MODELING THE EFFECTIVENESS OF TEACHING BASIC NUMBERS THROUGH MINI TENNIS TRAINING USING MARKOV CHAIN

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4 – 5 AUGUST 2021

CONTENTS

Introduction

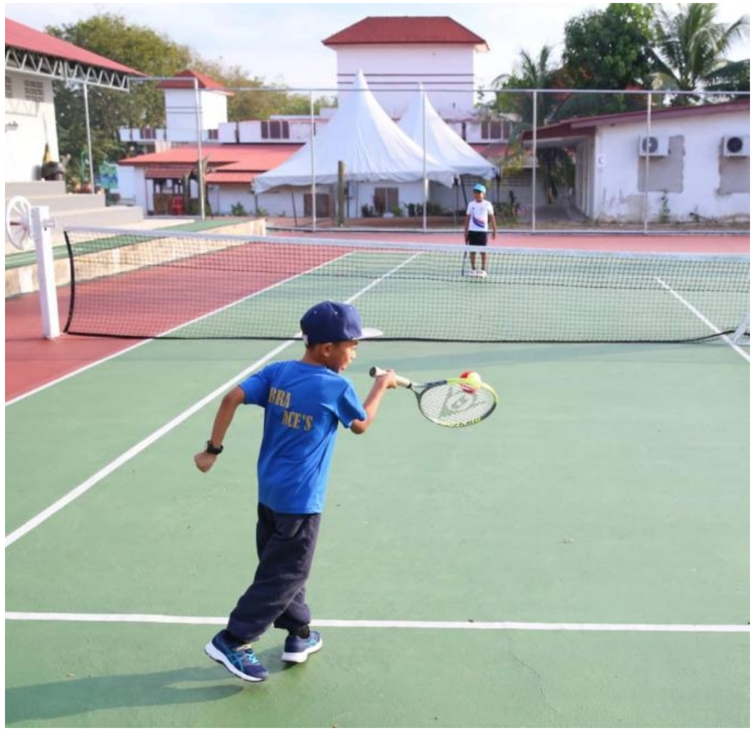
- Play activities in the teaching and learning process in school can benefit children in terms of development, learning and motivation as well as fun to play
- technique of counting basic numbers among children through a mini tennis game called AB-kiRA is introduced.
- guidance to instructors who will teach the basics of math to children through tennis game practice.
- ABRA is the abbreviation of the name of the founder of the children's tennis game training technique, namely Encik Abdul Rahim Bin Ismail, which was founded around the 1960s in Jitra, Kedah. The techniques practiced by him have proven successful in producing human beings with high self-esteem. These techniques will be absorbed according to the suitability of the current generation, technology and education.

Objectives

- to Introduce the new approach of learning basic numbers through mini tennis game called AB-kiRA.

- to measure the effectiveness of AB-kiRA using Markov chain model.

Mini Tennis



Literature Review

Most researchers agree the use of games can improve the achievement of mathematics subjects among children (Radford, 2020; Reikeras, 2020; Tsamir et al., 2020). Tsamir et al. (2020) stated that games are a positive method in improving achievement. According to them, children who are given the opportunity to play have a clear purpose, use materials to solve problems and require action to achieve goals, give children opportunities to relate play materials and provide space for children to imagine. The study of Tirosh et al., (2020) use the effects of training and transfer the executive function of preschool children, they found that playing repetitive games can improve the memory of working children. Tennis is a sport that requires repetitive shot practice. Therefore, this study chooses the sport of tennis as a game related to this theory in addition to the researcher's expertise in this field of play.

Methodology

- Experimental study

- 150 test samples were performed with the trainee hitting the ball 30 times while making the count. The experiments were conducted 150 times over 4 months. Trainees will be sent the ball to be hit in the form of practice and asked to count up to 30 counts. Correct counts are considered successful and incorrect counts are considered failed. The results are recorded as in Table 1 below.

Table 1: Transition Matrix of Observation on Trainee Performs Counting During Training.

		Count at n = i + 1		
		Pass (P)	Fail (F)	Total
Count at n = i	Pass (P)	100	23	123
	Fail (F)	23	4	27
	Total	123	27	150

$$P(\text{Count at } n = i{+}1 \mid \text{Count at } n = i) = \frac{n(\text{Count at } n = i{+}1 \cap \text{Count at } n = i)}{n(\text{Count at } n = i)}$$

Thus, the calculation of conditional probabilities is as follows:

$P(P \mid F) = \frac{n(P \cap P)}{n(P)}$ $= \frac{100}{123}$ $= 0.813008$	$P(F \mid P) = \frac{n(F \cap P)}{n(P}$ $= \frac{23}{123}$ $= 0.186992$
$P(P \mid F) = \frac{n(P \cap F)}{n(F)}$ $= \frac{23}{27}$ $= 0.851852$	$P(P \mid F) = \frac{n(F \cap F)}{n(F)}$ $= \frac{4}{27}$ $= 0.148148$

Next, the conditional probabilities are obtained as follows and constructed in the form of a transition matrix as in Table 2 below.

Table 2: Transition Probability Matrix of Observation on Trainee Performs Counting During Training.

		Count at $n = i + 1$		
		Pass (P)	Fail (F)	Total
Count at $n = i$	Pass (P)	0.813008	0.186992	1
	Fail (F)	0.851852	0.148148	1

$$\text{Tansition Probabillity Matrice, } \boldsymbol{T} = \begin{bmatrix} 0.813008 & 0.186992 \\ 0.851852 & 0.148148 \end{bmatrix} \qquad (1)$$

3. Equilibrium State

A steady state is a state where we can anticipate on the number of attempts to how many trainees will be able to master the skill of counting in the count of 30 correctly. The determination of trials at this steady state is important as a guide to be an indication of the minimum trials that need to be done during training in order to produce the skills desired by the trainee. In order to obtain a steady state, a transition matrix needs to be formed first. The transition matrix is the number of trainees who succeeded or failed to make the count known before the trainee had succeeded or failed to make the count. The transition matrix obtained in (i) is used to predict the k-state vector, X_k represents the probability of the trainee successfully making the calculation correctly on the k-th attempt which can be determined as below

$$\begin{aligned} \boldsymbol{X}_k &= \boldsymbol{X}_{k-1}\boldsymbol{T} \\ &= \boldsymbol{X}_{k-2}\boldsymbol{T}^2 \\ &= \boldsymbol{X}_{k-3}\boldsymbol{T}^3 \\ &\vdots \\ &= \boldsymbol{X}_{k-k}\boldsymbol{T}^k \end{aligned}$$

$$\therefore \boldsymbol{X}_k = \boldsymbol{X}_0\boldsymbol{T}^k$$

Next,by using Microsoft Excel, the results for 10 training trials with counts were predicted. Thus, the probability pattern of successfully making a calculation correctly can be plotted on a line graph. The equilibrium probability is obtained when the fixed state vector does not change its value on each subsequent attempt. Thus the steady -state vector, Q can be calculated using the following formula:

$$\boldsymbol{QT} = \boldsymbol{Q}$$

$$\boldsymbol{Q} = [q_1 \quad q_2]$$

The results for the trainee's 10th attempt to make the count correctly, X_{10} were compared with Q to test whether the probability of making the count correctly on the 10th attempt had reached equilibrium or not.

Results and Analysis

By using the original state vector, $x_0 = [0\ 1]$ assuming that the trainee failed to make the count correctly on the first attempt, the probability of the trainee succeeding or failing to make the count correctly on the 10 training attempts is shown as in Table 3 below.

Table 3: The probability of a trainee succeeding or failing to make a calculation correctly.

	$P(P)$	$P(F)$
x_1	0	1
x_2	0.851852	0.148148
x_3	0.818763	0.181237
x_4	0.820048	0.179952
x_5	0.819998	0.180002
x_6	0.82	0.18
x_7	0.82	0.18
x_8	0.82	0.18
x_9	0.82	0.18
x_{10}	0.82	0.18

The results showed that the probability of the trainee successfully making the count correctly focused to 0.82 as the number of attempts increased. However, the equilibrium probability for the trainee to successfully make the calculation correctly is reached when

$$\boldsymbol{QT} = \boldsymbol{Q}$$
$$\boldsymbol{QT} - \boldsymbol{Q} = \mathbf{0}, \text{ where } \boldsymbol{Q} = \boldsymbol{QI}$$
$$\boldsymbol{Q}(\boldsymbol{T} - \boldsymbol{I}) = \mathbf{0}$$

$$[q_1 \quad q_2]\left(\begin{bmatrix} 0.813008 & 0.186992 \\ 0.851852 & 0.148148 \end{bmatrix} - \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\right) = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$[q_1 \quad q_2]\begin{bmatrix} -0.186992 & 0.186992 \\ 0.851852 & -0.851852 \end{bmatrix} = 0$$

Since the system of equations has a trivial solution, the values of q_1 and q_2 are equal to 0. However, the steady -state vector must have the sum of all elements 1, therefore the trivial solution is rejected. In order to find another solution, another constraint needs to be added to the system of equations i.e.

$$q_1 + q_2 = 1$$

Finally the following result is obtained;

$$\boldsymbol{Q} = [0.82 \quad 0.18]$$

This means that the probability of the trainee successfully making the count correctly is stable at 0.82 after several training attempts are conducted. While the probability of trainees failing to make the count correctly was stable at 0.18 after several training attempts were conducted. It is clear that x_{10} is equal to Q, therefore, we can conclude that the chance for the trainee to successfully make the count correctly during training is stable after 10 training attempts are performed.

Conclusions

- Mini tennis exercises that require repeated shots of the ball can be used to train children to master basic number counting skills.
- cultivate children to master both academic and sports skills at the same time.
- The AB-kiRa Markov chain model developed in this study predicts the minimum number of shot-while-counting training attempts required by trainees to master a set of ascending number counting skills.
- This model has the potential to be expanded to other training skills where consistency is a key element in the training studied.

THANK YOU

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