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Article

Interactive Gesture-based Assessment for Preschool Hakka Language Learning: An Innovative Approach to Assessing Children's Proficiency

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Abstract: We investigated the application and effectiveness of interactive gesture–based assessment in evaluating the Hakka language abilities of young children. Unlike traditional one-on-one assessments, this innovative approach grounded in the principles of playful learning employs the interactive environment of computer games to provide immediate feedback on correctness, thereby facilitating self-learning during gameplay. This approach generally reduces stranger anxiety and helps children naturally engage with the gaming context. Qualitative research methods, including observations and interviews with children aged 3–6 and their teachers, were employed, and the results revealed that the use of interactive gesture–based assessment reduced the levels of fear associated with evaluation and encouraged the children to engage with the game. This, in turn, yielded higher response quality accurately reflecting the children's actual Hakka language abilities. These findings confirmed the feasibility of using interactive gesture–based assessment for evaluating young children's Hakka language skills and indicate that the developed large-scale systematic evaluation method may improve assessment efficiency. Future software development, particularly that utilizing artificial intelligence, may further facilitate effective language assessments. The primary limitation of this study was its small sample size. Therefore, in future studies, it is necessary to include larger samples to conduct in-depth analyses and refine the application of interactive gesture-based assessment in language assessments for young children. The result of this study assists in enhancing the quality of language teaching and assessment and offers a novel interactive approach to language acquisition in education.

Keywords: Interactive Gesture-based, Early Childhood, Hakka Language, Assessment

1. Introduction

Taiwan is ethnically diverse, with the population primarily comprising the Hoklo (Min Nan), the Hakka, Indigenous peoples, and new immigrants. The Hakka constitute the second-largest ethnic group after the Hoklo, with a population of approximately 4.69 million, representing nearly 20% of Taiwan's population. The Hakka language has a phonetic system of five tones and is essential to the preservation of the Hakka cultural identity. However, Taiwan has experienced a gradual decline in the use of Indigenous languages due to historical policies, societal changes, and assimilation-focused education, which has decreased the number of young individuals speaking these languages (Tiu, 2011). According to the Hakka Affairs Council (2022) and the language vitality indicators of the United Nations Educational, Scientific, and Cultural Organization, the Hakka language is "severely endangered" in terms of generational transmission and user population. In the key development areas for Hakka culture, 62.3% of individuals older than 40 years are proficient in Hakka, whereas only 13.8% of children younger than 13 years and 9.2% of children younger than 6 years can speak Hakka, indicating a major loss of the Hakka language. Therefore, additional efforts are required to instill the language in younger generations. With an increasing number of young parents no longer speaking Hakka, schools have become increasingly responsible for language transmission. Since 2006, the Taiwanese government has subsidized the integration of native languages and local culture into preschool education. Currently, the main long-term language preservation initiatives in Taiwanese preschools are Hakka Life Schools and Hakka Immersion Teaching programs.

According to a survey by the Hakka Affairs Council in 2021, most of the Hakka people (70 to 90%) are conscious of preserving their language, and they agree that the next generation must learn the Hakka language (Hakka Affairs Council, 2022). This indicates a trend toward increased recognition of the importance of Hakka language acquisition among future generations within the Hakka community. According to Chu and Joseph (2024), bilingual learning offers advantages and significantly influences early executive

functioning in young children. Therefore, initiating bilingual education in Mandarin and Hakka from an early age can not only enhance cultural identity among ethnic groups but also support early childhood development.

In 2012 and 2020, the Hakka Affairs Council, in collaboration with Pingtung University, developed editions 1.0 and 2.0 of the Children's Hakka Evaluation Game. This game promotes the acquisition of the Hakka language by young children by encouraging them to engage in challenge-based activities. The target audience for this game is children younger than 4 years, and the game represents Taiwan's only large-scale assessment of early childhood Hakka language competency. Thousands to tens of thousands of children use the game each year. Because each challenge in the game is one-on-one, considerable human resources must be invested every year for training on and administration of the game. However, children often experience stranger anxiety and tend to misunderstand questions or lack the motivation to respond in Hakka. Because assessors often face difficulties in providing guidance and feedback, children's language abilities may be underestimated due to misunderstanding of the questions.

To address the aforementioned problems, researchers have attempted to develop interactive game-based assessment methods and reduce the need for children to interact with strangers, which increases their motivation for participation. It also enables 3-year-old children to participate and provides hints when children provide incorrect answers and avoid misunderstanding by ensuring a more accurate assessment of children's abilities. In addition, this approach can enable more targeted annual investment in human and material resources, enabling more efficient use of resources. The assessment game is designed for self-learning and enables children to learn Hakka while playing.

Motion-sensing technology allows for intuitive physical interactions for users to engage more with game content. This technology has been used in various learning domains (Lin et al., 2017; Yang, 2023; Tao & Chuang, 2017), including language acquisition (Chen, 2019; Lu et al., 2012; Pan, 2017; Watthanapas et al., 2021) and early childhood education (Chen, 2012; Chi, 2022; Liu, 2020). According to the literature, interactive gesture–based assessments can enhance learning outcomes and increase motivation.

In this study, we developed an interactive gesture-based assessment game for evaluating the Hakka language skills of young children. The assessment aspects of the game included learning motivation and interactivity. Learning motivation was evaluated using the ARCS model of motivational design developed by Keller and Kopp (1987), and interactivity was evaluated using the criteria outlined by Lu et al. (2012). In this study, we determined how interactive gesture–based assessment can be used to evaluate young children's understanding of the Hakka language by analyzing the effectiveness of interactive gesture–based assessment in evaluating the Hakka language skills of young children. Based on the results, we offered recommendations for the application of interactive gesture–based assessment to evaluate Hakka language skills in young children.

2. Research Background

2.1. Evaluation of Young Children's Native Language Abilities

According to Hoff (2013), language assessment content includes structural elements (e.g., grammar) and pragmatic elements. Pragmatic elements involve illocutionary competence, encompassing aspects such as language strategies and functions; listening comprehension; pronunciation; spoken vocabulary; and fluency. These elements are typically prioritized in language ability assessments for young children.

Evaluations of native language abilities in young children may be formal or informal. Formal evaluations are conducted through one-on-one testing, whereas informal evaluations are primarily conducted through observations by the primary caregiver, with both forms of evaluation completed by individuals familiar with young children (First Peoples' Cultural Council, 2014). In this study, we established a large-scale, systematic model for native language assessment; therefore, the literature review was focused on formal evaluations. Thompson (2006) developed the Student Oral Proficiency Assessment to evaluate the oral Spanish proficiency of students in grades one to four. Peter and Hirata (2006) and Peter et al. (2008) investigated the effectiveness of Cherokee immersion in the United States by using a question-and-answer format and created assessment tools for both preschools (Cherokee Preschool Immersion Language Assessment) and kindergartens (Cherokee Kindergarten Immersion Language Assessment). The kindergarten version focuses on language regarding actions related to life and curricular activities, such as sleeping and reading, and scoring personnel are present during testing.

In Taiwan, Chang (2004) developed the earliest Hakka language test for young children by modifying the revised version of the Peabody Picture Vocabulary Test to a one-on-one format; the test comprised 116 items. Chen et al. (2009) used this test to determine the effectiveness of early experimental Hakka immersion teaching in Pingtung and evaluate children's Hakka vocabulary abilities. Chen (2016) recompiled the Peabody Picture Vocabulary Test into a Hakka listening and speaking test for young children in the Meinong area of Taiwan. This test included only seven listening items, seven speaking items, and one picture storytelling task. Therefore, less time is needed to complete than in previous tests for young children. Every year, Taiwan organizes the Young

Hakka Language Breakthrough event, which involves a one-on-one challenge with five situational games that are used to test Hakka language ability (Chen & Hsieh, 2021; Hsieh, 2022). These games vary in interactivity levels but are primarily conducted in a one-on-one format. Each level features an adult acting as the "game master" (interacting with the children through the games), questions and answers, and methods used to establish a lifelike scenario in which the children are asked to respond or provide answers.

In this study, we developed a one-on-one situational dialog game to assess the understanding of the Hakka language in young children in which the children could respond by using body language. In this assessment, the interactive partner was replaced by a computer.

2.2 Considerations for Evaluating Young Children's Native Language Abilities

According to the literature, children who engage in bilingual learning tend to significantly differ from those who do not in terms of early executive functioning. In addition, research indicates that children who receive Hakka immersion education tend to exhibit higher performance in numerical concepts and Mandarin auditory vocabulary recognition than those who do not. Therefore, a bilingual learning model involving Mandarin and Hakka can offer advantages in childhood development (Chen & Tsai, 2011; Chu & Joseph, 2024). The development of language and cognitive abilities in young children is crucial. In such children, language expression is primarily characterized by a tendency to respond with gestures, single words, or short phrases (e.g., telegraphic sentences) to convey complex meanings (Lightbown & Spada, 2013). Therefore, when designing language assessments for young children, researchers must employ simple questions that can be answered by children with gestures, single words, or two-word phrases rather than complex sentences. Moore (2014) argued that language abilities significantly correlate with a learner's cognitive development. Therefore, the difficulty of language assessment content must not exceed the child's cognitive load because this may adversely affect their performance. According to Li (1992), 3-year-old children can recognize directions (e.g., up and down), understand daily routines (e.g., waking up and sleeping) and simple actions or activities (e.g., changing clothes and singing), and are familiar with everyday objects (e.g., toothbrush).

The development of social and emotional abilities is crucial in young children. Young children cannot be effectively evaluated using paper-and-pencil tests, and when they are evaluated by an assessor, they may experience stranger anxiety. Preschool children often experience acute nervousness or anxiety when they encounter strangers or unfamiliar scenarios, which may affect their performance (Mitchell et al., 2013). In addition, younger children tend to experience greater levels of anxiety toward new environments; shifting children's attention to more pleasant stimuli, such as games or cute images, may help them overcome their stress (Thompson, 1998). In this study, computer and motion-sensing equipment was used to create interactive games. These games were developed to mitigate the need for interactions with strangers and provide physical activities that can distract children and reduce their anxiety levels.

Understanding the developmental stage of a child's attention span is essential. Three-year-old children have an attention span of approximately 5 to 15 minutes. They can follow simple instructions (e.g., "walk there" or "step on it") and are capable of imitating a series of actions. Because of their limited attention span, items for assessing these children are typically designed to be completed within 5 minutes.

2.3 Interactive Gesture–Based Assessment in Young Children's Learning

With the rapid advancement of technology, interactive gesture–based assessments have been increasingly used in various fields, with such assessments being particularly often used in education to combine learning with entertainment. These assessments are extensively used at all stages of learning and enhance students' learning motivation, stimulate interest, and increase engagement (Papastergiou, 2009; Lu et al., 2012; Tao & Chuang, 2017; Silva et al., 2017). In early childhood education, interactive gesture–based assessments can be used to enhance learning motivation and effectiveness and improve executive functions, motor skills, learning behaviors, and social capabilities (Chen, 2023; Chen, 2014; Huang, 2022). According to Lin et al. (2017) and Pan (2017), these assessments effectively promote learning motivation among elementary and junior high school students, thereby positively affecting their learning outcomes. However, the assessments do not significantly differ from computer games in terms of enhancing learning effectiveness. Interactive gesture-based assessments in early childhood may reduce the adverse effects of traditional computer games on young children's eyesight (Chen & Tsai, 2012).

Several factors must be considered in using interactive gesture-based learning. For instance, appropriate demonstrations and scaffolding must be provided to overcome learning barriers caused by emotional distress or misunderstanding (Chen, 2019; Huang, 2022). Sung et al. (2012) highlighted the importance of considering students' learning styles in improving learning motivation and effectiveness. Ariffin et al. (2014) and Watthanapas et al. (2021) argued that the design of a game should be developed with consideration of the user's background and the potential effect of their background on their motivation and performance as well as

on the suitability and challenge level of the game content. According to Chen (2023), instructional resources and environmental constraints are major factors influencing teachers' decisions to adopt motion-sensing interactive teaching methods. Van Eck (2006) argued that learning-centric digital games must be used within meaningful contexts that stimulate cognitive processes. Therefore, games need to be designed with consideration of different learning objectives and the support and infrastructure likely to be provided by institutions.

Interactive gesture–based assessments have strong potential in education; they are capable of inspiring learning motivation across various student demographics. For young children, who are naturally curious and inclined toward play-based learning, these assessments effectively promote engagement and increase participation and concentration in learning activities. However, to ensure the effectiveness of interactive gesture-based assessments, factors such as learner requirements, instructional design, and environmental factors must be considered.

2.4 Feedback Mechanism for Correct and Incorrect Responses in Evaluation of Young Children's Language Abilities

Hattie and Timperley (2007) proposed a feedback model to reduce the discrepancy between actual performance and desired performance. They indicated that this can be achieved by reconstructing learners' understanding of messages, providing additional information, directly clarifying instructions, or offering alternative strategies for understanding specific messages. Feedback mechanisms can be used in both teaching and assessment, and the majority of research on such mechanisms has focused on the teaching domain. Kluger and DeNisi (1996) conducted a meta-analysis and discovered that providing assessment participants with information regarding whether their answers are correct may have significant feedback effects. In another meta-analysis, Hattie (1999) discovered that in addition to providing specific instruction, providing cues, corrective feedback, and motivational encouragement may maximize the effect of the feedback mechanism.

Hattie and Timperley (2007) divided feedback into four levels: task-level feedback, process-level feedback, self-regulation feedback, and self-level feedback. Task-level feedback pertains to the task itself and includes indicating whether answers are correct or incorrect (Airasian, 1997). Process-level feedback focuses on the connection between the learner and the learning context and may involve, for example, providing problem-solving strategies (Balzer et al., 1989; Butler & Winne, 1995). Self-regulation feedback involves self-regulation, self-direction, and self-standard setting and may take the form of learners' thoughts, feelings, and actions regarding goals, which they can achieve by setting goals and identifying areas of improvement by, for example, monitoring and evaluating their learning situation (Zimmerman, 2000; Boud, 2013). Self-level feedback includes positive personal evaluations such as "You're doing great" or "Well done" and occasional negative feedback (Brophy, 1981).

In this study, we used task-level feedback (e.g., providing information on whether an answer was correct and the status of a task), which is the most common form of feedback in education. In teaching contexts, approximately 90% of the questions teachers ask in classrooms involve this type of feedback (Airasian, 1997). According to research, providing information on whether answers are correct can enhance learners' performance (Hattie, 1999; Tenenbaum & Goldring, 1989; Chiu & Alexander, 2014; Lysakowski & Walberg, 1982; Walberg, 1982). Hattie and Timperley (2007) argued that informing learners of whether their answers are correct plays a key role in enhancing their learning and self-regulation, particularly when the learners misunderstand tasks.

Simple feedback provided to learners tends to be more effective than complex feedback (Balzer et al., 1989; Kulhavy et al., 1985). In addition, task-level feedback alone was reported to be more effective than such feedback combined with personal evaluative feedback (Butler, 1987). In a study involving a four-level feedback model, Harris et al. (2015) discovered that task-level feedback is the most commonly used in peer assessments and self-assessments. Therefore, in this study, we used task-level feedback. After the children in the study provided answers, the gaming system offered feedback on the correctness of their answers, which we predicted, would enhance their performance.

3. Materials and Methods

3.1. Materials

We recruited nine participants, namely, two children aged 3 years, two children aged 4 years, two children aged 5 years, two children aged 6 years, and one experienced preschool teacher (Table 1). In the testing phase, the teacher observed the children. All of the children were of Hakka descent, and none of them were enrolled in Hakka immersion classes. Seven of the children had previous exposure to the Hakka language at school or home, and one child had no prior experience with the language.

Table 1. Participants

Age	Number
6	2
5	2
4	2
3	2
Preschool teacher	1

3.2. Methods

We examined the content and types of native language assessment tools currently used for young children in Taiwan. Currently, Taiwan does not have appropriate large-scale and systematic native language assessment tools for young children nor utilize motion-sensing interactive technology for assessment. Therefore, a panel of experts, including early childhood education curriculum specialists, bilingual learning experts, and preschool teachers, were invited to discuss appropriate assessment content, operational methods, and feedback mechanisms for such assessments for young children. After discussion, the panel of experts determined the most appropriate course of action as a part of the teaching material of the Children's Hakka Evaluation Game, promoted by the Central Hakka Affairs Council of Taiwan, as an assessment tool. The teaching material of this game was developed by a professional team and was confirmed to exhibit high reliability and validity (Chen & Hsieh, 2021). Once the content was determined, a game was designed, and an interactive gesture-based system was developed in collaboration with an information technology company. After the panel of experts completed additional joint discussions and provided suggestions for modifications, a final version was obtained.

As the participants played the game, observational records were created using an anecdotal record method to record actions and language aspects of the study's objectives. These records included the children's concentration levels (whether the child was engaged in the game and whether any distractions were present during the game), efficiency (the time required for each child to learn how to engage with the motion-sensing interactive game), and effectiveness (the number of mistakes made by each child when exploring using the motion-sensing interactive game). After assessment, informal interviews were conducted with the children, and semistructured interviews were conducted with the teacher. These interviews were conducted to determine the children's life experiences and game satisfaction levels ("Do you prefer the Hakka games you played before or this one?"), confidence levels ("Did you find this way of playing the game fun?" or "What part did you like the most?"), and sense of fulfillment (e.g., sharing information after returning to school).

We employed the interactive evaluation criteria outlined by Lu et al. (2012), which include efficiency, effectiveness, and satisfaction. Efficiency refers to the time required for children to adapt to a kinesthetic interactive game, effectiveness refers to the number of errors that children make while learning how to play a game, and satisfaction refers to a child's acceptance of a game, determined through efficiency and effectiveness and an interview with the child. The ARCS model of motivation proposed by Keller (1984) was used to evaluate the learning motivation of the children. This model emphasizes four key elements in instructional design, namely attention, relevance, confidence, and satisfaction, in effectively enhancing learners' willingness to learn. In this study, attention refers to the degree of concentration the children had in playing the game, relevance refers to the connection between the game and a child's living environment, confidence refers to a child's self-assurance regarding an assessment and their ability to independently complete such an assessment, and satisfaction refers to a child's sense of achievement and the likelihood of future engagement. Attention was gauged through observation, relevance was gauged through expert consultation, confidence was gauged through interviews with children, and satisfaction was gauged through discussions with a teacher.

Textual data were converted into text files for analysis. An open coding approach was adopted to encode the concepts in the text. After open coding was completed, key theoretical concepts and research directions were integrated into the coding process following the relevant literature (e.g., expressions such as "Stepping on it is fun" and "Hearing sounds is amusing"). Similar concepts were placed in the same categories. For example, "hearing a ding-dong sound signifies a correct answer and brings happiness" and "hearing a buzzing sound indicates a wrong answer and prompts further thinking" were classified as positive responses to feedback mechanisms. Finally, each concept was comprehensively analyzed to extract abstract categories and develop coherent interpretations. Data codes were presented in the following format: speaker/author (anonymized) - source of data - date (YYYY-MM-DD).

4. Results

4.1. Interactive Gesture–Based Assessment in Evaluating Young Children's Hakka Language Skills

4.1.1. Architecture

A large-scale interactive projection system was developed to evaluate the Hakka language skills of children, with a projector and mainframe platform serving as the primary carriers. This system provided an interactive virtual projection game for on-site training in Hakka language auditory reception for young children. Figure 1 illustrates the architecture of the system.

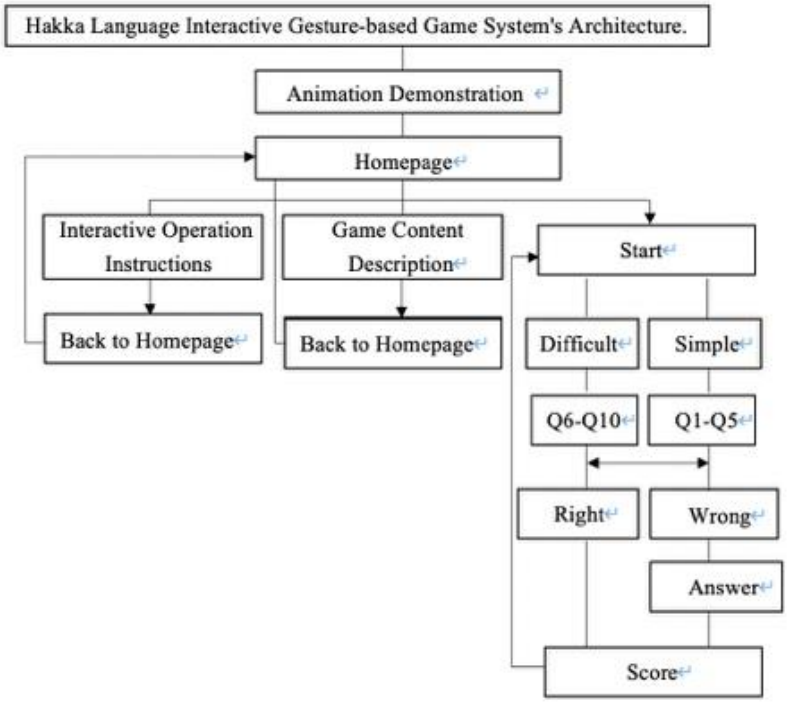

Fig. 1. Architecture of interactive gesture–based assessment system for the Hakka language.

4.1.2. Development of assessment content and operational instructions

After several expert meetings and discussions with early childhood education teachers and professors were held, topics for the Hakka sensory interactive assessment were selected from the teaching materials of the Children's Hakka Evaluation Game. These materials are commonly used in preschools across Taiwan for Hakka language teaching and are highly relevant to daily life. Because of the technical limitations associated with recognizing spoken Hakka, this game focuses on listening skills. Before the game starts, a guide demonstrates the gameplay to offer a clear example of how to play the game. The children are asked 10 questions, which can be categorized as easy (questions 1 to 5) and difficult (questions 6 to 10).

To start the game, children must step on the "GO PLAY" button, which directs them to a difficulty selection screen. To ensure consistency, all children in this study began at the "Easy" level. After the children step on the "Easy" button, a 5-second countdown appears on the screen. The game starts, with four picture cards appearing on the screen and an audio recording of a phrase being played (e.g., for the first question, "He is sleeping"). The child must step on the picture that matches the spoken phrase. After a picture is stepped on, a 5-second countdown appears on the top left of the screen. If the answer is correct, the game proceeds to the next question, and if the answer is incorrect, the correct picture is displayed for 3 seconds, and the question is repeated. If the correct picture is stepped on in the second attempt, the game proceeds to the next question, and if an incorrect picture is stepped on again, the process repeats. After the five questions at each level are completed, the phrase "Super Great" appears on the screen, accompanied by a celebratory sound effect. Finally, the screen returns to the home page, where the child can select the "Difficult" level through the aforementioned process. Figures 2 and 3 respectively present design schematics and actual test images for the game.

Because the sensory interactive device uses radar detection with a specific range, no obstacles should be placed in the radar's detection area, and individuals other than the game participant should be prohibited from entering the area to prevent interference. In addition, the lighting of the environment should be dimmed to enhance the brightness and color saturation of the projections to increase the child's focus and minimize distractions.

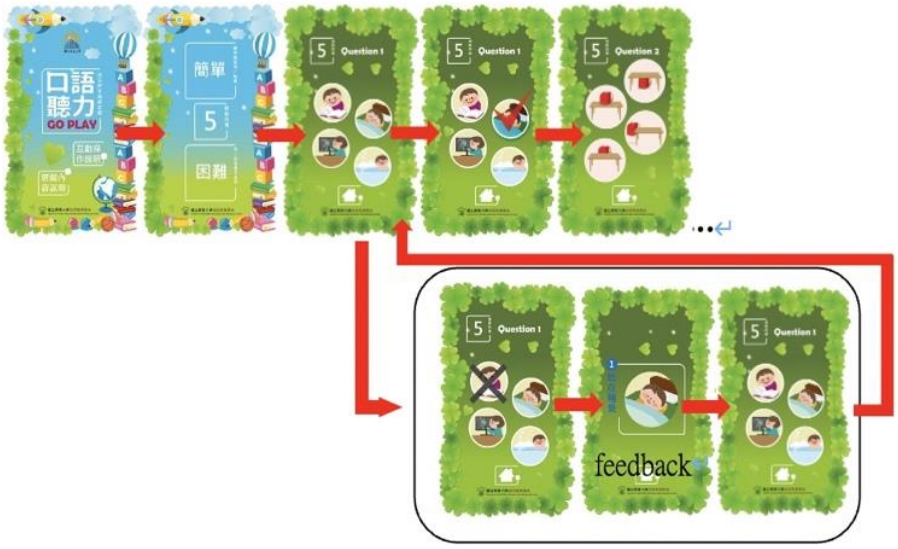

Fig. 2. Elements of design of game in this study.

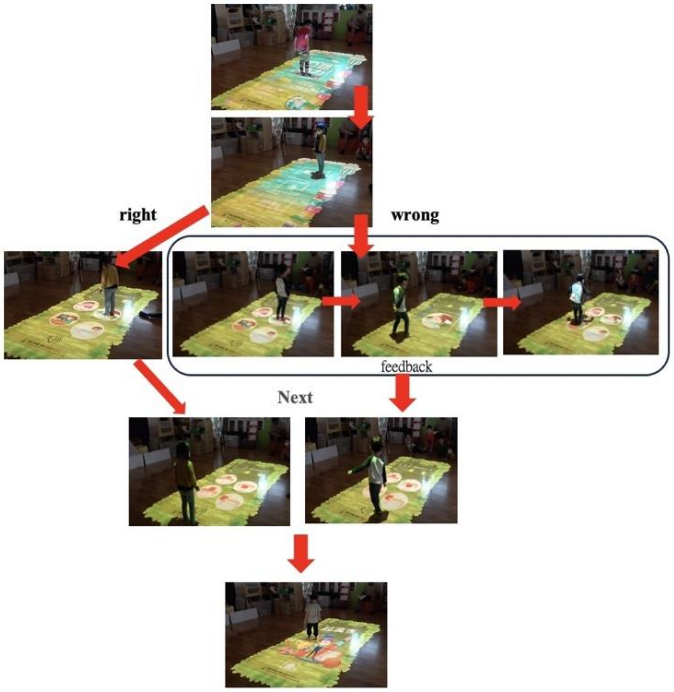

Fig. 3. Actual test images.

4.2 Efficacy of Sensory Interactive Games in Evaluation

4.2.1 Efficiency

In this study, efficiency refers to the time required for young children to adapt to the sensory interactive assessment. The results were based on the children's time records on the day of the test. Time performance was divided into three categories: Operation Before the Official Game, Official Game-Easy, and Official Game-Difficult. For the first category, the average time was 15 seconds for 6-year-old children, 10 seconds for 5-year-old children, 10 seconds for 4-year-old children, and 78 seconds for 3-year-old children. For the second category, the average time was 41 seconds for 6-year-old children, 35 seconds for 5-year-old children, 48 seconds for 4-year-old children, and 67 seconds for 3-year-old children. For the third category, the average time was 70 seconds for

6-year-old children, 50 seconds for 5-year-old children, 51 seconds for 4-year-old children, and 110 seconds for 3-year-old children (Table 2).

According to the results, the children aged 4–6 years were able to complete the first category of the game. However, the 3-year-old children were unable to independently play the game. In addition, the time required in the third category of performance was typically longer than that required in the second category. These results indicated either that the children required additional time to think about their answers when playing the difficult level of the game or that this more challenging category involved more incorrect answers.

Table 2. Efficiency in playing game.

Age	Before the Game	Game-Simple	Game-Difficult
6-year-old	15	41	70
5-year-old	10	35	50
4-year-old	10	48	51
3-year-old	78	67	110

Unit: seconds

4.2.2 Effectiveness

Effectiveness referred to the number of errors the children made during the sensory interactive assessment. This was assessed based on the precision of the children's operational steps and was categorized into two phases: before the game and during the game. In the first phase, the children aged 4, 5, and 6 years made no errors, whereas the children aged 3 years each made one error. In the second phase, none of the children made errors. These results indicated that after receiving a comprehensive demonstration from their teacher, the children aged 4–6 years were able to master the operational procedures and were therefore able to independently and accurately interact with the game interface. The interviewed teacher reported that this was "because you clearly tell them that you are going to step on something in a moment; they cannot read, so clear and precise instructions are essential" (T-I-20240103). The teacher believed that providing a detailed and clear demonstration before the operation was essential to facilitate the smooth execution of the tasks by the children. Nonetheless, because of the limited cognitive abilities of 3-year-old children, teachers must offer additional guidance and support in understanding the operational steps. In addition, the finding that the children aged 3–6 years did not make any errors when playing the game indicates that the design of the sensory interactive assessment game is intuitive and user-friendly for young children. The interviewed teacher provided positive feedback regarding the visual design of the game: "The colors are vibrant, and the answer screen is very clear. The kids can see it very clearly" (T-I-20240103).

4.2.3 Satisfaction

In this study, satisfaction referred to the preschool children's preference for and acceptance of the game and was evaluated through observations made during trial play sessions, feedback from the children, and the interview with the teacher. After completing the game, the eight children were asked to compare their current gaming experience with previous one-on-one tests. All children exhibited a positive attitude toward the game:

"I like the computer method; it's fun because you can jump around." (A-I-20231212)
"This is cool, really fun." (B-I-20231212)
"This is fun; I like the computer one; you can jump, and that's a projector; it's really fun." (C-I-20231212)
"This is so much fun." (D-I-20231212)
"I like this computer one; it's more fun." (E-I-20231212)
"I like jumping to choose the pictures." (F-I-20231212)
"I think this is super fun, I prefer this; jumping on it is more fun." (G-I-20231212)
"This is super fun." (H-I-20231212)

4.2.4 Evaluation of preschool children's learning motivation

1. **Attention:** We discovered that all of the children were highly engaged and exhibited clear interest as soon as they entered the game room. This indicates that our approach mitigated the anxiety typically associated with unfamiliar settings: "Upon entering the classroom and seeing the projection on the floor, all eight children showed curiosity, amusement, and excitement. They touched and stepped on the projections and remained focused on the game throughout, supporting each other with cheers and praise without getting distracted" (R-O-20231212). The teacher further commented on the game's appeal by stating, "The

novelty of the virtual aspect attracts the children's attention. When I was there, I noticed high participation levels because it was a fresh experience" (T-I-20240103).

2. **Relevance:** We analyzed the congruence between the game's content and the children's daily experiences. The teacher confirmed that the game's content was relevant to the children's life experiences and aligned with their needs and learning objectives thus leading to a more positive attitude toward engagement: "The content of the 10 questions in the game aligns with the everyday objects and experiences of young children and is closely related to their daily language use, and therefore, there isn't any disconnect between the content and their life experiences" (T-I-20240103).
3. **Confidence:** We explored whether the children gained confidence in independently accomplishing the tasks of the game. Unlike traditional tests, the game developed in this study offered immediate feedback on correct or incorrect responses, which increased the children's confidence and satisfaction. Several children expressed a preference for this self-led approach over one-on-one assessments conducted by an adult or teacher: "I like the feeling of tackling it by myself; it's more interesting when the computer talks" (C-I-20231212), "I prefer not having a teacher by my side" (F-I-20231212), and "It is like playing on my own, without a teacher" (G-I-20231212). These findings underscored the game's effectiveness in supporting the children's need for independence. One of the children mentioned, "I like the computer game because it tells me the answers" (F-I-20231212). Another child, who had no background in learning the Hakka language began to independently navigate and self-correct after making errors; "H, who did not have any prior knowledge, started to look at the answers in the feedback after making his second mistake and reminded himself of which picture on the floor was the correct answer" (R-O-20231212). However, the children aged 3 years required encouragement from the teacher after answering incorrectly; "When H was presented with a question he didn't know the answer to, he showed slight nervousness. After hearing the wrong answer sound, he stuck out his tongue, showing that he was embarrassed. But the teacher immediately encouraged him, letting him know it's okay to be afraid. H then responded more quickly and decisively, even when he was wrong, without fear, maintaining a smile throughout" (R-O-20231212). These findings indicated that the game is interactive and sensory not only facilitated self-guidance and self-monitoring but also reduced the anxiety and nervousness associated with one-on-one testing, thereby increasing the children's eagerness to continue.
4. **Satisfaction:** We evaluated the children's sense of accomplishment and satisfaction after they engaged with the game. We discovered that the children were visibly pleased when they heard the reward sounds for correct answers: "F smiled when the correct answer sound played, and his feet were dancing with joy at the end of a level. G smiled and jumped with joy. H smiled and jumped when hearing the correct answer sound" (R-O-20231212). The teachers also reported, "After our visit, some children said they found the 'ding-dong' sound very fun" (T-I-20240103). Some children indicated that they enjoyed the game's difficulty levels: "I like the computer version because there are easy and hard levels" (D-I-20231212) and "Super fun! I want to try even harder levels next time" (G-I-20231212). These findings indicate that our interactive sensory assessment game effectively provided immediate positive feedback and a sense of accomplishment, which motivated the children to continue challenging themselves.

5. Discussion

In Taiwan, a one-on-one approach is most commonly used to evaluate young children's Hakka language skills. This approach is limited by factors such as human resources, child developmental factors, and challenges arising from emotion, comprehension, and attention span constraints. In this study, we transformed the conventional assessment method and developed a kinesthetic interactive game format to provide a novel method for evaluating children's linguistic capabilities. Our goal was to reduce the nervousness or anxiety that children may experience when interacting with strangers or unfamiliar scenarios, which can negatively affect their performance (Mitchell et al., 2013). Overall, our findings indicate that our Hakka language assessment game successfully captures children's interest and leads to greater motivation, which is in line with the results of previous investigations (Chen, 2023; Chen, 2014; Huang, 2022). According to Chen (2019) and Huang (2022), appropriate demonstrations and scaffolding are required to overcome obstacles related to emotional distress or misunderstanding and thereby improve the learning outcomes of young children. These findings are consistent with the present results. We discovered that clear and comprehensive demonstrations by teachers improved children's operational proficiency and indirectly increased their willingness to engage with games. In terms of efficiency and effectiveness, the duration of gameplay decreased with the age of the participants; the average completion time for all eight children was approximately 146 seconds (approximately 28 seconds before the game, 48 seconds for simple levels, and 70 seconds for difficult levels). Unlike traditional Hakka listening assessments, which typically require 3–5 minutes for each child to complete, the incorporation of an immediate feedback mechanism for correct or incorrect answers did not extend the adaptation phase or the actual duration of the assessment.

Evaluations of satisfaction, confidence, and sense of achievement revealed that the children enjoyed the interactive gesture-based game. After interacting with the game, all children provided positive feedback on their experience, using terms such as "fun," "completing it by myself," and "want to play again." These findings indicate that the children maintained a high degree of learning interest when they were introduced to the novel tools and environment. In addition, the game's design, including its vivid colors and engaging pattern layouts, successfully captured the children's attention. These findings are consistent with those of Thompson (1998), who indicated that the anxiety levels that children experience in new settings are inversely proportional to their age, with younger children experiencing greater anxiety. Overall, the findings indicate that utilizing games and cute images can effectively shift children's focus. However, because 3-year-old children are still developing comprehension skills, they often require guidance, encouragement, and praise from teachers, which can reduce their anxiety regarding making mistakes and foster confidence and satisfaction with games.

In this study, we used a feedback mechanism to distinguish between correct and incorrect responses across various task levels. We discovered that the children were able to initiate self-learning based on the immediate feedback; similar findings were reported in previous studies (Hattie, 1999; Tenenbaum & Goldring, 1989; Chiu & Alexander, 2014; Lysakowski & Walberg, 1982; Walberg, 1982). These findings indicate that by providing feedback on both correct and incorrect answers, our game improved the children's learning outcomes and provided them with an opportunity for self-learning.

6. Conclusions

Compared with traditional Hakka language assessments, our interactive gesture-based assessment decreased the levels of fear in the emotional responses of children considerably. In addition, the game increased children's learning motivation and overcame the traditional challenges of educator resources, emotional states, and age-related constraints. Combining interactive gesture–based assessments with the evaluation of children's Hakka language skills has major potential, and further in-depth research is required to develop other innovative language acquisition assessment tools for young children.

The interactive gesture–based assessment tool of this study associates excellent efficiency, effectiveness, and satisfaction. Its feedback mechanism for correct and incorrect responses did not increase the actual testing time or the time required by the children to adapt. Furthermore, immediate feedback, combined with pleasant sound effects indicating correct answers, provided children with a sense of achievement and clarified the correct answer after an incorrect response was provided. These enabled them to learn from their mistakes. This approach increased response rates and fostered self-learning, indicating that implementing a feedback mechanism for correct and incorrect responses in various task levels enhanced children's self-learning capabilities and learning performance and promoted satisfaction. The interactive gesture-based assessment with its vibrant visual design was highly favored by the children and successfully increased their interest and motivation for learning through physical interaction, child-relevant topics, and user-friendly operation. The children rapidly became concentrated on and immersed in the game, which enabled them to gain confidence and develop a sense of satisfaction.

This study was exploratory, beginning with a preliminary analysis of a small sample. Only eight children aged 3, 4, 5, and 6 (with two children from each age group) and one teacher were invited to participate in the developmental phase of the interactive gesture-based game. Thus, future studies are necessary to collect more data samples, ensure consistent Hakka language exposure among participants, and establish control groups to more accurately evaluate the effectiveness of the game. Despite the popularity of the kinesthetic interactive assessment game among children and its ability to be adjusted in the testing environment, the computer was unable to provide demonstrations. Therefore, assessors in such assessments must provide comprehensive and clear practical demonstrations before the game. In the current study, after an adult provided a demonstration, the children aged 4–6 years were able to understand the techniques they needed to employ and to independently navigate the game's interface. However, the 3-year-old children required additional adult support and guidance, timely encouragement, and compliments to gain confidence in engaging with the game. Because the current corpus of the Hakka language remains incomplete, computers cannot judge the Hakka language-speaking capabilities of children. After the corpus is complete, functions for evaluating children's Hakka language speaking capabilities can be added to the game to evaluate the children's overall language proficiency. Furthermore, expanding the scoring function of the game would eliminate the need for assessors to manually tally scores and potentially enable larger-scale assessments. In addition, a variety of game formats may enhance the learning experience. The physical interactions in such games must extend beyond merely stepping actions to include kicking balls, throwing dice for question selection, and similar activities to foster engagement. In addition, games with increasing levels of difficulty, similar to level-based gameplay, need to be developed.

A limitation of this study is its small sample size. Nevertheless, the results and feedback obtained from the nine participants indicate that our interactive gesture-based game stimulated children's interest and motivation for learning. Overall, this research highlighted the feasibility of our novel approach to evaluating the Hakka language skills of children. Future research is required for large-scale sample analyses to provide additional information for improvement. In conclusion, the developed gesture-based game

in this study has the potential to evaluate children's linguistic skills. However, further research is required to investigate additional applications and formulate practical and feasible promotion plans.

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References

1. Airasian, P. W. (1997). Classroom assessment (3rd ed.). New York, NY, USA: McGraw-Hill.
2. Ariffin, M. M., Oxley, A., & Sulaiman, S. (2014). Evaluating Game-based Learning Effectiveness in Higher Education. *Procedia - Social and Behavioral Sciences*, *123*, 20–27. https://doi.org/10.1016/j.sbspro.2014.01.1393.
3. Balzer, W. K., Doherty, M. E., & O'Connor, R., Jr. (1989). Effects of cognitive feedback on performance. *Psychological Bulletin*, *106*(3), 410–433.
4. Boud, D. (2013). Enhancing learning through self-assessment. Abingdon, UK: Routledge.
5. Brophy, J. (1981). Teacher praise: A functional analysis. Review of Educational Research, 51, 5–32.
6. Butler, D. L., & Winne, P. H. (1995). Feedback and self-regulated learning: A Theoretical synthesis. *Review of Educational Research*, *65*(3), 245–274.
7. Butler, R. (1987). Task-involving and ego-involving properties of evaluation: Effects of different feedback conditions on motivational perceptions, interest and performance. *Journal of Educational Psychology*, *79*, 474-482.
8. Chang, L. J. (2004). In *The Relationship between Bilingual Language Proficiency and Creativity in Mandarin-Taiwanese Dual-Language Preschoolers*. Proceedings of the 2004 Hakka Knowledge Forum, Taipei City, Taiwan; December 12, 2004.
9. Chen, H. (2023). Comparing the Effects of Kinect-based Game with Point-of-view Video Modeling in Teaching Hand Washing to Children with Autism. Master's Thesis, National Taiwan Normal University, Taipei, Taiwan.
10. Chen, K.-H., Tsai, C.-C. (2012). A Study on the Developmental Process of Montessori Motion-sensing Interactive Installations. *STUST Journal of Humanities and Social Sciences*, *8*, 57–91. https://doi.org/10.29841/STUTJHSS.201211.0003
11. Chen, W.-N. (2014). A study of gesture-based interactive games affects children's motor skills. Master's Thesis, National Taiwan Normal University, Taipei, Taiwan.
12. Chen, Y. L. (2016). The impact of immersive instruction in Meinong Hakka on preschoolers' listening and speaking proficiency in Hakka. *Hakka Public Affairs Journal*, *13*, 25–43.
13. Chen, Y. L., & Hsieh, F. H. (2021). Design and Developmental Process of Children's Hakka Language Teaching Materials. *Journal of Textbook Research*, *14*(2), 75–103.
14. Chen, Y. L., Chen, R. F., & Tsai, D. L. (2009). The impact of Hakka immersion instruction on enhancing preschoolers' listening and speaking proficiency in Hakka. *Journal of Educational Psychology*, *41*(2), 345–360.
15. Chen, Y.-H. (2019). The Effect of Interactive Gesture-based Assessment on Preschoolers' Executive Function, Motor Skills, and English Learning. Master's Thesis, National Taiwan Normal University, Taipei, Taiwan.
16. Chen, Y.-L.& Hsieh, F.-H. (2021). Design and Developmental Process of Children's Hakka Language Teaching Materials. *Journal of Textbook Research*, *14*(2), 75–103. https://doi.org/10.6481%2fJTR.202108_14(2).03
17. Chen, Y.-L.& Tsai, T.-L. (2011). The Influence of Hakka Immersion Programs on Children's Performances of Chinese Listening Comprehension and Mathematical Concept. *NTTU Educational Research Journal*, *22*(1), 25–54.
18. Chi, Y.-H. (2022). The Influence of Somatosensory Interactive Games on Gross Motor Skills of Preschool Children. Master's Thesis. National Taipei University of Education, Taipei, Taiwan.
19. Chiu, S. & Alexander, A, P. (2014). Young children's analogical reasoning: The role of immediate feedback. *Journal of Psychoeducational Assessment*, *32*(5), 417–428.
20. Chu, L., & Joseph, G. E. (2024). The development of executive function among monolingual English-speaking and dual language learning children in early childhood settings. *International Journal of Bilingual Education and Bilingualism*, 1–17. https://doi.org/10.1080/13670050.2024.2321491

21. FPCC. (2014). Language Nest Handbook. Available Online : https://www.scribd.com/document/468192818/FPCC-LanguageNestHandbook-EmailVersion2# (accessed on December 15, 2023)
22. Hakka Affairs Council (2022). Survey on National Hakka Population and Language Basic Data, 2021 (AM010006). Available online: https://doi.org/10.6141/TW-SRDA-AM010006-1 (accessed on January 10, 2024)
23. Harris, L. R., Brown, G., & Harnett, J. A. (2015). Analysis of New Zealand primary and secondary student peer- and self-assessment comments: applying Hattie and Timperley's feedback model. *Assessment in Education: Principles, Policy & Practice*, *22*(2), 265–281
24. Hattie, J. & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81–112.
25. Henderlong, J., & Lepper, M. R. (2002). The effects of praise on children's intrinsic motivation: A review and synthesis. *Psychological Bulletin*, *128*, 774–795.
26. Hattie, J. (1999, June.). Influences on student learning (Inaugural professorial address, University of Auckland, New Zealand). Available online: http://www.arts.auckland.ac.nz/staff/index.cfm?P=8650 (accessed on January 5, 2024)
27. Hoff, E. (2013). Language development. Boston, MA, USA: Cengage Learning.
28. Hsieh, F.-H. (2022) Evaluation of the Listening and Speaking Abilities of Hakka Children Aged Four Years and Over. *Global Hakka Studies*, *18*, 233–266.
29. Huang, C.-H. (2022). Using Interactive gesture-based assessment to Explore Motor Skills, Learning Behaviors, and Social Skills among Kindergartners. Master's Thesis. National Taiwan Normal University, Taipei, Taiwan.
30. Keller, J. M. (1984). The use of the ARCS model of motivation in teacher training. In *Aspects of educational technology volume XVII: Staff development and career updating*. London, UK: Kogan Page.
31. Kluger, A. N., DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological Bulletin*, *119*(2), 254–284.
32. Kulhavy, R. W., White, M. T., Topp, B. W., Chan, A. L., & Adams, J. (1985). Feedback complexity and corrective efficiency. *Contemporary Educational Psychology*, *10*, 285–291.
33. Li, D. (1992). Child Development. Taipei, Taiwan: Wu Nan.
34. Lightbown, P. M., & Spada, N. (2013). *How Languages are Learned (4th edition)*. Oxford, UK: Oxford Publishing
35. University Press.Lin, Y.-T., Lin, C.-H., Shih, J.-L., Tseng, C.C. (2017). The Development and Learning Evaluation of Digital Somatosensory Game for Learning History and Culture. *International Journal on Digital Learning Technology*, *9*(4), 109–131. https://doi.org/10.3966/2071260X2017100904005
36. Liu, J.-C.(2020). A Study on the Impact of Sensory Interactive Games on Early Childhood Mathematics Learning, Motor Skills, and Executive Functions, Master's Thesis. National Taiwan Normal University, Taipei, Taiwan.
37. Lu, S.-J., Liu, Y.-C., Chuang, Y.-C., Peng, C.-P. (2012). A Research of Applying Physically Interactive Games in the Elementary Minan Dialect Curriculum and Instruction. *Curriculum & Instruction Quarterly*, *15*(2), 169–192. https://doi.org/10.6384/CIQ.201204.0170
38. Lysakowski, R. S., & Walberg, H. J. (1982). Instructional effects of cues, participation, and corrective feedback: A quantitative synthesis. *American Educational Research Journal*, *19*, 559–578.
39. Mitchell, R., Myles, F. & Marsden, E. (2013). Second language learning theories. New York, NY, USA: Routledge.
40. Moore, T. E. (2014). Cognitive development and acquisition of language. Toronto, CA: Elsevier.
41. Pan, W. F. (2017). The Effects of using the Kinect motion-sensing interactive system to enhance English learning for elementary students. *Journal of Educational Technology & Society*, *20*(2), 188–200.
42. Papastergiou, M. (2009). Digital Game-Based Learning in high school Computer Science education: Impact on educational effectiveness and student motivation. *Computers & Education*, *52*(1), 1–12. https://doi.org/10.1016/j.compedu.2008.06.004.
43. Peter, L., & Hirata-Edds, T. (2006). Using Assessment to inform instruction in Cherokee language revitalization. *International Journal of Bilingual Education and Bilingualism*, *9*(5), 643–658.
44. Peter, L., & Hirata-Edds, T. E. (2006). Using assessment to inform instruction in Cherokee language revitalisation. *International Journal of Bilingual Education and Bilingualism*, *9*(5), 643–658.
45. Peter, L., Tracy H. E., & Bradley, M. A. (2008). Verb development by children in Cherokee language immersion program, with implications for teaching. *International Journal of Applied Linguistics*, *18*(2), 166–187.
46. Sung, H.-Y., Hwang, G.-J., Hung, C.-M., & Huang, I.-W. (2012). Effect of Learning Styles on Students' Motivation and Learning Achievement in Digital Game-based Learning. Proceedings of the 2012 IIAI International Conference on Advanced Applied Informatics. Fukuoka, Japan; September 20–22; pp. 258–262. https://oi.org/10.1109/IIAI-AAI.2012.59.
47. Tao, S.-Y., Chuang, T.-Y. (2017). Effects of Motion Sensing Human Computer Interaction Technology and Game-Based Learning Environment for Elementary School Students. *International Journal on Digital Learning Technology*, *9*(3), 115–136. https://doi.org/10.3966/2071260X2017070903006.

48. Tenenbaum, G., & Goldring, E. (1989). A meta-analysis of the effect of enhanced instruction: Cues, participation, reinforcement and feedback and correctives on motor skill learning. *Journal of Research and Development in Education*, *22*, 53–64.
49. Thompson, L. E., Boyson, B. A., & Rhodes, N. C. (2006). Administrator's manual for CAL foreign language assessments, grades K–8. Washington, DC, USA: Center for Applied Linguistics.
50. Thompson, R. A. (1998). Early socio personality development. In *Handbook of child psychology*: *Social, emotional, and personality development*. New York, NY, USA: Wiley. pp. 23–104. https://psycnet.apa.org/record/2005-03132-000
51. Tiu, H.-K. (2011). Language revitalization: Concepts and practices in collaboration with families, communities, and schools. Taipei, Taiwan: Anlu Publishing Company.
52. Van Eck, R. (2006). Digital Game-Based Learning: It's Not Just the Digital Natives Who Are Restless. *Teaching, Leadership & Professional Practice Faculty Publications*, *41(2)*, 16–30. https://commons.und.edu/tlpp-fac/25
53. Walberg, H. J. (1982). What makes schooling effective? *Contemporary Education Review*, *1*, 1–34.
54. Watthanapas, N., Hong, J.-C., Ye, J.-H., Ye, J.-N., Hao, Y.-W. （2021）. Applying Motion Sensing Gaming to Learning Thai Syntax: Relationship Among Thai Learning Attitudes, Language Anxiety, Gameplay Flow, Test Anxiety and Self-Confidence Enhancement in Thai Syntax. *Journal of research in education sciences*, *66*(3), 213–246. https://doi.org/10.6209/JORIES.202109_66(3).0007
55. Yang, T.-F. (2023). The Effectiveness of Motion-Sensing Interactive Game Applied to Marine Culture Learning: A Case Study of Nanfang'ao Fishing Culture, Master’s Thesis. National Ilan University, Ilan, Taiwan.
56. Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts & P. R. Pintrich, (Eds.), Handbook of self-regulation (pp. 13-39). San Diego, CA, USA: Academic Press.