


# From Gamer to Game Designer: Task-Oriented Game Design Learning to Improve Learning Motivation

Heng-Sheng Lin  
*National Cheng Kung University, Taiwan*

Chih-Yun Chiang  
 <https://orcid.org/0000-0002-2408-120X>  
*Deguang Senior High School, Taiwan*

Cheng-Wei Huang  
*Deguang Senior High School, Taiwan*

Chao-Cian Wu  
*Deguang Senior High School, Taiwan*

Shuo-Jun Hong  
*Deguang Senior High School, Taiwan*

## ABSTRACT

Taiwanese students learn Chinese from 3 years old using Bopomofo (Zhuyin Fuhao), but they still struggle with spelling and reading, even in middle school. Thus, we guided students still struggling to read Chinese text to use their logical skills and creativity to incorporate the Bopomofo phonetic alphabet into the Rummikub strategy board game. Over six weeks of tutoring, the students shifted from a passive to an active learning attitude, enhancing their enthusiasm for learning. The Zhuyin Fuhao Rummikub board game developed by them received positive feedback in several areas: game experience (4.42/5), self-assessment of learning outcomes (4.31/5), clarity of rules (4.52/5), and learning motivation (3.85/5 and 3.79/5). These results indicate that the board game is highly effective and well-received, underscoring its value in Chinese language learning and teaching. In conclusion, this teaching module can benefit students, educators, and parents. Educators can use this game-based design to inspire the creation of more engaging instructional content.

## KEYWORDS

Game-Based Learning, Student-Centered, Zhuyin Fuhao, Board Game, Bopomofo, Rummikub, Curriculum Development, Instructional Development, Game-Based Learning Module

## INTRODUCTION

In the context of Chinese language learning, the introduction of the Pinyin system and the Bopomofo (Zhuyin Fuhao) system has provided significant scaffolding for students learning Chinese. These two systems have been widely used across various countries for decades to help students master the pronunciation of Chinese characters. In Taiwan, the Bopomofo system is employed and given both the complexity of Chinese characters and the absence of an alphabetic system—this strategy makes it easier for students to understand and memorize the pronunciation of each character, thereby reducing the challenges encountered during the learning process (Hayes-Harb & Cheng, 2016).

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The following study incorporated Bopomofo into the curriculum for several reasons. Firstly, Bopomofo is the primary phonetic system used in Taiwan to help students learn Chinese characters, operating much like the English alphabet. While Bopomofo is a helpful scaffold for students in the early stages of Chinese language acquisition, however, it also presents significant challenges. For example, many Chinese characters have multiple meanings; Chinese idioms, and classical literary references can be highly complex, and there are often discrepancies between the usages of classical and modern vocabulary. These factors can make reading comprehension difficult for students—a common issue for many Chinese language learners.

Although modern developments in information technology have somewhat reduced the emphasis on handwriting skills, the proliferation of available information has increased the importance of proficiency reading. Finding ways to enhance students' reading abilities by cultivating their interest in and familiarity with the written language is a valuable aim to pursue. Using Bopomofo character tiles was a strategy intended to help students make stronger connections in language acquisition. By engaging with language in this innovative way, the researchers hoped students would develop a deeper understanding and improved mastery of Chinese.

## **LITERATURE REVIEW**

### **The Benefits and Challenges of Gaming: A Focus on Board Games**

Across cultures, games have long been regarded as a beneficial leisure activity, and many have evolved to promote healthy development (Wang & Cheng, 2022). Through engagement in play, children can improve their thinking skills and develop various areas of knowledge and abilities, including their cognitive, metacognitive, social, and emotional capacities (Pinedo et al., 2022). According to Vygotsky, play allows the child to achieve “beyond his average age, above his daily behavior; in play, it is as though he were a head taller.” Through play, the child can demonstrate capabilities and behaviors that exceed their existing level of development. Play and games create a “zone of proximal development” that enables the child, with the assistance of an adult or more capable peer, to perform beyond their typical daily level of performance (Vygotsky, 1987, p. 102). Studies emphasize the impact of internet gaming addiction on adolescents, however, noting that teenagers are particularly vulnerable to addiction due to their developmental stage and social needs. This susceptibility can result in a decline in academic performance and interpersonal relationship problems, along with mental health challenges (Kuss & Griffiths, 2012).

Board games form a unique category of games that foster social interaction, strategic thinking, and creativity. Unlike many digital games, which may lead to excessive screen time and potential addiction, traditional tabletop games typically promote face-to-face engagement and can therefore enhance interpersonal skills. They provide a platform for players to connect, collaborate, and compete in a shared environment, making them a valuable tool for building relationships and developing cognitive abilities. Overall, board games offer a balanced form of entertainment that can be both enjoyable and beneficial for mental and social well-being (Tan & Ng, 2022).

### **Gamification in Education: Enhancing Engagement and Developing Multidisciplinary Skills**

Recently, gamification has garnered significant attention in learning and education. Incorporating gamification into teaching practices is widely regarded as an effective instrument for stimulating learners' motivation, engagement, and social influence (Zainuddin et al., 2020). Both gamification and game-based learning have emerged as prominent trends in the educational landscape. Using the elements of games positively impacts learning outcomes. Game-based pedagogy is based on constructivist learning—practical learning through environment and social interaction peers (York & deHaan, 2018). If teachers can design or adapt the content of board games in alignment with course

objectives, board games can serve as effective media and materials for learning (Lee, 2023). The application of gamification principles manifests in diverse forms within different learning contexts. One approach is the integration of game design elements into vocabulary-focused instruction to help students expand their lexical repertoire (Zainuddin et al., 2020). Games are understood to have six main characteristics, codified as: active, experiential, contextualized, social, intrinsically motivated, and problem-based (Carr & Cameron-Rogers, 2016). By skillfully combining gaming experience with educational content, learning can be made more enjoyable and cultivate students' logical thinking, creativity, and collaborative skills—thereby achieving comprehensive educational goals.

Previous literature has explored game design in educational contexts from various perspectives, emphasizing its effectiveness as a learning tool that significantly enhances student academic performance and satisfaction. Research indicates that game design increases student engagement and fosters their creativity and collaboration skills. Through game design, students can apply their learned knowledge in practice and receive immediate feedback, which further enhances their motivation to learn. Additionally, such studies highlight the importance of considering gender differences and individual preferences in curriculum design to better meet the diverse needs of students and, ultimately, improve the overall learning experience and outcomes (Hsu, 2013; Lester et al., 2014). These findings highlight the effectiveness of integrating game design strategies into educational curricula to engage students, enhance their motivation to learn and facilitate their academic success across various disciplines. Additionally, cultivating students' multidisciplinary skills is essential to equip them to face future challenges.

By using the module presented in this study in curriculum design, students can utilize various cross-disciplinary skills, including linguistics, game design, creative thinking, and logical reasoning.

## **METHODS**

### **Student Population, Preparation, and Implementation of This Module**

Students now often strongly prefer digital games, frequently devoting significant time to mobile devices and online activities at home. At times, this extensive engagement with digital media has adversely impacted family dynamics and parent-child relationships. The following study aimed to harness student interest in games by guiding them through designing their own board games. By tasking students with conceptualizing and creating their board game designs, the following key objectives were sought:

- Help students develop an understanding of core game design principles.
- Foster a greater sense of accomplishment and authenticity in students' lived experiences.
- Reduce excessive reliance on computer games and mobile applications.
- Enable students to gain a deeper appreciation for the essence of games.

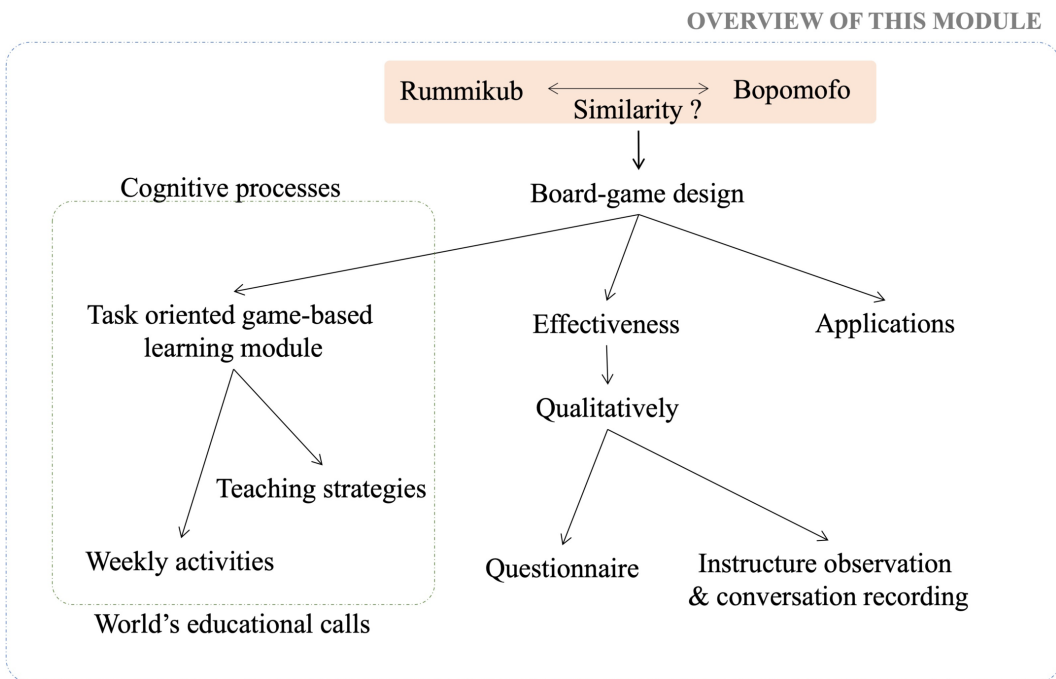
Through in-depth case study methodology and to achieve the six critical characteristics of game-based learning, the authors examined the process of task-based learning and game design activities. By engaging students in hands-on experiences of board game creation, the aim was to shift their perspective from being passive consumers of digital entertainment to becoming active game designers. This pedagogical approach sought to harness students' enthusiasm for learning, while guiding them toward a more balanced, meaningful, and constructive relationship with learning and games.

### **Development of the Module Instructional Design for Board Games**

When students were engaged in the popular Rummikub board game, they expressed curiosity regarding the numeric arrangements and rules of the game. After two weeks of exposure and

familiarity, however, the novelty and appeal of Rummikub gradually diminished, leading to a decline in the motivation and concentration during gameplay. It became evident that relying solely on commercial board games as a teaching method might have limited success. Additionally, the practical implementation of non-electric board games in the classroom presented challenges, such as the high cost of purchase. Recognizing the high level of student interest in mathematics, but a lack of confidence in language skills, the authors considered guiding students to design their own games related to language content, using logic skills. The overview of the research structure is shown in Figure 1.

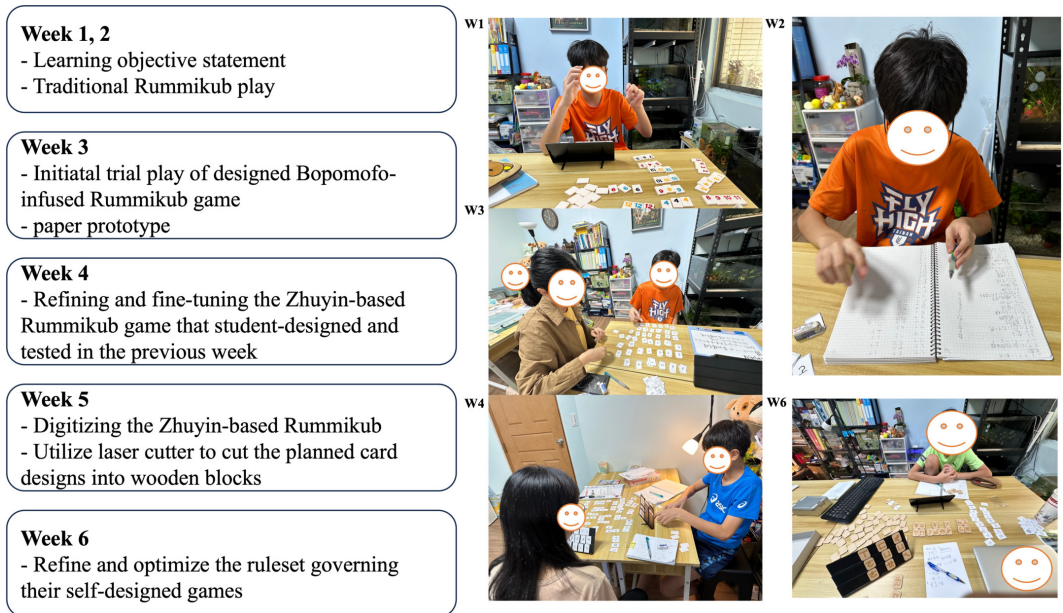
Figure 1. The research flow of the module



*Note. This graph presents the cognitive apprenticeship throughout the whole research; the left part shows the cognitive processes of this module, and the right part shows the research flow, including the effectiveness and applications of this module.*

By empowering students to design their own games, it was then possible to tap into their intrinsic motivation and engagement, thereby leveraging students' mathematical inclinations while simultaneously addressing potential language barriers. This shift from using pre-existing board games to student-designed games presented an opportunity to foster a more meaningful and personalized learning experience for the learners. The following section has listed the activities in this game-design curriculum module (Figure 2).

Figure 2. Weekly activities of the curriculum module



*Note. The left part of the figure refers to the activities. The right part of the figure relates to the student activities.*

The entire activity was structured progressively, moving from foundational knowledge to hands-on practice, culminating in the presentation of student projects. Over six weeks, students engaged in a structured game design process that began with learning the fundamentals of game design and studying the rules of traditional board games during Weeks 1 and 2. The primary goal at this stage was to familiarize students with game design frameworks and spark their creativity. In Week 3, students transitioned to brainstorming their board game concepts, drafting initial designs, and creating prototypes. This phase focused on identifying core elements and mechanics, while outlining the rules and physically building game components for preliminary testing. In Week 4, students conduct playtests, collecting feedback from peers and instructors, which enable them to adjust their game designs to enhance the overall gaming experience. In Week 5, students not only made final adjustments based on testing results but also focused on digitalizing their game designs and creating components, using laser cutting technology. This process allowed them to refine their prototypes further and prepare for presentation. Finally, in Week 6, students presented their completed designs, allowing them to share their creative works with others.

### The Cognitive Processes of This Task-Oriented Game-Based Learning Module

The task-oriented, game-based learning module discussed in this report aligns with numerous key priorities in international, future-oriented education calls. Table 1 outlines the competencies and literacies that could be cultivated through this module, and it lists the corresponding world's educational calls (Taguma and Frid, 2020).

**Table 1. Workflow of task-oriented game-based learning design module with corresponding educational abilities and competencies**

Cognitive process	Activities for task-oriented board game design module		Alignments with the world’s educational calls	
Interdisciplinary integration and application capability	Competencies	<ul style="list-style-type: none"> <li>- Proposing innovative game mechanisms and rules</li> <li>- Collaborating with team members to think outside the box</li> </ul>	Organization for Economic Cooperation and Development (OECD) “The Future of Education and Skills: Education 2030” Elements	Creating new value
		<ul style="list-style-type: none"> <li>- Reflecting on and evaluating design decisions</li> <li>- Considering personal, ethical, and societal goals</li> </ul>		Taking responsibility
	Knowledge	<ul style="list-style-type: none"> <li>- Integrating knowledge from fields such as design, linguistic ability, and sociology to enrich the game design</li> </ul>		Interdisciplinary knowledge
		<ul style="list-style-type: none"> <li>- Understanding the purpose and relevance of game design to ensure the content is meaningful</li> </ul>		Epistemic knowledge
	Skills	<ul style="list-style-type: none"> <li>- Critical thinking and problem-solving abilities</li> <li>- Reflective and self-regulatory skills</li> </ul>		Cognitive and meta-cognitive skills
		<ul style="list-style-type: none"> <li>- Communication and collaboration skills</li> <li>- Empathy and social intelligence</li> </ul>		Social and emotional skills
		<ul style="list-style-type: none"> <li>- Prototyping and testing abilities</li> <li>- Visual and interaction design skills</li> </ul>		Practical skills
	Attitudes and values	<ul style="list-style-type: none"> <li>- Reflecting fairness, inclusivity, and social responsibility in the game design</li> </ul>		Creating values of fairness and responsibility
Self-directed learning ability and lifelong learning attitude	Proactively exploring the history and characteristics of phonetic symbols, and continuously learning and experimenting to improve game design		United Nations Educational, Scientific and Cultural Organization (UNESCO) “Rethinking Education: Towards a global common good?”	
Digital literacy and innovative application skills	Utilizing digital tools for game prototyping and testing, and creatively applying digital technologies to enhance the gaming experience		International Society for Technology in Education (ISTE) standards	
Empathy and social responsibility	Designing mechanisms to promote player interaction and collaboration, and considering the needs and experiences of players from diverse backgrounds		Collaborative for Academic, Social, and Emotional Learning (CASEL)	
Critical thinking, problem-solving ability, communication, cooperation	Analyzing problems encountered during the game design process and proposing solutions, evaluating the feasibility and improvement potential of design proposals,		The World Economic Forum proposes a visionary framework for 21st Century education.	
	present arguments for discussion with teachers, to complete each stage of board game design, students learn to communicate, coordinate and cooperate with different units to complete the task.			

### Data Collection and Analysis in the Study

This study employed various data collection strategies, including surveys, interviews, and field observations. First, surveys were designed and distributed to gather opinions and feedback from game participants. Additionally, surveys were administered to a control group to assess the preferences and familiarity of students with similar backgrounds who had not participated in the Rummikub board game trial regarding Zhuyin Fuhao symbols, Chinese language, and idioms. Secondly, in-depth, individual semi-structured interviews were conducted with willing student participants in the course module to collect qualitative data and insights. Furthermore, field observations were conducted in relevant environments to obtain data on real-world conditions. Data analysis included quantitative analysis of survey data to calculate averages, standard deviations, and other indicators, as well as thematic analysis of interview and observation records to identify key trends and patterns.

## RESULTS AND DISCUSSION

### Implementation of the Module: Weekly Activities

During the module, the instructor guided students to ensure they experienced authentic task-oriented and game design—to think like a game designer. The activity outlines, insights, and photos are listed in Figure 2, Table 2, and Table 3.

**Table 2. The description of weekly activity and teacher insights**

Week	Activities	Teacher insights
1	<ul style="list-style-type: none"> <li>• Instructor introduced the board game Rummikub to the student.</li> <li>• Student learned the basic rules and gameplay of Rummikub.                             <ul style="list-style-type: none"> <li>• Instructor observed the student’s logical and mathematical reasoning skills.</li> </ul> </li> <li>• Student explored the fundamental mechanics and structure of Rummikub.</li> <li>• Student analyzed the game’s core gameplay loop, scoring system, and tile placement rules.</li> </ul>	<ul style="list-style-type: none"> <li>• Student exhibited strong logical and mathematical reasoning skills.                             <ul style="list-style-type: none"> <li>• Student expressed that he is poor at learning language.</li> </ul> </li> </ul>
2	<ul style="list-style-type: none"> <li>• The instructor guided the student to design his own board game based on the Rummikub concept.</li> <li>• Student proposed using the Bopomofo (Zhuyin Fuhao) phonetic system as the core element.</li> <li>• Student explored innovative ideas to incorporate Bopomofo into the game design.</li> </ul>	<ul style="list-style-type: none"> <li>• Student enthusiastically explored ideas to leverage Bopomofo’s unique features in the game design.</li> <li>• Instructor provided facilitation to help the student concretize their ideas.</li> </ul>
3	<ul style="list-style-type: none"> <li>• Student conducted an initial trial play of the Bopomofo-infused Rummikub game using paper prototypes.</li> <li>• Student participated in playtesting sessions with classmates and documented their observations.                             <ul style="list-style-type: none"> <li>• Student critically analyzed the gameplay, mechanics, and user experiences.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Playtesting provided valuable insights to inform the next iteration of the board game design.</li> <li>• The game included the finals (vowels and vowel-like sounds) from the Bopomofo phonetic system.</li> <li>• The game used Chinese character numerals, one (一) to ten (十), as part of the card set.                             <ul style="list-style-type: none"> <li>• The game objectives and setup were clearly defined.</li> <li>• The icebreaker rules focused on three-character words or idioms to facilitate initial gameplay.</li> </ul> </li> <li>• Players could discard cards by completing word/idiom combinations.                             <ul style="list-style-type: none"> <li>• Challenges identified included insufficient available vocabulary and the overlapping usage of Chinese characters and Zhuyin Fuhao.</li> </ul> </li> <li>• Potential enhancements discussed included incorporating the four tones of Bopomofo.</li> </ul>

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Table 2. Continued

Week	Activities	Teacher insights
4	<ul style="list-style-type: none"> <li>● Refined and fine-tuned the Zhuyin-based Rummikub game design based on feedback from initial playtesting.</li> <li>● Identified and addressed issues such as shortage of vowel tiles, that lead to gameplay stagnation.</li> <li>● Modified the icebreaker rules to require the use of four-character idioms or words with four or more Zhuyin symbols.</li> <li>● Introduced lexical unit groupings to allow the formation of meaningful nouns, verbs, adjectives, or action word constructs.</li> <li>● Enabled the assembly of three or four of the same Zhuyin symbols as a valid move.</li> <li>● Simplified and clarified the game rules and procedures to enhance intuitiveness.</li> <li>● Adjusted the game mode and scoring mechanism to shorten the overall duration.</li> <li>● Conducted repeated playtesting and document feedback and modifications in detail.</li> </ul>	<ul style="list-style-type: none"> <li>● The shortage of vowel tiles can lead to gameplay stagnation, so adjusting the tile distribution is necessary.</li> <li>● Increasing the difficulty of the icebreaker criteria can encourage players to engage their knowledge of longer lexical units.</li> <li>● Allowing the formation of multi-character lexical units can enhance the intellectual challenge and richness of the gameplay.</li> <li>● Simplifying and clarifying the rules and procedures can improve the overall intuitiveness of the game.</li> <li>● Adjusting the game mode and scoring mechanism can help reduce the overall gameplay.</li> <li>● Meticulous documentation of the iterative design process, including playtesting feedback and modifications, is crucial.</li> </ul>
5	<ul style="list-style-type: none"> <li>● Digitized the plans developed in previous weeks.</li> <li>● Learnt to create digital vector illustrations using Inkscape.</li> <li>● Utilized a laser cutter to cut the planned card designs into wooden blocks.</li> </ul>	<ul style="list-style-type: none"> <li>● Reinforced the student’s understanding of the design process by translating paper prototypes into digital files.</li> <li>● Digital representation enabled the use of advanced fabrication tools like the laser cutter.</li> <li>● Understood the underlying principle of laser cutting—its ability to recognize and process vector graphics.</li> <li>● Learnt to convert designs into vector format, as this is the only way the laser cutter can accurately cut the desired shapes.</li> <li>● Used Inkscape to render conceptual designs into digital vector files and carefully considering the dimensions and proportions of the intended game components.</li> <li>● Mastered vector graphics software to develop essential digital design skills for transitioning board game concepts from ideation to fabrication.</li> <li>● Conducted a series of tests when exploring various modes in the laser cutting machine, adjusting the text presentation from filled characters to simple outlines to enhance the rendering process and improve fabrication efficiency.</li> </ul>
6	<ul style="list-style-type: none"> <li>● Students thoroughly refined and optimize the ruleset governing their self-designed games.</li> <li>● They examined each game mechanic element and made adjustments to enhance coherence, balance, and intuitiveness.</li> <li>● Students identified and explored potential in-game situations, devising solutions and contingency plans.</li> <li>● Rigorous documentation of linguistic choices and evolution of game-related lexicon.</li> </ul>	<ul style="list-style-type: none"> <li>● Rule optimization, scenario planning, and linguistic documentation are essential for creating exceptional and compelling educational games.</li> <li>● The lexical recombination mechanic is a distinctive and demanding feature that can stimulate students’ cognitive and linguistic skills.</li> <li>● Incorporating Chinese characters 1-10 as an optional tool kit and integrating a visual timer can improve game accessibility and usability.</li> </ul>



Table 3. Weekly activities descriptions

Week	The description of the activities
1-2	<p>The instructor introduced the popular board game Rummikub to the student in the first week. The student learned Rummikub's basic rules and gameplay by playing the game (<b>Figure 2</b>). During the gameplay, the instructor observed the student's performance and found he exhibited solid logical and mathematical reasoning skills. However, he often says that he is poor at learning language</p> <p>Building upon the insights gained in the first week, the focus of the second-week shifts to guiding student to design his own board game. The instructor asks the student: "If you were a board game designer wanting to create a new game based on the Rummikub concept, what familiar elements would you incorporate into the design?" The students immediately propose using the English letters or Bopomofo (Zhuyin Fuhao) phonetic system as the core element to integrate into the game design.</p> <p>Since the English letter version of Rummikub games already exist. The instructor encourage the student to share his understanding of Bopomofo and discuss how he would creatively incorporate this familiar Chinese phonetic system into the new Rummikub-inspired board game.</p> <p>Student enthusiastically explores various innovative ideas, exploring how the unique features of Bopomofo could be leveraged to create engaging game mechanics and rules. The instructor provides timely facilitation to help the students concretize their ideas. Subsequently, the student designed the board game, embedding the Bopomofo system throughout the game.</p>

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Table 3. Continued

Week	The description of the activities
3	<p>In the third week, the student engages in an initial trial play of his designed Bopomofo-infused Rummikub game (Figure 2). Using paper prototypes, the students participate in playtesting sessions with their classmates. During this process, the students are encouraged to closely observe and record their experiences, paying attention to any aspects of the game that may require refinement or modification. The hands-on playtesting allows the student to experience the strengths and weaknesses of the game designs directly. We guide the student to critically analyze the gameplay, mechanics, and overall user experiences. Students discuss and provide feedback on elements such as the integration of Bopomofo, the coherence of the rules, the intuitiveness of gameplay, and the overall level of engagement and challenge.</p> <p>By actively participating in the trial play sessions and documenting their observations, the students gain valuable insights that inform the next iteration of their board game designs. This iterative design process enables the students to make data-driven decisions to improve their games, further enhancing the creativity and problem-solving skills they have developed.</p> <p>The first version design of the Bopomofo Rummikub game provides the Chinese character numerals from one (一) to ten (十) as part of the card set. This allows players to utilize these numerical characters for their face value and creatively construct idiomatic expressions, phrases, and words during gameplay.</p> <p>The game objectives were clearly defined - the first player to legally discard all the tiles in their hand would emerge victorious. For the game setup, it was decided that players with less prior experience with the game would be given priority to start to facilitate a more inclusive learning environment. The icebreaker rules stipulated that only three-character words or idioms could be used to initiate gameplay. This decision was made as it was the inaugural playtest, and the students anticipated that fully depleting one's rack with multiple tiles in hand might prove challenging. By focusing the icebreaker criteria on more extended lexical units, it was hoped that the initial gameplay would be more fluid and engaging for all participants.</p> <p>Players only have the right to throw out the cards in their hands after completing the icebreaker challenge individually, whether to release words (more than two-word phrases) or help themselves to release the cards by reorganizing the words already on the desk.</p> <p>During the iterative design process, the students encountered several challenges and discussion points that were noted for future improvement. One key issue was the insufficiency of available vocabulary, as players needed help to compose valid combinations from the tiles in their hands. To address this, the team proposed providing exemplary lexical items such as “白日依山盡, white sun setting beyond the mountains) and “一石二鳥” (一石二鳥, killing two birds with one stone) to help players better understand the type of acceptable words.</p> <p>Another point of discussion centered around the overlapping usage of Chinese characters and Zhuyin Fuhao. The student suggested reducing the reliance on Chinese characters in the next iteration and instead focusing on increasing the number of Zhuyin tiles to better align with the core design objectives.</p> <p>Additionally, the possibility of incorporating the four tones (first, second, third, and fourth tones) was raised as a potential enhancement to the game mechanics. This could introduce an additional layer of complexity and challenge for players to consider the tonal qualities of the words they compose.</p>

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Table 3. Continued

Week	The description of the activities
4	<p>In the fourth week, the students focused on refining and fine-tuning the Zhuyin-based Rummikub game they had designed and tested the previous week (<b>Figure 2</b>). Several improvements were identified based on the feedback collected from the initial trial run. The students found that the shortage of vowel tiles often led to a situation where players could not discard their tiles, resulting in gameplay stagnation. As a result, further adjustments were made to the game rules, and minor modifications were also applied to the tile distribution.</p> <p>The icebreaker rules were modified to require players to use four-character idioms or words consisting of four or more Zhuyin symbols to initiate gameplay. The revised icebreaker rule was introduced in response to the previous discussion around potential challenges with insufficient Zhuyin symbols. With the increase in the available stock of the vowel tiles, the design team opted to raise the difficulty of the icebreaker criteria incrementally. This change was intended to encourage players to actively engage their knowledge of four-character idioms, classical poetry, and other longer lexical units during gameplay.</p> <p>Regarding the valid tile combinations, the second change was the introduction of lexical unit groupings. Players were now permitted to form meaningful nouns, verbs, adjectives, or action word constructs consisting of two or more Zhuyin symbols. The only requirement was that the combination incorporate at least one initial consonant sound.</p> <p>This revision allowed for more flexibility in word composition, as players could now strategically arrange tiles to create coherent linguistic units rather than being limited to homogenous symbol groupings. The inclusion of this rule was designed to foster a deeper level of cognitive engagement, as players would need to draw upon their vocabulary knowledge and language skills to construct valid, semantically meaningful combinations.</p> <p>By enabling the assembly of multi-character lexical units, the design aimed to enhance the intellectual challenge and richness of the gameplay experience while preserving the core Zhuyin-based mechanics underpinning the game's unique identity.</p> <p>Regarding the valid tile combinations, two key changes were introduced. Firstly, groups of the same Zhuyin symbol could now be played as a set of three or four tiles at a time. For example, a player could discard ㄨ, ㄨ, ㄨ as a valid move.</p> <p>Specific rules and procedures also needed to be further simplified and clarified to enhance the overall intuitiveness of the game. Additionally, the overall game duration could have been more lengthy, suggesting the need for adjustments to the game mode and scoring mechanism to reduce the playtime. Applying these insights, the students proceeded to make the necessary modifications.</p> <p>The game rules were further simplified with more straightforward instructions provided, and the game mechanics were refined to shorten the overall duration. The modified version was then subjected to repeated playtesting, during which observations were made on the students' usage patterns, and additional feedback was collected. The details were continuously fine-tuned to ensure a smooth and intuitive game flow. Throughout this process, the team meticulously documented each round of playtest feedback and the corresponding modifications, preserving version files to trace the evolution of the design. The week's critical refinement points and learning insights were also summarized, providing a solid foundation for subsequent presentations and reflection on the iterative design process.</p>

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Table 3. Continued

Week	The description of the activities
5	<p>In the fifth week, the instructor will guide students in digitizing the plans they have developed in the previous weeks (<b>Figure 3</b>). Students will learn to create digital vector illustrations of their designs using vector graphics software such as Inkscape. The instructor will then teach students to utilize a laser cutter to cut the planned card designs into wooden blocks, allowing the students' board game concepts to become more tangible and concrete.</p> <p>This hands-on activity serves several pedagogical purposes. Firstly, it reinforces the student's understanding of their design process by translating their paper prototypes into digital files. This digital representation enables advanced fabrication tools like the laser cutter, which can precisely cut the wooden elements to the students' specifications.</p> <p>During the module, students must understand the underlying principle of laser cutting: its ability to recognize and process vector graphics. Therefore, the first task is for students to learn how to convert their designs into vector format, as this is the only way the machine can accurately cut the desired shapes. To achieve this, the instructor will provide a tutorial on the free vector graphics software Inkscape and guide the students through creating vector illustrations (<b>Figure 3a</b>).</p> <p>Students will use Inkscape to render their conceptual designs into digital vector files during this initial stage. They will carefully consider the dimensions and proportions of their intended game components and translate these ideas into the vector format that the laser cutter can interpret. This foundational step ensures that the physical wooden tiles produced by the laser cutter will faithfully reflect the students' original design vision (<b>Figure 3b</b>).</p> <p>By mastering the vector graphics software, student K develops essential digital design skills for transitioning their board game concepts from the ideation phase to the fabrication stage. The ability to create vector-based illustrations equips students with the technical know-how to leverage advanced manufacturing technologies, such as the laser cutter, to bring their creative ideas to life in an actual, physical state.</p> <p>Students conducted a series of tests when exploring various modes in the laser cutting machine. Initially, they relied on the shallow engraving feature of the laser but discovered that this approach was quite time-consuming and led to a rapid increase in the machine's temperature. In response, the students adjusted their approach. They modified the text presentation from filled characters to simple outlines. This change significantly enhanced the text rendering process's speed and improved the fabrication's efficiency (<b>Figure 3c</b>). The final results of the wooden tiles are shown in <b>Figure 3d</b>.</p>

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Table 3. Continued

Week	The description of the activities
6	<p>During the sixth week of the Zhuyin Rummikub game design course, students thoroughly refine and optimize the ruleset governing their self-designed games. They meticulously examine each constituent element within the game mechanics, carefully weighing the implications of targeted adjustments to enhance the gameplay's overall coherence, balance, and intuitiveness. Concurrently, students dedicate substantial time and effort to the identification and detailed exploration of potential in-game situations that players may encounter throughout the game. They collaborate to devise well-considered solutions for each of these anticipated situations, developing contingency plans and adaptive strategies to ensure a smooth and engaging player experience. Notably, students maintain rigorous documentation of their linguistic choices, carefully recording the combinations and reorganizations of Zhuyin vocabulary in their game designs. This meticulous record-keeping is a valuable resource, enabling them to track the evolution of their game-related lexicon and inform future design decisions. Students sharpen their critical thinking, problem-solving, and language skills by engaging in this comprehensive process of rule optimization, scenario planning, and linguistic documentation, positioning themselves to create exceptional and compelling educational games firmly rooted in the Zhuyin phonetic system.</p> <p>Within the Zhuyin Rummikub gameplay context, students have retained the most stimulating and challenging rule from traditional Rummikub, redesigned as the 'Lexical Recombination' mechanism. 'Lexical Recombination' is an engaging gameplay mechanism that empowers students, after experiencing an initial 'ice-breaking' round, to creatively assemble previously played cards into novel legitimate card combinations, even without any valid tile sets. This flexible resource-leveraging approach is indeed one of the most captivating elements of the game. Students must possess exceptional analytical insight, combinatorial skills, and linguistic sensitivity to generate new legitimate card arrangements when lacking valid tile sets. This tests their comprehension of the game state and challenges their creativity and improvisational aptitude.</p> <p>Through 'Lexical Recombination', students can exercise their innovative capacities, discovering novel ways to make plays even with suboptimal hands. This game mechanism enhances the overall entertainment value and rigorously assesses students' strategic thinking, synthesis capabilities, and linguistic dexterity. It can be said that 'Lexical Recombination' is a distinctive and demanding feature that can stimulate students' cognitive and linguistic skills within the game context.</p> <p>To reduce difficulty and unblock progress, students have suggested incorporating Chinese characters 1-10 as an optional tool kit within the gameplay. Incorporating Chinese characters 1-10 can lower the game difficulty and increase students' use of idiomatic phrases. The constraint of using only two characters in four-character idioms should be applied throughout the game, including the "ice-breaking" stage and other stages, to maintain a reasonable level of challenge. Additionally, the current time constraints may require more work to adhere to. Integrating an hourglass timer visually into the game set could provide a more intuitive time-keeping mechanism without necessitating complex electronic operations.</p>

The board game content designed by students is listed in Table 4 and Table 5.

Table 4. Student-designed Bopomofo Rummikub board game: First version of the card composition

Phonetic component (consonant sounds)	ㄅ	ㄆ	ㄇ	ㄏ	2 each
	ㄉ	ㄊ	ㄋ	ㄌ	2 each
	ㄍ	ㄎ	ㄍ		2 each
	ㄐ	ㄑ	ㄒ		2 each
	ㄓ	ㄔ	ㄕ	ㄖ	2 each
	ㄗ	ㄘ	ㄙ		2 each

*continued on following page*

Table 4. Continued

Medial/semivowel sounds	一	ㄨ	ㄛ		2 each
Rhyming component, finals (vowel and vowel-like sounds)	ㄚ	ㄛ	ㄜ	ㄝ	2 each
	ㄛ	ㄨ	ㄨ	ㄨ	2 each
	ㄛ	ㄨ	ㄨ	ㄨ	2 each
	ㄨ				2 each
Chinese character numerals	一	二	三	四	4 each
	五	六	七	八	4 each
	九	十			4 each
Joker card represents a wildcard symbol that can substitute for any Zhuyin Fuhao (Bopomofo) symbol	Smiley Face Joker				4 total

Total Number of Cards: 120

Table 5. Student-designed Bopomofo Rummikub board game: Second version of the card composition

Phonetic component (consonant sounds)	ㄅ	ㄆ	ㄇ	ㄏ	2 each
	ㄉ	ㄊ	ㄋ	ㄌ	2 each
	ㄍ	ㄎ	ㄍ		2 each
	ㄑ	ㄒ	ㄒ		2 each
	ㄓ	ㄔ	ㄓ	ㄓ	2 each
	ㄗ	ㄘ	ㄗ		2 each
Medial/semivowel sounds	一	ㄨ	ㄛ		4 each
Rhyming component, finals (vowel and vowel-like sounds)	ㄚ	ㄛ	ㄜ	ㄝ	4 each
	ㄛ	ㄨ	ㄨ	ㄨ	4 each
	ㄛ	ㄨ	ㄨ	ㄨ	4 each
	ㄨ				2 each
Chinese character numerals	一	二	三	四	0 each
	五	六	七	八	0 each
	九	十			0 each
Joker card represents a wildcard symbol that can substitute for any Zhuyin Fuhao (Bopomofo) symbol	Smiley Face Joker				2 total

Total Number of Cards: 106

For teachers who may need to use them, the rules for the Bopomofo Rummikub game (as developed by the students) are included in the Appendix.

### The Development Process of the Board Game, as Recorded by Students

#### Element Analysis

First, there were 21 initial consonants: ㄅ, ㄆ, ㄇ, ㄏ, ㄉ, ㄊ, ㄋ, ㄌ, ㄍ, ㄎ, ㄍ, ㄑ, ㄒ, ㄒ, ㄓ, ㄔ, ㄓ, ㄓ, ㄗ, ㄘ, ㄗ; 13 final vowels: ㄚ, ㄛ, ㄜ, ㄝ, ㄛ, ㄨ, ㄨ, ㄨ, ㄨ, ㄨ, ㄨ, ㄨ; and 3 medials: 一, ㄨ, ㄛ.

### Combinations Formed From Zhuyin Symbols

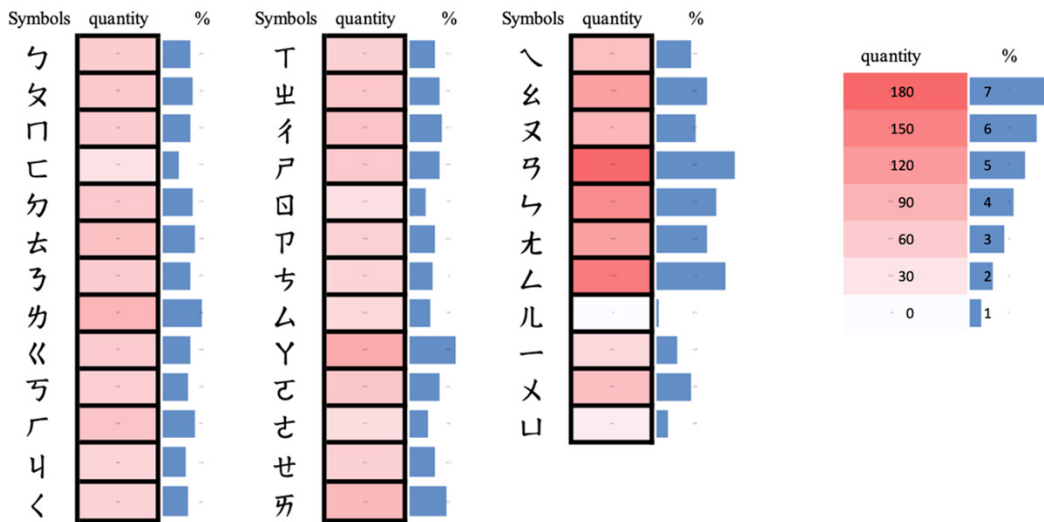
According to the patterns of combining Zhuyin Fuhao to form Chinese characters, there are single-syllable, two-syllable, and three-syllable combinations. However, not every combination can form a valid character. Therefore, based on actual conditions, valid combinations of Zhuyin symbols able to form characters were designated as 1 (Figure 3, shown in red). Those that could not form characters were designated as 0. This leads to the results illustrated in Figure 3.

Figure 3. All possible combination that could form Chinese characters of Zhuyin symbols



Among these, there were a total of 69 possible single-syllable combinations that were able to form Chinese characters. When considering the statistics for two-syllable and three-syllable combinations (including medials), it became evident that the number of characters each initial consonant could form varied (see Figure 4).

Figure 4. Quantity and proportion of formable characters in Zhuyin symbols



Overall, the highest occurrence was observed for ㄅ, with 163 instances, which accounted for 6.8% of the total, thereby indicating its prevalence in the vocabulary. Following ㄅ were ㄆ (144 instances, 6%), ㄇ (125 instances, 5.2%), and ㄏ (104 instances, 4.4%). Regarding other initials, ㄏ had an occurrence of 81 (3.4%), while ㄩ had 93 (3.9%). Additionally, ㄨ (69 instances, 2.9%), ㄗ (67 instances, 2.8%), ㄘ (65 instances, 2.7%), and ㄟ (64 instances, 2.7%) also demonstrated relatively high occurrences.

Conversely, initials with a lower percentage of character formation included ㄌ, with only three instances, representing just 0.1%. Furthermore, ㄒ (21 instances, 0.9%) and ㄜ (37 instances, 1.6%) indicated a lesser capacity for character formation. These proportions may serve as a reference for determining the quantity of game elements in future applications.

## ASSESSMENTS AND ANALYSIS

### User Feedback and Effects of the Student-Designed Board Game

After completing the second edition of the Zhuyin Fuhao Rummikub board game, tests were conducted across different groups of players to understand the impact of this board game on Chinese language learners at various stages. After participating in the game, participants' reflections were collected.

### Participants in the Student-Designed Board Game Testing Questionnaire

The participants involved in the student-designed game testing and survey for this study comprised 48 elementary and middle school students from Southern Taiwan. Among them, 21 identified as male, accounting for 43.8%, while 27 identified as female, representing 56.3%. The age distribution of the participants was diverse. There were eight participants aged 6-8 years (16.7%), ten participants aged 9-12 years (20.8%), and another ten participants aged 13-15 years (20.8%). Additionally, there were 20 participants aged 16-18, making up 41.7% of the total.

The control group consisted of participants who had not engaged in the Zhuyin Fuhao Rummikub activity. This control group provided baseline data regarding students' familiarity with Zhuyin Fuhao, attitudes toward learning Chinese, and engagement levels prior to any intervention. In contrast, the



experimental group was assessed after participating in the Rummikub activity, which integrated play elements into language learning. The students in the control group did not participate in the gameplay process, and were accustomed to traditional pedagogical methods used for teaching Zhuyin and idioms.

The questionnaire included questions regarding interest level and confidence in the Chinese language, familiarity with Zhuyin Fuhao, and whether increased use of Zhuyin Fuhao symbols might enhance effectiveness in learning idioms. The results indicated that, prior to engaging with the phonetic symbol Rummikub game, there was no significant difference in interest in learning Chinese between the experimental group and the control group. After participating in the Rummikub game, however, students showed a marked increase in interest regarding learning Chinese. Participants' information gleaned from the questionnaires is listed in Table 6.

**Table 6. Participant background information**

Background	Category	Number	Percentage (%)
gender	male	21	43.8
	female	27	56.3
age	6-8 years	8	16.7
	9-12 years	10	20.8
	13-15 years	10	20.8
	16-18 years	20	41.7

For the control group, 50 questionnaires were randomly distributed and then 43 valid responses were collected—these were used as the control group. The gender and age composition of the participants is presented in Table 7. This survey primarily focused on participants' interests in Zhuyin Fuhao symbols and Chinese idioms, assessing familiarity, usage frequency, capabilities, and learning attitudes.

**Table 7. Questionnaire developed by students for players' experiences and feedback**

No.	Category	Characteristics	Question Description
1	Basic Information	-	What is your age range?
2		-	What is your biological sex?
19	Game Improvement and Future Development	Social Interaction and Proactivity	What suggestions do you have for improving the game?
20			What new elements would you like to see added in future games?
6	Game Rules and Operational Experience	Contextualization	How would you rate your overall satisfaction with the Zhuyin Rummy game?
7			Do you think the game rules are clear and easy to understand?
8			Were you able to easily recognize the Zhuyin symbols during the game?
13			Were you able to smoothly convert Zhuyin symbols into text during the game?

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Table 7. Continued

No.	Category	Characteristics	Question Description
9	Game Difficulty and Challenges	Challenge	How do you perceive the difficulty of the game?
3	Game Experience and Recommendations	Proactivity: Player Engagement	Have you ever played a Rummy-type game before?
4			Would you recommend this game to others?
10		Social Interaction: Emphasizing Interaction with Other Players	Did you find the game enjoyable and interactive?
5	Self-assessment of Learning Outcomes	Experiential: Emphasizing Learning Experience Gained from the Game	Have you noticed an increase in the number of times you thought about idioms during the game?
11			After playing, did your understanding of Zhuyin symbols improve?
12			Do you believe that learning Zhuyin symbols helps enhance your language sensitivity?
14		Problem-Based	If you have used idioms, how helpful do you think their use is in the game?
17			Which elements of the game do you think are most beneficial for learning Chinese?
15	Learning Motivation and Self-Efficacy	Intrinsic Motivation	How interested are you in learning Chinese?
16			How do you feel about your self-efficacy in learning Chinese?
18			What do you believe is the primary motivation for learning Chinese?

The results indicated that participants had a relatively high level of familiarity with Zhuyin Fuhao symbols (mean score of 4.53, with SD 0.74) and demonstrated fluent usage (mean score of 4.58, with SD 0.73). Particularly notable was a lack of enthusiasm for learning Chinese (mean score of 3.16, with SD 0.87), and idioms (mean score of 3.05, with SD 0.97). This suggests that familiarity with phonetic symbols does not necessarily translate into a passion for learning Chinese and idioms. There is a need to explore effective teaching methods and strategies to enhance interest and promote participants' motivation to learn in these areas. Even with the ability to use the tools, interest in learning content remains crucial to improve learning outcomes.

Additionally, participants were also asked whether they would be interested in participating in a board game learning activity focused on Chinese language learning, should there be an opportunity to learn through non-traditional methods. Interestingly, 60% of respondents indicated they would likely recommend such an approach, while 40% expressed a strong desire to participate. This suggested a significant level of openness and enthusiasm towards alternative learning methods, highlighting the potential for innovative educational strategies that can engage learners more effectively.

### Development of the Questionnaire by Students

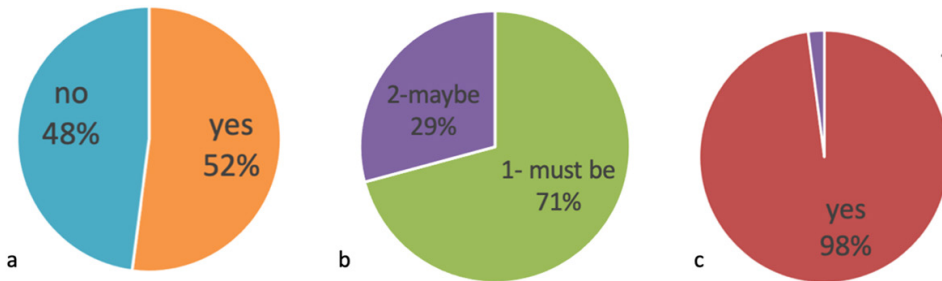
To understand participants' reflections after playing the Zhuyin Fuhao Rummikub board game, questions were structured to address several elements: game experience and game recommendations, self-assessment of learning outcomes, clarity of game rules and operational experience, level of game difficulty and challenges, learning motivation and self-efficacy in Chinese, as well as suggestions for game improvement. These questions corresponded to various characteristics inherent in the

game—these included proactivity, experiential learning, contextualization, social interaction, intrinsic motivation, and problem-based learning.

### Positive Feedback on Students Experiencing the Board Game

The following three questions focused on participants' experiences with the game, whether they would recommend it to others, and whether they noticed an increased frequency of thinking about idioms during gameplay (Figure 5).

Figure 5. Feedbacks on students experiencing the board game



These questions were as follows.

Question 3: Have you ever played a Rummikub-type game?

Question 4: Would you recommend this game to others?

Question 5: Did the frequency of your thoughts about idioms increase during the game?

Regarding Question 3, the survey results indicate that 52% of participants had experience playing Rummikub-related games, while 48% had yet to be exposed to Rummikub (Figure 5a).

For Question 4, the results show that over 71% of participants were willing to recommend the game to others after playing it. The remaining 29% indicated that they might consider sharing the game, with no participants choosing to decline to promote it (Figure 5b).

Concerning the frequency of thinking about idioms during the game, it was observed that 98% of participants reported increased thoughts about idioms. This suggests that the Zhuyin Fuhao Rummikub game effectively promotes Chinese language learning, particularly in using and understanding idioms (Figure 5c).

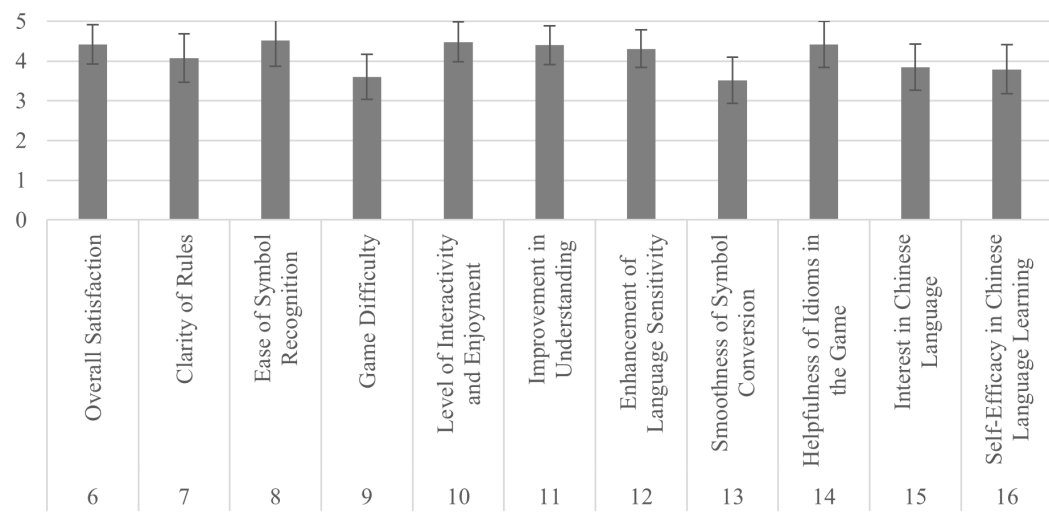
In addition to the experiential aspects of the game, Table 8 presents Questions 6 to 16, which demonstrate various dimensions, including game experience and recommendations, self-assessment of learning outcomes, clarity of game rules and operational experience, game difficulty and challenges, learning motivation and self-efficacy.

**Table 8. The questionnaire received from students experiencing the board game**

No	Questions	Mean	S.D.	1	2	3	4	5
6	How would you rate your overall satisfaction with the Zhuyin Rummikub board game?	4.42	0.5	1	2	3	4	5
7	Do you find the game rules to be clear and easy to understand?	4.08	0.61	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
8	Are you able to easily recognize Zhuyin symbols during the game?	4.52	0.65	Very Unclear	Unclear	Neutral	Clear	Very Clear
9	How do you perceive the difficulty level of the game?	3.6	0.57	Very Difficult	Difficult	Neutral	Easy	Very Easy
10	Did you find the game to be engaging and interactive during play?	4.48	0.5	Very Simple	Simple	Neutral	Difficult	Very Difficult
11	Has your understanding of Chinese improved after playing the game?	4.4	0.49	Very Boring	Boring	Neutral	Interesting	Very Interesting
12	Do you believe that learning Zhuyin contributes to the enhancement of your language sense?	4.31	0.47	Significantly Decreased	Decreased	No Change	Some Improvement	Significantly Improved
13	Were you able to smoothly convert Zhuyin symbols into text during the game?	3.52	0.58	Completely Useless	Useless	Neutral	Helpful	Very Helpful
14	If you have used idioms, how helpful do you find their use in the game?	4.42	0.58	No Interest at All	No Interest	Neutral	Interested	Very Interested
15	How would you rate your interest in learning Chinese language and literature?	3.85	0.58	Very Unconfident	Unconfident	Neutral	Confident	Very Confident
16	How do you feel about your self-efficacy in learning Chinese?	3.79	0.62	1	2	3	4	5

Figure 6 presents feedback from players of the Zhuyin Fuhao Rummikub game.

Figure 6. Results of player experience after participation (N=48)



Questions 6 to 16, “How would you rate your overall satisfaction with the Zhuyin Fuhao Rummikub game?” received an average score of 4.42. This indicates that participants generally expressed high satisfaction with the game. Specifically, 28 participants (58.3%) reported being satisfied, while 20 (41.7%) indicated they were “delighted.” This suggests that the players’ overall experience with the game was exceptionally positive, with all respondents being either satisfied or more than satisfied.

Regarding enjoyment, Question 10 revealed an average score of 4.48 for the level of interest, with 52% of participants having found the game enjoyable and approximately 48% as very interesting. This indicates that the game was perceived as highly engaging. According to the responses to Question 7, the clarity of the game rules received a favorable rating, with an average score of 4.08; 62.5% of participants selected “clear,” while 37.5% chose “very clear,” indicating that the instructions were communicated effectively. Question 8 yielded a high average score of 4.52, indicating that most participants found it easy to recognize Zhuyin symbols during the game.

Regarding learning outcomes, Question 11 demonstrated an average score of 4.4, indicating that participants generally felt their understanding of Zhuyin symbols improved after playing the game. Question 12 recorded an average of 4.31, suggesting that participants believed learning Zhuyin symbols significantly enhanced their language sensitivity. Similarly, Question 14 yielded an average score of 4.42, suggesting the usefulness of idioms in the game.

Concerning the game’s difficulty, however, Question 9 presented an average score of 3.6, indicating that participants rated the game’s difficulty as moderate. This may imply that the game presented a level of challenge suitable for players of varying skill ranges. Finally, the average scores for Questions 15 and 16 were 3.85 and 3.79, respectively, indicating that participants maintained a relatively high level of interest in learning Chinese and felt confident in their abilities.

Overall, these results suggest that the Zhuyin Fuhao Rummikub game performed well in promoting learning and increasing interest, while also demonstrating strong playability and interactivity, making it worthy of further promotion and development.

The Zhuyin Fuhao Rummikub board game developed by students in this study received positive feedback across various areas, including game experience and recommendations (4.42 out of 5), self-assessment of learning outcomes (4.31 out of 5), clarity of game rules and operational experience (4.52 out of 5), and learning motivation and self-efficacy (3.85 out of 5, and 3.79 out of 5). Among the 48

participants aged 7 to 18, these results demonstrate that the board game created by the students was highly effective and well-rated, thereby indicating its potential for successful application in Chinese language learning and teaching.

### **From Disinterest to Self-Motivation: Students' Transformation in Language Learning Through the Game-Design Module**

Student K (a pseudonym) identified as lacking self-confidence because of difficulty learning Chinese characters in sentences and sentence combinations in compositions. Negative phrases, such as “I am a language idiot” occasionally appear in life, and he needs to be encouraged to express them orally. Moreover, Student K appeared to be a frequent user of computer and mobile games. Student K was relatively confident in mathematics, where they were not so confident in written language skills. In accompanying Student K in playing board games, the authors discovered that Student K was interested in analogue gaming formats. This discovery occurred as the researchers were becoming aware of pedagogical strategies that incorporate board games as learning tools—and how integrating board games into teaching might enhance active student engagement and learning outcomes. Leveraging these new insights, popular board game activities were utilized to teach Student K sentence construction and idiomatic language usage skills; the goal was to guide the student in adopting a game designer perspective to problem-solving, rather than that of simply a player—this way, it was possible to harness the educational potential of gaming to boost Student K's motivation and self-confidence.

Reframing K's relationship to games through participating in the board game design module—a shift from passive consumer to active designer—catalyzed a multifaceted positive transformation in Student K's attitudes, behavior, and self-perceptions regarding their learning. Student K's hands-on experience of conceptualizing and creating their own board game design shifted their perspective from passive digital consumer to active game designer. Student K communicated that this process fostered a greater sense of accomplishment, as they could apply known strengths in mathematics and problem-solving to a creative task.

Engaging in the game design activities gave Student K a deeper appreciation for the design of games, beyond just playing them. Notably, Student K's parents observed that their child had shifted from a passive mindset of being drawn into digital games and now demonstrated a more proactive approach, actively considering how “game mechanics and strategies could be useful for my board game design.” Furthermore, Student K began engaging in more frequent discussions about board game design process with family members, suggesting increased communication and sharing of learning experiences. When playing other games, Student K made insightful comments such as, “Oh, that strategy could be useful for my board game design,” indicating a more active, analytical perspective on gaming. This shift from a passive instruction recipient to a self-motivated learner exemplifies the course's profound impact on this student's attitudes and learning behavior. Rather than reluctantly engaging with language-focused tasks, Student K now saw the practical value and necessity of developing strong oral communication skills to support their ambitions regarding game design. This intrinsic motivation to enhance language proficiency was a significant departure from their previous disinterest in non-mathematical subjects. By recognizing the real-world applications of language skills within the context of game development, Student K actively sought opportunities to improve oral communication skills. This example underscores the power of contextualizing learning within meaningful, student-centered activities to foster positive changes in student mindsets and behaviors.

Overall, the module was found to have harnessed Student K's enthusiasm for learning and guided this student toward a more balanced, constructive relationship with games and academic study, ultimately improving their self-confidence and self-perception. The multifaceted positive outcomes for Student K highlight the transformative potential of engaging students in hands-on, meaningful design tasks that bridge their interests and academic growth.

## Comparative Analysis of Students Who Participated in the Game Design Process: H and W's Experiences With Task-Oriented, Game Design Learning

When the game development study concluded, semi-structured interviews were conducted with the other two students involved in the process, in addition to the interview conducted with Student K. Below are some noteworthy points extracted from the wider interview process, including an analysis of the interviews with Students H and W, outlining both their similarities and differences.

The first area of note was the change in student interest regarding language learning. After participating in the Zhuyin-Rummikub board game design process, both Student H and Student W expressed an increased interest in language learning. Student H stated: "After playing Rummikub, I found I was more interested in learning languages." Student W mentioned: "After playing, I felt less resistant to learning Zhuyin."

Both students noted that, while facing challenges in the game, they also enjoyed the learning experience. Student H said: "The more you play, the more it enhances your learning." Student W commented: "It wouldn't be as dry as usual." After participating in the games, both students reported a boost in their confidence regarding learning and exams. Student H expressed: "I feel more confident in writing and exams." Student W mentioned: "I felt more willing to learn Zhuyin and some idiomatic expressions."

Both students interacted with classmates during the games, and their responses emphasized the importance of collaborative learning. Student H noted: "I might invite them to play this game in the future." Student W stated: "[We] just played the board game together, and from there we could learn some uses of Zhuyin."

There emerged some differences between the two students, regarding interest in language learning. Although indicating no initial dislike of language learning, Student H shared that their interest increased with participation in the game, stating, "After playing Rummikub, I found I was more interested in learning languages." Student W, on the other hand, indicated a low level of interest in language learning, rating it between "three to five," however it increased to "seven or eight" after participating in the game—that "after playing, I felt less resistant to learning Zhuyin."

Regarding specific learning challenges, Student H mentioned having difficulty in understanding classical Chinese literature and poetry, saying: "I find it hard to understand ancient texts and poetry." Student W stated that while learning Zhuyin, some sounds were difficult to distinguish, and the work required a lot of memorization, noting that: "Some sounds are hard to differentiate, and it takes a lot of memorization."

Student H participated in the development of the Rummikub game, with involvement ranging from the initial prototype to the improved version, declaring that: "I was involved in testing and improving the game." Student W engaged primarily in the learning process of existing games and did not directly partake in design or development. Student W remarked: "[We] just played the board game together, and from there we could learn some uses of Zhuyin." Student H noted that it was easy to focus on Rummikub without wanting to play mobile games simultaneously, stating: "I can concentrate on Rummikub without being distracted by mobile games." Student W did not mention the impact of mobile games but mainly focused on the challenges encountered in the learning process. Student W commented: "I was more focused on the challenges of learning Zhuyin."

These similarities and differences indicate that while both students benefited positively from game-based learning, enhancing motivation and confidence, they each differed regarding their initial interest in language learning, specific challenges encountered in the experience, and the process of participation. These factors may have influenced their experiences and outcomes in game-based learning.

In addition, parents' observation of student H and student W were gathered through ..., Student W's parent observed: "W has enjoyed playing board games since childhood, likely due to being an only child; the game-design process has provided him with opportunities for interaction and socialization." Through these games, Student W developed a sense of group rules and communication skills,

enhancing their courage, verbal abilities, and self-confidence while allowing enjoyment of the process. Despite a busy academic schedule, Student W remains enthusiastic about participating in game development activities, demonstrating strong interest and ongoing motivation. In contrast, the parents of Student H noted: “[Student H’s] earlier understanding and expression were somewhat fragmented and lacked systematic coherence, often leading to inconsistent logic.”

Student H demonstrated significant improvement over the study, becoming more systematic in organizing information and self-expressing, with noticeable improvements in the fluency and completeness of sentences, presumably due to involvement in game-based learning. The families of both students indicated that task-oriented game-design learning positively impacted their respective student’s social skills, language expression, and self-confidence. Despite their differing backgrounds and traits, Students W and H gained valuable experiences and skills through playing games, suggesting that future game-based learning activities could be tailored to individual student characteristics to promote overall development.

### Student Attitudes and Engagement Transformed by Collaborative Communication Implemented in the Curriculum

To see whether the curriculum had a positive impact on students, dialogue records between parents and teachers were analyzed (Table 9 and Table 10). These records revealed a remarkable transformation in student attitudes and engagement throughout the classes. Initially, one student exhibited a reluctant and sour disposition, resisting attendance and expressing discomfort. However, a significant positive change emerged through the teacher’s guidance and the student’s progress.

Figure 7. Progress in week 5



Note. This graph presents the task-oriented activities of week 5, which included the following. (a) Students learned to use digital vector illustrations of their designs, such as Inkscape. (b) Students learned to test-cut their digital designs using the laser cutter, gaining hands-on experience with the product manufacturing process. (c) Students learned to run their digital files on the laser cutter in the initial trial. (d) Students arranged, organized, and inventoried the wooden tiles



**Table 9. Observing and analyzing student attitudes and participation changes through parent-teacher dialogue**

Timeframe	Mother's Observations	Teacher Observations	Student Attitude
Before class begins	<ul style="list-style-type: none"> <li>- The student had a tantrum and was not in a good mood.</li> <li>- The student said he wanted to attend class first before deciding whether to continue.</li> </ul>	<ul style="list-style-type: none"> <li>- Student had a sour face when he came to class</li> </ul>	<ul style="list-style-type: none"> <li>- Student was reluctant to attend class</li> </ul>
1st week after class	<ul style="list-style-type: none"> <li>- Student is okay at math but tends to be careless and reads questions slowly</li> </ul>	<ul style="list-style-type: none"> <li>- Student is very good at math.</li> <li>- Student has much potential in reaction time and logical thinking skills</li> </ul>	<ul style="list-style-type: none"> <li>- Student agreed to continue attending the classes</li> </ul>
3rd week after class	<ul style="list-style-type: none"> <li>-The student's class has poor overall academic performance, so he still has much to work on.</li> <li>- Student will be happy if he does not have to write.</li> </ul>	<ul style="list-style-type: none"> <li>- Student analyzed the strategies for the board games and seemed very happy</li> <li>- Student happily said goodbye after class</li> <li>- Student is doing quite well, starting from not resisting attending the class</li> </ul>	<ul style="list-style-type: none"> <li>- Student became engaged and happy during the classes</li> </ul>
4th week after class	<ul style="list-style-type: none"> <li>- Student recorded many things in his class notebook and mentioned working with a teaching assistant</li> </ul>	<ul style="list-style-type: none"> <li>- Student's progress is quite good</li> <li>- Student has organized some of the game rules he designed, and the concepts of game strategy are becoming more apparent through recording them</li> <li>- Student raised some views and had some insights and analysis on the first version of the rules, and he plans to adjust the rules</li> </ul>	<ul style="list-style-type: none"> <li>- Student became more analytical and organized in his approach to the board game design</li> </ul>
5th week after class		<ul style="list-style-type: none"> <li>- Student's board game has transitioned from a paper prototype to a physical, realized form</li> </ul>	<ul style="list-style-type: none"> <li>- Student is excited to test and refine the self-designed board game</li> </ul>
6th week after class	<ul style="list-style-type: none"> <li>- The student is looking forward to having others play his board game.</li> <li>- He has proactively asked about taking a public speaking course</li> </ul>	<ul style="list-style-type: none"> <li>The student brought up the idea of taking a public speaking course, which is a course he used to resist strongly in the past.</li> </ul>	<ul style="list-style-type: none"> <li>- Student is now proactively seeking to improve his skills to present his work</li> </ul>
After the whole course	<ul style="list-style-type: none"> <li>- Student now enjoys attending the classes</li> </ul>	<ul style="list-style-type: none"> <li>- Student seems much more cheerful now than the first time he attended the class</li> </ul>	<ul style="list-style-type: none"> <li>- Student has become more engaged and enthusiastic about the classes</li> </ul>

**Table 10. Questionnaire developed by students for players' experiences and feedback**

No.	Category	Characteristics	Question Description
1	Basic Information	-	What is your age range?
2		-	What is your biological sex?
19	Game Improvement and Future Development	Social Interaction and Proactivity	What suggestions do you have for improving the game?
20			What new elements would you like to see added in future games?

*continued on following page*

Table 10. Continued

No.	Category	Characteristics	Question Description
6	Game Rules and Operational Experience	Contextualization	How would you rate your overall satisfaction with the Zhuyin Rummy game?
7			Do you think the game rules are clear and easy to understand?
8			Were you able to easily recognize the Zhuyin symbols during the game?
13			Were you able to smoothly convert Zhuyin symbols into text during the game?
9	Game Difficulty and Challenges	Challenge	How do you perceive the difficulty of the game?
3	Game Experience and Recommendations	Proactivity: Player Engagement	Have you ever played a Rummy-type game before?
4			Would you recommend this game to others?
10		Social Interaction: Emphasizing Interaction with Other Players	Did you find the game enjoyable and interactive?
5	Self-assessment of Learning Outcomes	Experiential: Emphasizing Learning Experience Gained from the Game	Have you noticed an increase in the number of times you thought about idioms during the game?
11			After playing, did your understanding of Zhuyin symbols improve?
12			Do you believe that learning Zhuyin symbols helps enhance your language sensitivity?
14		Problem-Based	If you have used idioms, how helpful do you think their use is in the game?
17			Which elements of the game do you think are most beneficial for learning Chinese?
15	Learning Motivation and Self-Efficacy	Intrinsic Motivation	How interested are you in learning Chinese?
16			How do you feel about your self-efficacy in learning Chinese?
18			What do you believe is the primary motivation for learning Chinese?

The student, although initially resistant, agreed to continue attending the classes beyond the first week. The student presented as increasingly engaged and happy as the classes progressed, actively analyzing game strategies and enthusiastically sharing insights. The student’s analytical and organizational skills also improved, as evidenced by detailed notetaking and plans to refine the game rules. The most striking transformation occurred in the latter stages of the course, where the student proactively sought to improve their presentation skills by inquiring about extra public speaking training—a course previously resisted. Furthermore, the student looked forward to having others play a board game they had designed themselves, demonstrating a newly found pride and enthusiasm.

The differences in observations between the mother and teacher highlight the importance of collaborative communication in understanding a student’s development. While the mother in this case initially expressed concerns about the student’s reluctance and academic performance, the teacher’s insights revealed the student’s strengths and potential. This collaborative approach enabled a more comprehensive understanding of the student’s progress, leading to the remarkable transformation witnessed over the course of the classes.

## Expanding Vocabulary With Zhuyin Fuhao-Based Board Game Designed by Students

During the iterative and testing process over a period of a few weeks, the teacher asked the students to record the vocabulary and Zhuyin Fuhao that they used in their self-designed games. It was revealed, in addition to using four-character idioms for the icebreaker phase, that the students also occasionally incorporated five-character Tang Dynasty poetry, along with some common expressions. Some of these outcomes are shown in Figure 10. The corresponding Zhuyin phonetic notions used are listed in Tables 11, 12, 13, and 14.

Figure 8. Gameplay outcome displays from students' tests in weeks 5 and 6



Note. Image “a” shows the sequential arrangement of Zhuyin-based board game tile formations. Image “b” shows that the laser cutter cut the student-designed Zhuyin phonetic tiles. Images “c”–“e” shows students' gameplay outcomes, with corresponding Zhuyin phonetic notations and idiomatic expressions in tables 11-14.

Table 11. Corresponding Zhuyin phonetic notions and idiomatic expression used in student gameplay in Fig 8-(c)

The first Zhuyin letter	The tiles that student used in the Fig 8-(c)	The real phrases	The whole Zhuyin of the phrases
ㄨ	ㄨ ㄨ ㄩ	一五一十	ㄨ ㄨ ㄩ
ㄉ	ㄉ ㄉ	等待	ㄉ ㄨ ㄉ ㄩ
ㄉ	ㄉ ㄉ	忐忑	ㄉ ㄩ ㄉ ㄨ
ㄎ	ㄎ 、 ㄎ ㄨ	請客	ㄎ ㄨ ㄨ ㄎ ㄨ
ㄇ	ㄇ 、 ㄍ	木瓜	ㄇ ㄨ ㄍ ㄨ ㄩ
ㄅ	ㄅ 、 ㄇ	比賽	ㄅ ㄨ ㄇ ㄩ

continued on following page

Table 11. Continued

The first Zhuyin letter	The tiles that student used in the Fig 8-(c)	The real phrases	The whole Zhuyin of the phrases
一	一、尸、二、ㄋ	一石二鳥	一尸儿ㄋ一ㄠ
ㄟ	ㄟ、ㄨ	澄清	ㄟㄨㄨㄨㄨ
ㄨ	四、ㄇ、八、ㄨ	四面八方	ㄨ一ㄇ一ㄋㄋㄨㄨㄨ
ㄒ	ㄒ、日	信任	ㄒ一ㄨ日ㄨ
ㄨ	ㄨ、一、ㄒ	皮影戲	ㄨ一ㄨㄨㄨㄨ
ㄨ	ㄨ、ㄨ	胃口	ㄨㄨㄨㄨ
ㄖ	ㄖ又、一ㄨ	走音	ㄖ又ㄨㄨ
ㄨ	ㄨ、ㄨ	預算	ㄨㄨㄨㄨ
ㄨ	@ㄨㄨㄨㄨㄨ	黃河入海流	ㄨㄨㄨㄨㄨㄨㄨㄨㄨㄨㄨ
ㄨ	ㄨ、ㄨ、ㄨ	跑步機	ㄨㄨㄨㄨㄨㄨ
ㄋ	ㄋ、儿	鳥兒	ㄋ一ㄠ儿

Table 12. Corresponding Zhuyin phonetic notions and idiomatic expression used in student gameplay in Fig 8-(d)

The first Zhuyin letter	The tiles that student used in the Fig 8-(d)	The real phrases	
ㄨ	ㄨ、ㄨ	等待	ㄨㄨㄨㄨ
一	一、ㄨ、ㄨ	一五一十	一ㄨㄨㄨㄨ
ㄨ	ㄨ、ㄨㄨ	請客	ㄨㄨㄨㄨ
一	一、尸、二、ㄋ	一石二鳥	一尸一儿ㄋ一ㄠ
ㄨ	ㄨ、日、一、尸、ㄨ	白日依山盡	ㄨㄨ日一尸ㄨㄨㄨ
ㄨ	ㄨ、ㄟㄨ、ㄨ	預產期	ㄨㄨㄟㄨㄨㄨ

Table 13. Corresponding Zhuyin phonetic notions and idiomatic expression used in student gameplay in Fig 8-(e)

The first Zhuyin letter	The tiles that student used in the Fig 8-(e)	The real phrases	The whole Zhuyin of the phrases
ㄨ	ㄨ、尸	淡水	ㄨㄨ尸ㄨㄨ
ㄨ	ㄨ、ㄒ	螃蟹	ㄨㄨㄨㄨㄨ
儿	儿、ㄨㄨ	洱海	儿ㄨㄨ
日	日、ㄟ	日出	日ㄟㄨ
ㄨ	ㄨㄨ、ㄇ	散漫	ㄨㄨㄨㄨ
ㄨ	ㄨㄠ、ㄨ	陶瓷	ㄨㄠㄨ
尸	尸、ㄨ	石頭	尸ㄨㄨ
ㄋ	ㄋ一ㄠ、ㄋㄨ	牛奶	ㄋ一ㄠㄋㄨ

continued on following page

Table 13. Continued

The first Zhuyin letter	The tiles that student used in the Fig 8-(e)	The real phrases	The whole Zhuyin of the phrases
ㄅ	ㄅㄣ、ㄉ、ㄐ	肯德基	ㄅㄣ ㄉㄛ ㄐㄟ
ㄨ	@、儿	偶爾	ㄨ 儿
ㄎ	ㄎ、ㄐ	奇蹟	ㄎㄟ ㄐㄟ
ㄘ	ㄘ、ㄉ	專欄	ㄘㄨㄛ ㄉㄛ
ㄉ	ㄉㄛ、ㄆ	籃子	ㄉㄛ ㄆ
ㄌ	ㄌㄣ、@-ㄨ	醞釀	ㄌㄣ ㄣㄟ-ㄨ
ㄍ	ㄍ、ㄍㄩ	尷尬	ㄍㄣ ㄍㄛ
ㄑ	ㄑㄨㄥ、ㄘ、ㄎ	蔥抓餅	ㄑㄨㄥ ㄘㄨㄥㄩ ㄎㄟ

Table 14. Corresponding Zhuyin phonetic notions and idiomatic expression used in student gameplay in total

The first Zhuyin letter	The tiles that student used in the Fig 8-(e)	The real phrases	The whole Zhuyin of the phrases
ㄅ	ㄅㄣ-ㄉㄛ ㄐ	白日依山盡	ㄅㄣ ㄉㄟ-ㄉㄛ ㄐㄟ-ㄣ
	ㄅㄣ @@@ㄉ	八九不離十	ㄅㄣㄩ ㄐㄟ-ㄨㄛ ㄅㄣ ㄎㄟ-ㄉ
	ㄅㄣ、ㄌㄛ	半圓	ㄅㄣ ㄌㄛ
	ㄨㄣ	跑步/漂白	ㄨㄣ ㄨㄨ / ㄨㄣ-ㄨㄣ ㄨㄨ
	ㄅㄣ	波斯	ㄨㄣ ㄅㄣ
	ㄌㄣㄎㄣ	四面八方	ㄌㄣ ㄎㄟ-ㄈㄣ ㄎㄟㄩ ㄎㄟ
ㄨ	ㄨㄣ	跑步/漂白	ㄨㄣ ㄨㄨ / ㄨㄣ-ㄨㄣ ㄨㄨ
	ㄐ、ㄨㄨ	雞排	ㄐㄟ-ㄨㄨ
	ㄉㄣㄨㄘ	如法炮製	ㄉㄣ ㄨㄣㄩ ㄨㄣ ㄨㄘ
ㄎ	ㄌㄣㄎㄣ	四面八方	
	ㄎㄣ	玫瑰	ㄎㄣ ㄎㄣ
	ㄌㄣㄎㄣ	四面八方	
ㄎ	ㄎ、ㄨㄩ	分岔	ㄎㄣ ㄨㄩ
	ㄌㄣㄎㄣ	四面八方	
ㄉ	ㄉㄉ	等待	ㄉㄣ ㄨㄨ
ㄊ	ㄊㄅ	投靠	ㄊㄟ ㄨㄨ ㄊㄟ
ㄋ	ㄋㄟ-ㄨㄣ、ㄋ	牛奶	ㄋㄟ-ㄨㄣ ㄋㄟ
	ㄊㄣㄨㄉ	婀娜多姿	ㄊㄣ ㄎㄟㄨㄣ ㄊㄣ ㄊㄟ
ㄉ	ㄉㄨㄛ、ㄊ	亂想	ㄉㄨㄛ ㄊㄟ-ㄨ
ㄍ	ㄎㄣ、ㄍㄣ	飯羹	ㄎㄣ ㄍㄣ
ㄅ	ㄅㄣ、ㄨ	啃食	ㄅㄣ ㄨ
ㄆ	ㄆㄟ	孩子	ㄆㄟ ㄆㄟ

continued on following page

Table 14. Continued

The first Zhuyin letter	The tiles that student used in the Fig 8-(e)	The real phrases	The whole Zhuyin of the phrases
	ㄈㄨㄨㄚˊ ㄌㄢ	花園	ㄈㄨㄨㄚˊ ㄌㄢ
ㄐ	ㄐㄩㄥ	九牛二虎	ㄐㄩㄥ ㄋㄩㄥ ㄉㄨㄥ ㄉㄨㄥ
	ㄐㄨㄚˊ ㄐㄨㄚˊ	九流十家	ㄐㄩㄥ ㄋㄩㄥ ㄐㄨㄚˊ ㄐㄨㄚˊ ㄐㄨㄚˊ ㄐㄨㄚˊ
	ㄅㄩㄥ ㄉㄞ ㄐㄨㄚˊ	白日依山盡	
ㄍ	ㄍㄨㄥ ㄌㄢ ㄍㄨㄥ	逡巡	ㄍㄨㄥ ㄌㄢ ㄍㄨㄥ
ㄊ	ㄊㄨㄥ ㄉㄨㄥ	笑裡藏刀	ㄊㄨㄥ ㄉㄨㄥ ㄐㄨㄚˊ ㄐㄨㄚˊ ㄉㄨㄥ
ㄗ	ㄗㄨㄥ	窒息	ㄗㄨㄥ ㄉㄞ
ㄨ	ㄨㄥ	除夕	ㄨㄥ ㄉㄞ
	ㄘㄨㄥ ㄉㄞ ㄩ	分岔	
ㄆ	ㄆㄨㄥ ㄌㄢ	一石二鳥	ㄆㄨㄥ ㄌㄢ ㄉㄞ
	ㄅㄩㄥ ㄐㄨㄚˊ ㄐㄨㄚˊ	八九不離十	
	ㄅㄩㄥ ㄉㄞ ㄐㄨㄚˊ	白日依山盡	
ㄇ	ㄇㄨㄥ ㄉㄞ	日出	ㄇㄨㄥ ㄉㄞ
	ㄅㄩㄥ ㄉㄞ ㄐㄨㄚˊ	白日依山盡	
	ㄅㄩㄥ ㄐㄨㄚˊ ㄐㄨㄚˊ	八九不離十	
ㄆ	ㄆㄨㄥ	子宮	ㄆㄨㄥ ㄍㄨㄥ
ㄑ	ㄑㄨㄥ ㄑㄨㄥ	陶瓷	ㄑㄨㄥ ㄑㄨㄥ
ㄇ	ㄇㄨㄥ	撕碎	ㄇㄨㄥ ㄍㄨㄥ
	ㄅㄩㄥ	波斯	
	ㄇㄨㄥ ㄍㄨㄥ	四面八方	
一	ㄉㄨㄥ ㄉㄞ	一五一十	ㄉㄨㄥ ㄉㄞ
	ㄆㄨㄥ ㄌㄢ	一石二鳥	ㄆㄨㄥ ㄌㄢ ㄉㄞ
	ㄅㄩㄥ ㄉㄞ ㄐㄨㄚˊ	白日依山盡	ㄅㄩㄥ ㄉㄞ ㄐㄨㄚˊ ㄐㄨㄚˊ ㄐㄨㄚˊ
ㄨ	ㄉㄨㄥ ㄉㄞ	一五一十	ㄉㄨㄥ ㄉㄞ
ㄌ	ㄌㄢ ㄉㄞ ㄐㄨㄚˊ ㄍㄨㄥ	預產期	ㄌㄢ ㄉㄞ ㄐㄨㄚˊ ㄍㄨㄥ
	ㄅㄩㄥ ㄐㄨㄚˊ ㄐㄨㄚˊ	半圓	ㄅㄩㄥ ㄐㄨㄚˊ ㄐㄨㄚˊ
	ㄌㄢ ㄉㄞ ㄍㄨㄥ	月掃	ㄌㄢ ㄉㄞ ㄍㄨㄥ
ㄩ	ㄘㄨㄥ ㄉㄞ ㄩ	分岔	ㄘㄨㄥ ㄉㄞ ㄩ
ㄘ			
ㄘ	ㄘㄨㄥ ㄉㄞ ㄐㄨㄚˊ	婀娜多姿	ㄘㄨㄥ ㄉㄞ ㄐㄨㄚˊ ㄐㄨㄚˊ ㄐㄨㄚˊ
ㄘ	ㄌㄢ ㄉㄞ ㄍㄨㄥ	月掃	ㄌㄢ ㄉㄞ ㄍㄨㄥ
ㄎ	ㄎㄨㄥ	矮子	ㄎㄨㄥ
ㄨ			
ㄨ	ㄌㄢ ㄉㄞ ㄍㄨㄥ	月掃	ㄌㄢ ㄉㄞ ㄍㄨㄥ
ㄨ	ㄨㄥ ㄉㄞ	偶然	ㄨㄥ ㄉㄞ

continued on following page

Table 14. Continued

The first Zhuyin letter	The tiles that student used in the Fig 8-(e)	The real phrases	The whole Zhuyin of the phrases
	ㄨ ㄦ	偶爾	ㄨ ㄦ
ㄇ	ㄨ ㄇ	平安	ㄨ - ㄥ ㄇ
ㄣ	ㄣ ㄥ	恩惠	ㄣ ㄥ ㄨ ㄟ
ㄨ	ㄥ ㄨ、一	行業	ㄥ - ㄥ 一 ㄟ
ㄥ	ㄥ ㄇ、ㄥ ㄥ	飯羹	ㄥ ㄇ ㄥ ㄥ
	ㄥ、ㄥ ㄥ	麵羹	ㄥ - ㄇ ㄥ ㄥ
ㄦ	ㄦ ㄆ	兒子	ㄦ ㄆ
X	@ ㄥ ㄇ ㄥ ㄥ	黃河入海流	ㄥ ㄨ ㄦ ㄥ ㄟ ㄇ ㄨ ㄥ ㄥ ㄥ
	ㄣ ㄨ @ @ ㄆ	八九不離十	ㄣ ㄨ ㄨ - ㄨ ㄣ ㄨ ㄥ ㄥ ㄆ

### From Apathy to Empathy

One of the functions of games is to enhance social interaction. When the teacher asked the students about the rationale behind the game rules, the student provided a response that demonstrated empathy, revealing an additional valuable aspect of the course. The student provided useful feedback regarding the rules for the “icebreaking” phase of the game. For the “icebreaking” phase, using four similar characters was deemed acceptable, as this could strengthen the confidence of players possessing limited idiom knowledge. Additionally, having these four same characters belonging to one player increased the difficulty for others when forming complete idioms. The rule for the same four characters in icebreaking enhanced the game’s fairness.

### Alternatives to Laser Cutting and Laser Engraving

Even without access to laser cutting or laser engraving equipment, the instructor was still able to guide students through designing game components, using alternative media such as corrugated cardboard or thick paper stock. While the substrate differed, the fundamental objective remained: To lead students through the transition from abstract conceptual ideas to tangible physical forms.

In this scenario, the instructor was able to adapt the instructional approach to adjust for available resources in the learning environment. Rather than relying on the laser cutter, for example, students employed manual cutting, scoring, and assembly techniques to transform their digital vector designs into physical prototypes. This flexible approach ensured that the core learning goals were not compromised, even if the specific fabrication methods were adjusted to suit the constraints of the classroom or workshop setting.

By guiding students through converting their visual ideas into physical game components, regardless of the chosen medium, the instructor reinforced the essential skills and mindset required for successful product development. Students learnt to think critically about the relationship between their digital designs and materializing those ideas into physical form, a crucial competency for any designer or maker working in board game creation.

The instructor’s ability to adapt the instructional approach while maintaining the integrity of the learning objectives demonstrated a versatile and learner-centric teaching philosophy. This adaptability empowered students to focus on the core design and fabrication principles, rather than being constrained by the availability of specific technologies. Ultimately, this flexible approach ensured that students gained a robust and transferable skillset able to be applied in various contexts, both in and beyond board game development.

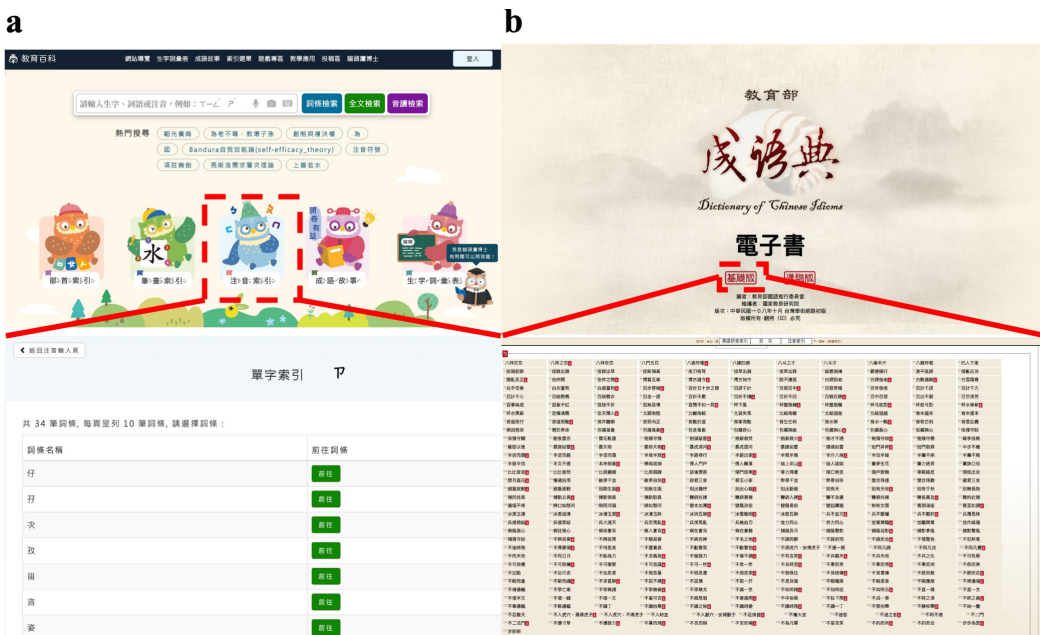
## FURTHER RECOMMENDATIONS

### Utilizing Online Vocabulary Resources for Effective Classroom Teaching and Combining Them With the Zhuyin Rummikub Board Game

Regarding the sources of the idiom vocabulary database, in addition to traditional idiom dictionaries or paper-based dictionaries, if classroom equipment is sufficient and internet access is convenient, teachers can also guide students to use online vocabulary search tools. Two websites are provided here that teachers can utilize for instructional purposes, and included in References: The Ministry of Education’s idiom dictionary, hosted by the National Academy for Educational Research (<https://dict.idioms.moe.edu.tw/search.jsp>); and the education encyclopedia on the education cloud platform, <https://pedia.cloud.edu.tw/>.

The education cloud platform’s education encyclopedia website has a “Doctor Owl” button, allowing interactive dialogue. This dialogue interface is explicitly designed for vocabulary-related inquiries (Figure 11). As Figure 11 demonstrates, teachers can guide students to utilize the phonetic symbol-based word search feature. Of course, teachers can also lead students in using the idioms and Zhuyin Fuhao as provided by the Open AI dialogue assistant. This enables students to acquire and leverage additional vocabulary resources in activities like the Zhuyin Rummikub board game. This approach enhances the efficiency of games and indirectly fosters student agency and vocabulary acquisition.

Figure 9. Utilization of online vocabulary resources



Note. Image “a” shows the education encyclopedia on the education cloud platform. Use the Zhuyin character to search for related phrases. Image “b” shows the Ministry of Education’s idiom dictionary is hosted by the National Academy for Educational Research.



Figure 10. Utilization of open AI as the vocabulary resource



Note. Image “a” shows the interactive dialogue service of the education encyclopedia. The teacher could guide students to chat with the interactive helper, for students to have deeper and instant responses to their questions. Image “b” shows the Open AI dialogue assistant providing idioms with Zhuyin Fuhao.

### Applications and Value of the Bopomofo Rummikub Game

For foreign learners, acquiring Chinese idioms and classical poetry typically presents a significant challenge. Regarding idioms, the difficulty arises from several factors. Idioms are often composed of four characters and implanted with rich cultural connotations and historical allusions. The literal meaning of an idiom frequently diverges from its actual usage, requiring deep familiarity with Chinese culture. Furthermore, the appropriate contextual application of idioms is demanding, as improper usage can impede effective communication. Additionally, the sheer volume of Chinese idioms necessitates extensive memorization and comprehension.

Learning classical Chinese poetry also poses substantial difficulties. The complex poetic structures, with their specific rules governing tonal patterns and rhyme schemes, creates obstacles for non-native learners. The poems often contain implicit metaphors and historical references, requiring a profound understanding of Chinese history and culture. Classical poetry’s highly concise and refined language demands careful consideration and fine appreciation. Developing the specialized cognitive mindset and aesthetic sensibilities required for composing and appreciating Chinese poetry further compounds the challenge for international learners.

For beginners, Pinyin can be used as an introduction, but learners still need to gradually transition to Zhuyin phonetic symbols when learning idioms. Compared with the Pinyin system, Zhuyin symbols can better reflect the subtle pronunciation changes in idioms and help to understand the meaning of idioms accurately. At the same time, learners must systematically study an idiom’s formation, history, and cultural background to deeply understand their connotations and foster a deeper appreciation for Chinese culture.

## Recommended Extensions of the Zhuyin Fuhao-Integrated Game-Based Learning Module

Extended activities can be categorized into three main types. After students complete the Zhuyin Fuhao-integrated Rummikub game design module, teachers can then guide students to the next stage of cognitive development, based on their learning progress. Teachers can also lead students to delve deeper into the relevant content through these extended activities and competitions. For instance, in independent research competitions, students can utilize their Zhuyin Fuhao Rummikub game design skills to explore the mathematical permutations and combinations of the Zhuyin Fuhao symbols. While the content may be complex, teachers can help students establish a logical framework that integrates language learning with affinity for mathematics.

Furthermore, promoting lifelong learning and self-directed learning is crucial. Teachers can guide and encourage students to document and analyze the process of designing their own board game. In addition to recording the process in their learning portfolios, students can also organize and synthesize their experiences to participate in self-directed learning exploration competitions, showcasing the game they have developed based on this task-oriented game-based learning module. This can help promote the module to more teachers and students. Additionally, teachers can guide students in conducting a scientific and logical analysis of their game design process and organize their findings into creative and practical science fair exhibits and activities, including posters or physical prototypes, for competitions and presentations. For a teacher-designed questionnaire to help use the student-designed game explored in this article, please see Table 15.

**Table 15. Questionnaire for future course module**

		Strongly disagree	Disagree	Slightly disagree	Mildly agree	Agree	Strongly agree
Autonomy	I could choose different strategies and actions during the board game design process.	1	2	3	4	5	6
	I am willing to proactively think about and explore the rules and gameplay of the board game.	1	2	3	4	5	6
	I can independently control my decision-making and actions within the board game.	1	2	3	4	5	6
Experience	I can acquire a profound learning experience through this board game.	1	2	3	4	5	6
	The interactions in this board game can arouse my curiosity and desire for exploration.	1	2	3	4	5	6
	I can fully immerse myself in the context of the board game.	1	2	3	4	5	6
Contextualization	The context of the board game can effectively simulate the real-world contexts where the vocabulary is used.	1	2	3	4	5	6
	I can connect the vocabulary in the board game and my life experiences.	1	2	3	4	5	6
	The context of this board game can facilitate my learning and understanding of the vocabulary.	1	2	3	4	5	6
Sociality	I will share my insights and strategies about the board game with my peers.	1	2	3	4	5	6
	I will proactively discuss the board game's problems and solutions with my peers.	1	2	3	4	5	6
	I will collaborate or discuss with my peers to complete the tasks in the board game.	1	2	3	4	5	6

*continued on following page*

Table 15. Continued

		Strongly disagree	Disagree	Slightly disagree	Mildly agree	Agree	Strongly agree
Intrinsic Motivation	I will proactively invest time and effort to explore the board game.	1	2	3	4	5	6
	I will participate because of my inherent interest in the board game itself.	1	2	3	4	5	6
	I will continue to participate because of the inherent enjoyment of the board game.	1	2	3	4	5	6
Problem-Oriented	The boardgame can guide me in thinking about and solving real-world problems.	1	2	3	4	5	6
	The challenges in the board game can stimulate me to seek out solutions.	1	2	3	4	5	6
	The process of the board game can promote my critical thinking (reasoning, evaluation, innovation, reflection).	1	2	3	4	5	6

## LIMITATIONS OF THE ZHUYIN FUHAO INTEGRATED GAME-BASED LEARNING MODULE

This study was subject to several limitations that may affect the generalizability and applicability of its findings. Firstly, the sample size was constrained due to the nature of the course, which involved leading students in game design and development. Consequently, the sample of players and feedback from the experimental group were influenced by time and spatial limitations inherent to the course structure. Unlike larger research projects with more substantial funding and resources, this study could not accommodate extensive sample testing, potentially limiting the extrapolation of results to a broader population.

Additionally, the curriculum design and implementation of the Zhuyin Fuhao Rummikub board game faced specific challenges. The resource requirements for materials and tools, such as traditional Rummikub games, increased costs and preparation time. The diversity of student language abilities and learning styles may have impacted the effectiveness of this game-based learning approach, as some students might not have been interested, or may have struggled to adapt to the game format.

Time constraints also restricted the depth of exploration into phonetic and language concepts, while the effectiveness of implementation depended on the teacher’s familiarity with the game. Technical issues related to digital tools further hindered the course’s progression. Lastly, the informal nature of the game presented challenges in assessing student learning outcomes, particularly in quantifying effectiveness.

Despite these limitations, the study garnered numerous positive responses. In addition to quantitative data, researchers conducted qualitative observations and comparative analyses of participating students, which still provide valuable insights into this field. Authors are actively exploring opportunities for future funding to conduct larger-scale promotions and tests, aiming to provide more students with alternative learning experiences within relevant curricular areas. The authors hope this initiative will serve as a catalyst for other educators and scholars interested in future course development.

Additionally, for users who are unfamiliar with the use of Zhuyin (Bopomofo), it is recommended not to use Zhuyin for the Rummikub game. Instead, students should be encouraged to utilize this game development module to engage in game creation. Furthermore, for educators interested in Zhuyin Rummikub, a comparison of Pinyin and Zhuyin is provided to facilitate further exploration and application. This information is made available by the Ministry of Education at the following URL: <https://reurl.cc/IN2rQI> (Ministry of Education, 2025).

## CONCLUSIONS

The Zhuyin Fuhao Rummikub board game developed by the students has the potential for interdisciplinary application and can also serve as an effective vehicle for promoting diverse learning. From a linguistic perspective, this game helps international learners of the Chinese language and young students master the Chinese phonetic system; it also provides them with a deeper understanding of Chinese idioms and culture. Additionally, this module can be expanded to train pronunciation rules for other languages. In mathematics education, guiding students through game design involves mathematical operations such as combinations, arrangements, and calculations, which helps cultivate learners' logical thinking and reasoning abilities.

Furthermore, as this task-oriented module is integrated into game-based learning activities, students can actively participate in the design and improvement of the game, thereby unleashing their creative thinking. Students can apply relevant mathematical principles and linguistic knowledge to scientific practice, demonstrating autonomous learning and a spirit of inquiry. Teachers can also flexibly incorporate this game into interdisciplinary teaching of language and science, technology, engineering, arts, and mathematics teaching, stimulating learning interests and enhancing classroom participation and interactivity. For example, the game's requirement of designing and producing game cards can be combined with the practical technology course, and the need for artistic design can be integrated with art and other courses through collaborative teaching. In summary, the task-oriented Zhuyin Fuhao Rummikub game contains potential for rich interdisciplinary application, providing a valuable teaching approach to promote the diverse development of learners.

## CONFLICTS OF INTEREST

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## CORRESPONDING AUTHOR

Correspondence should be addressed to Chih-Yun Chiang (Taiwan, chyuchiang@gmail.com)

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*Heng Sheng Lin received his PhD from National Cheng Kung University. He has delivered numerous educational lectures and served as a teacher, at both secondary school and university levels. He is currently a researcher at the Artificial Intelligence for Digital Transformation Research Center, at National Cheng Kung University. In recent years, through observing children's activities and leading them in creative thinking exercises, Dr. Lin now designs curricula to enhance student motivation. His current research focuses on how students and teachers can exchange science-related ideas, use logical thinking, and deepen comprehension. Dr Lin can be contacted by email: t58601109520@gmail.com.*

*Chih Yun Chiang received her PhD from National Cheng Kung University. She has served as a teacher at school for several years and researches non-traditional and innovative ways of guiding students in their learning. Dr. Chiang collaborates with Dr. Lin in designing curricula to student learning delivered numerous educational lectures—her current research focuses helping students visualize their thoughts related to science. Dr. Chiang can be contacted by email: chyuchiang@gmail.com.*