

# The Effects with Robot-Assisted Language Learning for Fourth-Graders' Academic Emotions

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## Abstract

Nowadays, Robot-Assisted Language Learning has been expanded as tutors with a considerable increase in the number of publications. However, research that has empirically documented the relationship between learners' academic emotions and robotics is scant. Therefore, the aim of this study attempts to build a robot system that can respond to primary school students' emotions and detect their emotions.

This study was designed as an emotional detection system and adopted Zenbo-lab environment. The students were detected while they were interacting with a robot.

The expected results are as follows:

- a. Robot-Assisted Language Learning in this study can significantly predict learner's positive emotions.
- b. Robot-Assisted Language Learning in this study can significantly predict learner's negative emotions.

**Keywords : Robot-Assisted Language Learning, Academic Emotions, Emotional robots**

## I. Introduction

Emotions are the heart of the foreign language learning process (Dewaele, Jean-Marc, 2015). For many language learners, emotions in language learning played a vital role. It's not only for learners but also for the learning process. With Dewaele's recent studies, emotions in the language classrooms can be classified into two types. One is positive (foreign language enjoyment), and the other is negative (foreign language anxiety). Both emotions can affect learners' language learning. Most important of all, it related to both learners and teachers in managing emotions in the classroom.

Macintyre et al. (2012) indicated that positive emotion facilitates language learning because positive emotion can broaden a person's perspective to absorb the language. In contrast, negative emotion produces the opposite effects, a restriction of the range of potential language input. Moreover, emotions are quite instant, subjective, but motivation has a long-term, goal-oriented perspective. Also, as MacIntyre (2002) mentioned, attitudes alone are not sufficient to support motivation. Hence, it's worthwhile to investigate the emotions in language learning study.

Over recent years, Robot-assisted language learning (RALL) has continued to expand dramatically as tutors with a considerable increase in the number of publications. (van den Berghe et al., 2019). It's widely recognized that robot in education supports foreign language learning studies. In the discussion of RALL studies, learning motivation is the factor that has been most emphasized. In word learning studies stress that humanoid robot can boost the learner's positive attitude and reduce anxiety (Alemi et al., 2015). Studies have indicated that students in the RALL group had great fun in learning English; they also believed they were learning more effectively, which helped them boost their motivation. In addition, robot can be interactive for children learning languages. Hsiao, Chang, Lin & Hsu (2015) found that using iRobiQ robot as a learning tool had many advantages, for example, iRobiQ is a both effective and interactive learning companion, and it can create active and interactive learning environment for children. Hence, it's very practical to develop robotics activities for instructional design tool in English as a foreign language (EFL).

Although robots can be the instructional tool for the class, they can be designed with emotional model so as to benefit user experiences. To give an example, Jimenez, F. et al. (2015) indicated that educational-support robot in the proposed system expressing emotions generates more favorable impressions than a robot expressing random emotions. Through this model, the agent autonomously expresses the user's emotions and establishes effective interactions between agents

and humans. Another case is that adaptive emotional expressive robots interacted with children. The result showed that the children who react to the affective robot is more positive than the non-affective robot which doesn't have the adaptive emotional expression model. (Myrthe Tielman et al., 2014). Thus, we concluded that emotional model robots can be designed with interactive and user-friendly for different users. In addition, robotics has attracted the interest from teachers as valuable educational tools from schools. The implementation of social-support behaviors in robot tutors, particularly in the emotional dimension, can make a significant contribution to learning efficiency (Imbernón Cuadrado LE et al., 2016). Hence, with robot's emotional model system, learning motivation was enhanced when the robot responded to learner with meaningful interaction and give them confidence to speak English. (Sungjin, Lee et al., 2011). The robot using the model allows the learner to enjoy learning languages in immersive environment. The results showed that learners from experimental group have a more positive learning experience than learners that don't. Another case is that autonomous social robotic plays a learning companion role with children. With an automatic facial expression analysis system, children's valence and engagement were measured. These signals were combined into a reward signal that fed into the robot's affective reinforcement learning algorithm (RL). RL robot gave students the personalized affective feedback strategy and showed a significant increase in valence. Students can gain the new words during tutoring sessions (Gordon, G et al., 2016).

However, most research and engineering efforts on emotions in robotics have focused on the use of emotions to facilitate the human-robot interaction. (Nitsch, Verena & Popp, Michael, 2014). Few studies have integrated academic emotions into robotics. Therefore, it can be potential to take into account that academic emotions in social robot studies. It is necessary to consider not only the learning subject but also learner's affective experience, for instance, how students feel in the class. Pekrun et al. (2002) pointed that how emotions related directly to teaching, student's learning, and academic achievement that's called academic emotions. Furthermore, when the teachers are smiling, angry, or upset in class, it has the effects on learners' emotions. Hence, we considered to investigate how to improve the learners' academic emotions by using social robotics as an instructor. There has been an increasing interest in the role of academic emotions, especially for how emotions shape student engagement and learning (Linnenbrink- Garcia, Lisa & Pekrun, Reinhard, 2011). Positive emotions help students to sustain their interest in learning. Yet, negative emotions reduce the learners' motivation in learning. Thus, it's crucial to improve students' academic emotions. Promoting positive learning environment can help students build the confidence. By external and

internal factors, student can be affected by emotions. These will be related to students' academic achievement. For instance, Lei, H., & Cui, Y. (2016) analyzed the effects of academic emotions and the results revealed a significant positive correlation between academic emotions and academic achievement.

While Robot assisted language learning may be widespread in both enhancing learning effect and motivation, it is interesting to note that there still seems to be uncertainty as whether robot in emotional model set can improve academic emotions and create positive learning atmosphere. Hence, the aim of this study is to help the learners' have the positive academic emotions through social robot system.

Consequently, it can be proved that learning motivation is not the only factor that can affect students' foreign language learning. Emotions are of fundamental importance to learners' language learning and performance (Kaiqi Shao, Reinhard Pekrun, Laura J. Nicholson, 2019). In achievement emotion research, it can be a perfectly fit into foreign language learning. From a new perspective, learning emotions in psychology can provide crucial insights into language learning.

In previous research studies, a RALL system framework has been conducted. The developed framework provides a practical tool for instructors to teach learners to learn a foreign language that can easily add external resources so as to script and program the anthropomorphized robots. Moreover, our robot system can also be utilized in the emotional model. Therefore, the goal of present study is, first to provide a practical study of creating an RALL system to support EFL learners' academic emotions. Then, present the relationship between RALL and academic emotions. Specifically, through this emotional model in educational robot system, this chapter describes the impact of Robot-Assisted Language Learning.

In our current study, the participants in the research are two groups of the fourth-grade elementary students in Taiwan. They were targeted to make the comparison. The experimental group used the RALL program, whereas the control group participated in traditional course. Hence, utilize the RALL system in this program whether it can promote elementary school students' learning emotions or not.

They were all selected for the following reasons: (a) As second-year for elementary school student to learn English in courses in the early stage (b) Have the knowledge in Basic English vocabulary.

## II. Related works

### 2.1 Robot-Assisted Language Learning

Robot-assisted language learning (RALL) is defined as the use of robots to teach people language expression or comprehension skills—such as speaking, writing, reading, or listening. This includes native and non-native language instruction in both spoken and non-verbal languages (Natasha Randall, 2019). In various ways of robotic system, learners can learn foreign language well by using it with repeated practice. Through the RALL system, robot can assist and supplement teacher's lessons and reinforce the material. The more time the children interact with robot, the more gains in learning children can get.

As previously stated, robot can assist student's language learning. Moreover, Chang et al. (2010a) further indicated that seven features designing an ideal teaching robot in RALL field that includes, repetitiveness, flexibility, digitization, humanoid appearance, body movement, interaction, and anthropomorphism. These studies are crucial because of the growing needs of designing teaching robot. Therefore, in this study, Robot-Assisted Language learning refers to the use of robots which can teach people to acquire the language skills that can communicate with others.

### 2.2 Academic Emotions

Academic emotions are defined as the academic settings that students experienced in emotions such as class-related, learning-related, and test-related situations and are characterized by subjective control and value perceived by learners in the control-value theory (Pekrun 2006). According to this theory, positive achievement emotions such as joy and hope related positively to K-12 students' interest and intrinsic motivation, whereas negative emotions such as anxiety, didn't relate. This model points that positive activating emotions (e.g., joy, hope, pride) enhance motivational engagement, whereas negative deactivating emotions (e.g., hopelessness, boredom, frustration) undermine motivational engagement.

In addition, these affective states are grouped according to the relative degree of positive versus negative valence and activation versus deactivation (e.g., Feldman Barrett & Russell, 1998). The circumplex can be transformed into a 2x2 taxonomy including four broad categories of emotions and moods (positive activating: e.g., enjoyment, hope, pride; positive deactivating: relief, relaxation; negative activating: anger, anxiety, shame; negative deactivating: hopelessness, boredom; Pekrun, 2006). Hence, academic emotions in this study defines to the emotions that the learners experienced in different situations in learning-related activities.

### 2.3 Emotional robots

Emotional robot is a subcategory of socially assistive robots (see Kolling et al., 2013, for a review). Emotional robots can perform this task by fulfilling the specific psychological needs of interaction, communication, companionship, and attachment. (C. D. Kidd, W. Taggart and S. Turkle, 2006) Therefore, emotional robot in this study, is that the robot which can satisfy psychological needs and communicate with others.

## III. Research Design

### 3.1 Experimental Design

The primary objective of the current study was to show the impact on learners' academic emotions while learning robot-assisted language learning system in an English classroom. The overall design in research method is quasi-experimental method. There were four times for the class in the research. In the first stage, we built the pretest with Zenbo Junior robot. In the second stage, we used the robot to keep the student data from the class. In the final stage, the final post-test will be conducted. The participants are all fourth graders. Compare the effectiveness of the class and to confirm whether emotional detection system in robot can enhance the students' academic emotions to learn and achieve

**Table 1.** Quasi-experimental method

Teaching Content and Methods	Pretest	Posttest
Course time	40 min/per class, for first time	40 min/per class, for final stage
Course Contents	Elementary school textbook	Elementary school textbook
Teaching methods	Using robots to teach children	Using robots to teach children
Software and hardware equipment	Zenbo Junior robot	Zenbo Junior robot

### 3.2 Research Instrument

Our post-test adopted the formal questionnaire AEQ designed by Pekrun. This questionnaire which is designed to assess various achievement emotions experienced by students in academic settings. The instrument includes scales for nine different emotions (enjoyment, hope, pride, relief, anger, anxiety, hopelessness, shame, and boredom) was supported two criteria. First, we selected emotions that occur frequently in students, as recorded in our exploratory studies (Pekrun, 1992c; Pekrun et al., 2002; Titz, 2001). Second, we chose emotions to reveal vital emotion categories as defined by the three-dimensional taxonomy outlined in advance. Accordingly, the AEQ is noted as activity emotions (enjoyment, tedium, and anger), prospective

outcome emotions (hope, anxiety, and hopelessness), and retrospective outcome emotions (pride, relief, and shame). The instrument measures both positive and negative emotions in terms of valence, and as for activation, it assesses both activating and deactivating emotions. As such, the AEQ makes up the four emotion categories comprising the valence and activation dimensions: positive activating (enjoyment, hope, pride); positive deactivating (relief); negative activating (anger, anxiety, shame); and negative deactivating (hopelessness, boredom). Students needed to read the corresponding questions carefully and choose the suitable options.

The instrument used for evaluating academic emotions was AEQ including four scales, positive activating, positive deactivating, negative activating, and negative deactivating along with a total of 8 questions for each section.

### **3.3 Research Questions**

- (a) Does Robot-Assisted Language Learning in this study has significantly enhanced learner's positive emotions?
- (b) Does Robot-Assisted Language Learning in this study has significantly reduced learner's negative emotions?

### **3.4 RALL Framework**

The RALL framework in our research is consisted of a programmable humanoid robot, Zenbo Junior (see Figure 1). The programmable robot, Zenbo Junior, is a commercial development toolkit that provides the features such as Block-based Programming and AI Sensing, face detection, and so on. There are several pieces of sensors, 3D simulators, and wireless Wi-Fi functions. This type of robots has the weight of 2.75 kg and 16GB storage. In this research, we used this robot in face detection. Using the face detection, it can record the learner's data and differentiate the emotions. Moreover, it has the adorable humanoid appearance. By using this robot, it can be suitable for students to the learning environment in schools because such an outlook can make students relaxed with the robot. Instead, they don't need to be nervous while they are learning.



Figure 1. Zenbo Junior

In order to promote the interaction of robot learning in the classroom and the adaptation and understanding of the classroom content, we intend to design a robot that can be used for teaching, which can cooperate with the teachers within the classroom and interact with students, by using different pronunciations and

intonations to help them in their class learning. The robot that we use is that the ASUS Zenbo Junior robot and scratch programming. Zenbo Junior programming is scratch-based coding that is used for children and it is easy to program by graph block. The students can use Scratch to code their own Zenbo Junior interactive actions in ZenboLab (see Figure 2).



*Figure 2. ZenboLab*

The goal is for the robot to assist both the teachers and the students after class. Robots are often used to teach school students, where teachers can use them to arrange their teaching courses and let students interact with them, to reinforce their interest and willingness to learn English. The final goal of our approach is for students to predict the students' emotions and improve their academic emotions. Our proposed system, which is predicated on emotional data, can help the teacher to note the student's learning emotions and performance. Our work is critical within the following four ways: Firstly, build the human face data in the model set. In this model, robot can be built up for six different face emotions. Secondly, open the camera to detect human faces. In emotion recognition system, it can record the images of the students. Thirdly, set the if else-statement in Zenbo lab with robot so that the robot can analyze the students' faces and differentiate the emotions. Finally, teachers can check the students' learning patterns by recognizing the emotions and retrieve better insights from the learning process with robots. Face detection AI was adopted as our emotional tool in our system to detect the students' facial expressions, and it records the students' facial expressions, also as their data. If we can collect more and more data on learning features, this could improve the educator's teaching model, and we could predict the students' learning performance, using machine learning or the Emotion Recognition System (see Figure 3).



Figure 3. Emotion Recognition System

### Build the model

To test students' emotions, we implemented the face detection model in our system which was classified by six kinds of emotions such as, happiness, sadness, anger, fear, disgust, and surprise. It was built by face data and then saved in the Cloud Database (see Figure 4).

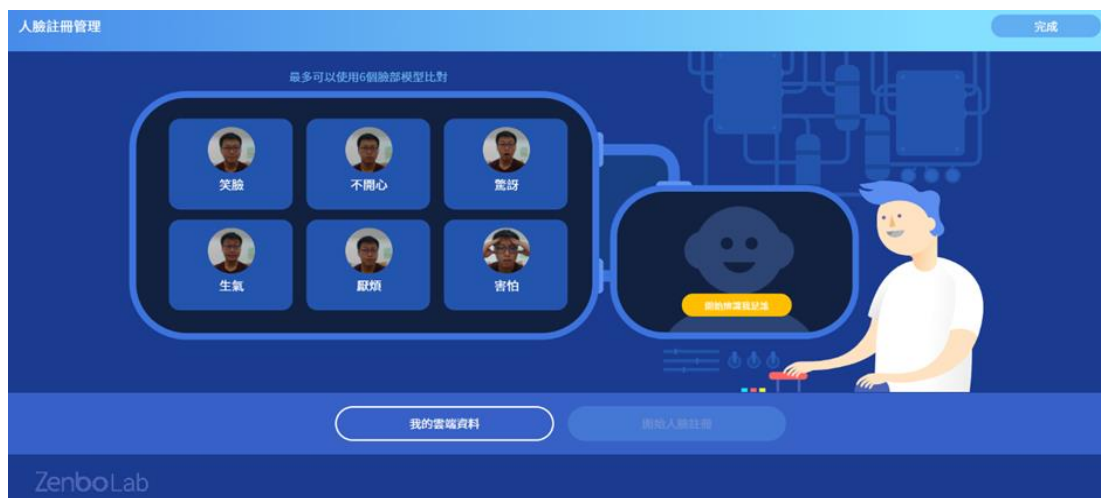


Figure 4. Cloud Database

### Open the Camera

In this section, we used the camera which is inside the robot to take photos from participants. According to these photos, they can be saved in the cloud data. Then, we choose the data to assist robots to detect human faces (see Figure 5).



Figure 5. Human face

### Set if-else statement

As we set if-else statement in ZenboLab, the robot can follow the command we set up. For instance, if the user set the command that is the robot can comfort people when the participant is unhappy (see Figure 6).

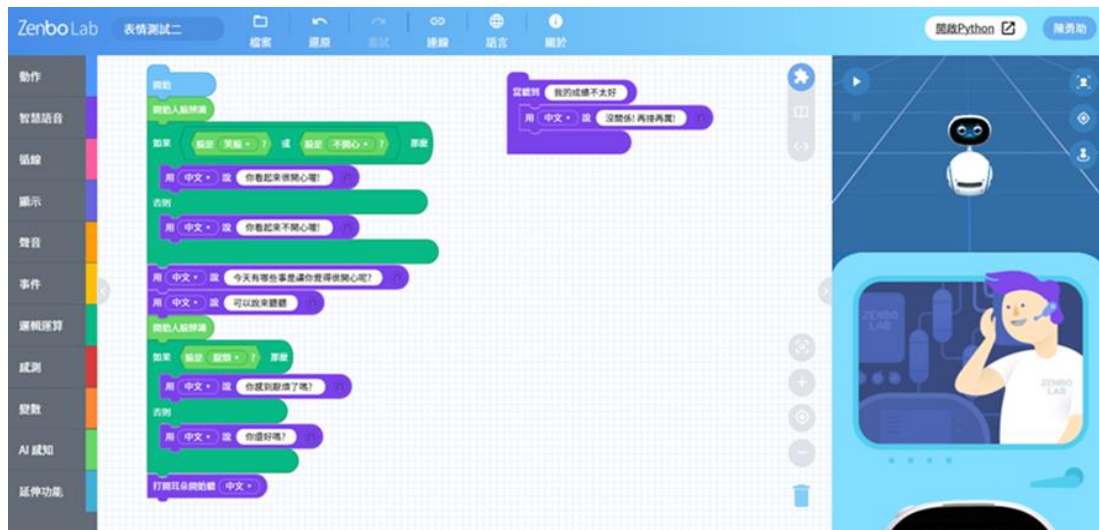


Figure 6. Set if-else statement

### Recognize the emotions

After setting if-else statement, we can implement the project on ZenboLab. The robot can differentiate the students' emotions so that it can interact with the participants (Figure 7).



Figure 7. Recognize the emotions

## 3.5 Participants

This study was conducted at an elementary school in Taiwan. The participants were fourth graders. These students' course would be designed with pretest and posttest. The robot would take these photos from these participants. The researchers did not inform students of the special experimental lessons to be learned partly because of the reason of protecting from Hawthorne Effect in doing course research, meaning if the subjects are told to be involved within the experiment, they could behave differently, unnaturally, or positively. In short, the experiment was integrated into normal lessons to get real research results.

## 3.6 Curriculum Design

The curriculum and teaching materials adopted during this experiment were supported on a textbook approved by the Ministry of Education in Taiwan. In the

experimental courses, the contents were presented in the system with a Zenbo Junior robot. The teacher conducted robot teaching activities in the class. The teacher engaged in all activities with a robot, and these activities are supported by the Zenbo Junior robot to share the teacher's jobs such as leading certain activities and accompanying the students in their learning processes.

Five types of teaching activities were applied in both classrooms: warm-up, story time, and sentence box, music box as well as play and say. Storytelling activity intended to facilitate listening ability. In the traditional class like the control group, the teacher can present a story in English and practice with students. However, in the class, the robot was assigned to be a main performer to read the story, do actions, and play games.

#### **The warm-up activity**

The warm-up activity was based on audio-lingual method that aimed at increasing a learner's verbal and pronunciation by reciting words and sentences. The robot would lead students to read words and sentences loudly. Furthermore, the student would also know the words with robot. If students can answer it correctly, the robot would say, "That's right." If students give the wrong answer, the robot would encourage them and say, "try again."

#### **Story time**

The story time activity aimed at facilitating learners' listening ability. In the group, the robot teacher would lead students to listen to words and sentences carefully. Furthermore, the student would also know the pronunciation of words and phrases.

#### **Sentence box**

The sentence box activity aimed at speaking correct sentences. In the group, the robot teacher would lead students to read and say the sentences. Furthermore, the teacher would also explain the structure of a sentence and vocabulary. That would facilitate an elementary learner to increase basic ability to write sentences correctly. The robot shared with the teacher's job to lead students to recite sentences. Compared with the human teacher, the humanoid robot might ease students' feelings of nervousness when they spoke in English.

#### **Music box**

The music box activity was aimed at pronunciation of song. The humanoid robot might offer the audio sample to students to mimic. Moreover, the robot can do actions and play the music at the same time.

#### **Play and say**

Play and say activity was aimed at gamifying the teaching materials. The robot can play with students and detect their emotions. Moreover, robot can give response

to student according to their emotions in order to increase their positive learning emotions.

During these curriculum design, the robot would detect student's emotions and give a response to students. For example, there is an answer and reply procedure in the robot system (see Figure 8).

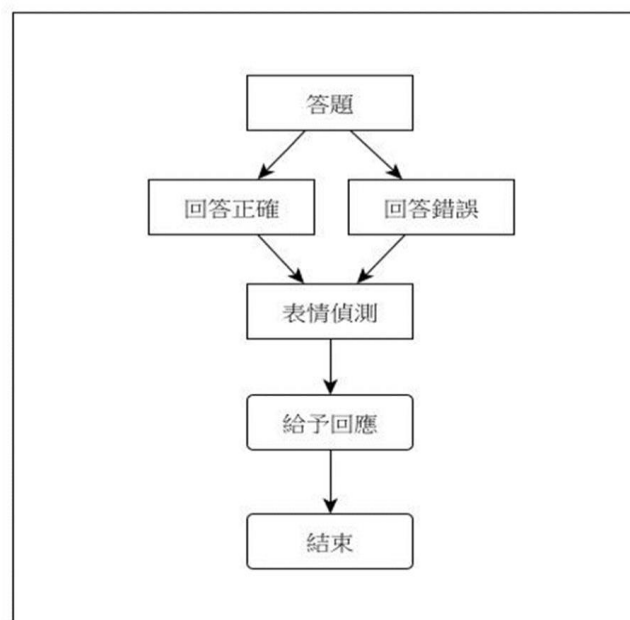


Figure 8. Answer and reply procedure

### 3.7 Data analysis

Numerical data contains the results of pre-test and post-test of the calculation of AEQ questionnaire. The results of the pre-test and the post-test were compared by SPSS 25 to examine whether the robot-assisted language learning method was significantly effective.

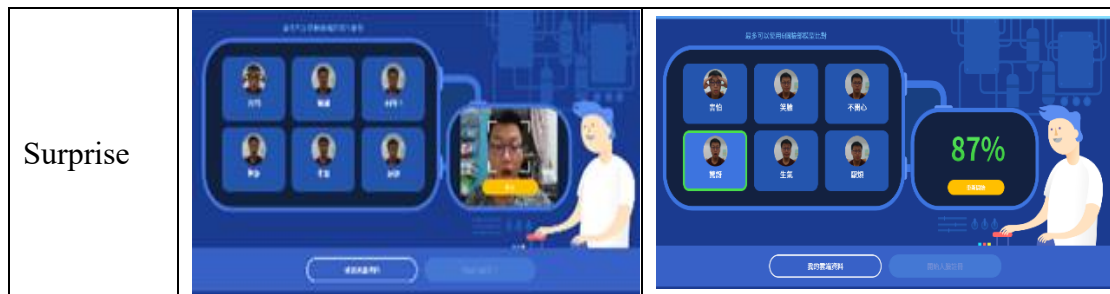
Interviews with the students and classroom observation were conducted mainly to gain qualitative information and deep insights into academic emotions by transcribing the recordings. It will make the study more comprehensive and objective and triangulate with the quantitative data.

## IV. Conclusion and Discussion

Up to this point, the results which facial expression system detected are consistent with those test data. From the face detection model, this system accuracy 83%-89% for total facial expression categories are 6 such as happiness, sadness, anger, scare, boredom, surprise. Using zenbo lab with block-based programming language, AI sensing in face detection has succeeded to predict the face model. For example, the compared model set in 6 emotions are as follow. (see Table 2)

Table 2. Compared model set in 6 emotions

Face Emotion	Test data	Accuracy
Happiness		
Sadness		
Anger		
Scare		
Boredom		



However, in this detection model, we haven't concluded that it can work on all the people. Due to the system, we can only detect someone's emotion who provides the face data. Hence, there is the need to develop the whole system which can detect different person in the future work.

## V. Future work

Based on our research results, more opportunities for future research in this field can be done to extend this work. First, more emotional data samples can be collected from many people in our system, and these samples can be used in the facial emotion recognition for the teaching purpose or testing purpose. Second, form an emotional big database to benefit other researchers in this area. If it has such a database that can be collected, it may become a milestone in the teaching field by using this emotion recognition system.

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## Appendix

### Play and Say

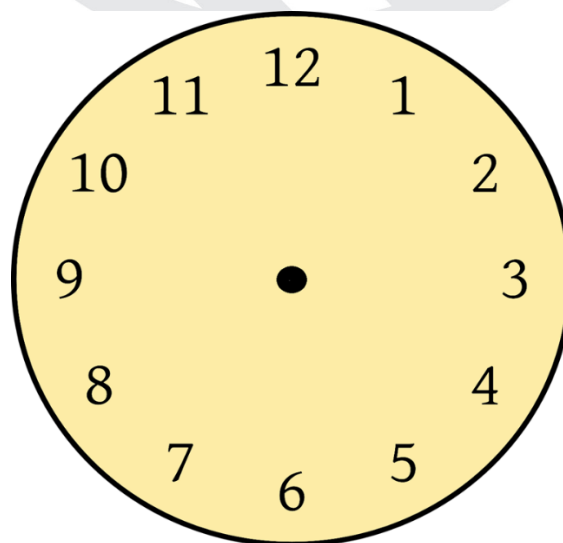
#### Can you ride a bike? (Lesson 1)

<b>Start</b>	<b>1</b> <b>Dance</b>	<b>2</b> <b>Go Forward</b> <b>1 Step</b>	<b>3</b> <b>Read</b>
<b>4</b> <b>Sing</b>	<b>5</b> <b>Go back</b> <b>1 step</b>	<b>6</b> <b>Ride a bike</b>	<b>7</b> <b>Draw</b>
<b>8</b> <b>Swim</b>	<del><b>9</b> <b>Start again.</b></del>	<b>10</b> <b>Can you</b> <b>Dance?</b>	<b>11</b> <b>Go Forward</b> <b>2 Step</b>
<b>12</b> <b>Can you</b> <b>Read?</b>	<b>13</b> <b>Hurry up!</b>	<b>14</b> <b>Try again.</b>	<b>Finish</b>

#### Game description:

Use the robot to download the dice app. Roll the dice and go forward! If the number is 6, students should say, "Ride a bike". Then take turn for the next one. Moreover, there is a trap in the map that is number 9. If someone gets this number, he or she will start again from the beginning. Finally, the first one who reached the finish line would be a winner.

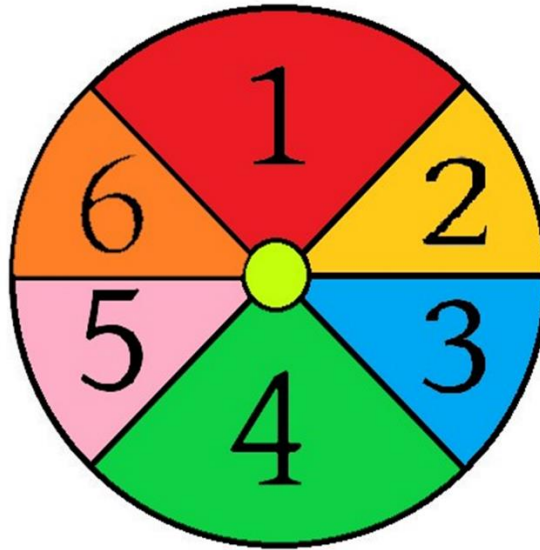
#### What time is it? (Lesson 2)



**Game description:**

Use the robot to download the spinner app. Start spinning before the number comes out. Each group has only one number. They can decide whether to show the number or not. When Students want to show the number, teacher can ask them, “What time is it?” They need to reply with the number they spin. For example, if the number is 3, then there will be third o’clock. Finally, the higher number who gets will wins.

**Where’s my hamster? (Lesson 3)**




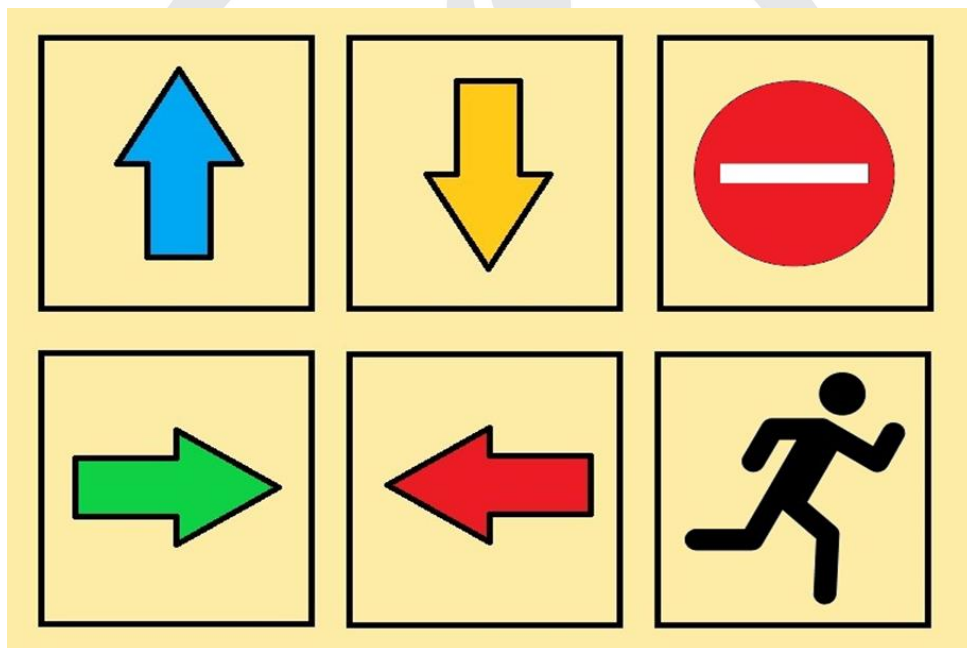
**Game description:**

When the teacher asked, “where is my hamster?” Then students use the spinner app to rotate the numbers. While the number comes out, turn the number card and answer the question. If students answer correctly, the group can get one point. If not, it will be another group to take turn. Finally, the one who get more points wins.

**Finding Joe (Lesson 4)**

<b>Start</b>			
			Living room
	Bathroom		
Kitchen			<b>Joe</b> Dining room

<b>Start</b>			
			Living room
Kitchen	<b>Joe Dining room</b>		Bathroom



**Game description:**

When the teacher asked, “Find Joe?” Then students use the cards to go forward. While the students use the direction cards to find Joe, say the cards you used. If students answer correctly, the robot would give you a bonus. Moreover, there are five function cards and one stop symbol in this game. For instance, go forward, go back, turn left, turn right, and jump card. As for stop symbol, if there is a stop symbol on the map, then this block can’t go forward. Finally, the one who finished the game, the robot would take the photo with him/her to complete the task.