency Students' confidence in Chinese language Students' academic and personal growth	Develop a research-based theory of change and logic model (DONE) Analyse existing students' performance scores, completion of tasks and responses to personalized AI feedback Develop pre- and post-course survey questionnaire to assess teachers' attitudes towards Turtle Learn adoption and long-term use Partner with a research organisation/university team to design an empirical study and application for funding/grant	Report on Spring data analysis Continued collection of teacher reports/survey data Approach local schools in Hong Kong, obtain ethical permission for the study and begin recruitment for empirical study	Begin data collection for a correlational study that examines students' learning and the use of Turtle Learn over at least a 3-month period. Focus on standardized outcome measures in all five domains. Pay attention to enabling and hindering factors for the use of Turtle Learn. Analyse the data with attention to various types of learners, including children with ADHD and SEN.	Analyse data from 2024 with attention to relevant contextual data preparing for a rigorous ESSA Tier II study in subsequent years. Use the analysis together with the Logic Model and Theory of Change (Spring 2024) as a decision-making tool for determining the key (max 2) outcome variables, target group and contextual variables necessary for conceptualising the design and implementation of the Tier II study. Continue collecting other forms of evidence to enhance the company's evidence portfolio of research studies.	Conduct a rigorous intervention study using best practices for supporting causality, as specified in ESSA Tier II and Tier guidance. Focus on the outcome measures that prove as most significant in empirical studies conducted between 2024-2026. Continue collecting other forms of evidence relevant not only to current product but also the learning with other possible languages supported by Turtle Learn.

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