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Article

Development of An Award-Winning Board Game for Teaching Children about Road Safety

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Abstract: Innovative Traffic Safety Teaching Aids (ITSTA), a new educational board game designed to teach children important road safety rules. Through the design patent, this product was exhibited in the Green Idea International Invention Competition and won the gold medal. This study has two main objectives. Firstly, it presents the practice of designing and manufacturing the game set, and secondly reports the analysis of both quantitative and qualitative results on its educational effectiveness. In the design thinking process, the researchers compared commercial road safety teaching products available in the market. They established six key elements that helped shape the development of the board game. After the initial stage, the researchers progressed to production stage, at which they made drawings of all ideas, producing scaled down versions, and testing the complete model. The mixed methods research was also used to increase the level of understanding regarding the effectiveness of the new product. A 12-question, 5-point Likert-scale questionnaire was administered to 34 educate givers to collect quantitative data, while interviews were conducted for qualitative data. The findings show that the majority of the personnels reported a preference of ITSTA over other competitors in the same market. The three themes that emerged from interview data are facilitation, autonomy, and challenges.

Keywords: Early childhood education, Teaching innovation, Road and traffic safety, Board game, Product design

1. Introduction

In 2020 alone, traffic accidents caused 2,972 deaths and more than 480,000 minor or serious injuries in Taiwan. These traffic accidents affected not only the victims but also their families. Transportation is an everyday activity for many of us. When the advancement in technology changes traffic conditions, it becomes necessary to modify road traffic safety education to respond to the changes. In school, administrators and teachers first ensure that everyone follows traffic safety procedures, then create and teach lessons tailored to the traffic environment in which the school is located. After that students' learning outcomes should be evaluated by surveys or other instruments to understand if the level of awareness towards traffic safety has improved.

The Ministry of Education in Taiwan released the Children's Traffic Safety Handbook to introduce children to being safe around traffic and obeying traffic safety rules. Unfortunately, this handbook is designed only for elementary school students, inappropriate for younger children or kindergartners. Therefore, we developed a set of teaching materials, including special traffic signs and maps, to increase kindergarten students' traffic safety knowledge. The purposes of our study were: (1) investigating the advantages and disadvantages of commercial traffic safety educational toys currently available in the market; (2) using concept maps to clarify relationships before setting the main design direction for our project; (3) drawing a blueprint and making a prototype of the product Innovative Traffic Safety Teaching Aids (ITSTA) based on the blueprint; (4) creating a questionnaire that gathers information about the product outcome and administering it to 34 parents; and (5) interviewing nine administrators or teachers who had utilized our product to teach their kindergarten students (four or five years old), and collecting experience data that can be used in future product development.

2. Design Concepts of Innovative Traffic Safety Teaching Aids

Teaching aids are important for children's development (Guo, 2011). Innovative Traffic Safety Teaching Aids (ITSTA) was designed to help preschoolers to understand traffic signs and obey traffic rules (see Table 1). ITSTA is a board game set that

introduces kids to different road dangers. It has a board, playing car shape pieces, and a picture book component. Students move their pieces along the board and complete quests to win the game. The picture book that was created around bear characters and their castle gives knowledge regarding traffic signs and rules. ITSTA helps preschoolers improve their road safety awareness and accident response by understanding the interrelationships between pedestrians, cars and roads correctly through the role-play practice.

Table 1. Teaching Aids Items, Design Concepts and Production Methods.

<table>
<tr><th colspan="4">Complete Set of ITSTA</th></tr>
<tr><td colspan="4">  </td></tr>
<tr><th>Items</th><th>Photo</th><th>Design Concept</th><th>Production Method</th></tr>
<tr><td>Game Board</td><td>  </td><td>A simple map of students' neighborhood with common road traffic signs motives and attracts students to learn.</td><td>Make a cut out map from non-woven fabric. Weaved images of buildings and traffic objects include fire stations, parks, hospitals, schools, police stations, gas stations, post offices, convenient stores, railway stations, construction sites, residences, parking lots, public restrooms, roundabouts, sidewalks, crosswalks, traffic lights and level crossings.</td></tr>
<tr><td rowspan="2">Custom Bottle Caps & Playing Cards</td><td>  </td><td rowspan="2">Help children start to recognize and identify common traffic signs and symbols often seen in their daily life.</td><td>Print and laminate symbols and signs on bottle caps, such as warning signs, symbols of various institutions, prohibition signs, instruction and traffic signs.</td></tr>
<tr><td>  </td><td>Use a computer program to create an image file using traffic signs, playing card symbols and numbers. Print the design on card-stock.</td></tr>
</table>

Table 1. Teaching Aids Items, Design Concepts and Production Methods (cont.)

Item	Photo	Design Concept	Production Method
Soft Toy Cars		Kids are naturally attached to cars. So they get excited to play this game using car pieces.	Hand sew all different models of cars (postal card, taxi, ambulance, private car) with non-woven fabric and white cotton.
Wooden Doll Figures		Kids are also attracted to colorful wooden doll figures.	Put on layers of paint on wooden dolls with different sizes and shapes and wait until the water evaporates to let the paint dry.
Card Sets		Number cards, point cards, and task cards are used with the board game to provide concentrated practice for preschoolers.	Cut out images from computer and paste on playing cards.
Picture Manual		A picture instruction manual gets kid' attention and develops their love for reading. The manual lists and explains rules and all objects in the game.	Draw and cut the characters and settings. Write down the tasks that kids need to complete.
Movable Characters		Use movable characters to complement the story manual to enhance kids' learning experience.	Make a paper cut-out of supporting characters. Laminate and attach Velcro to the character.

3. Results and Discussion

3.1. Quantitive Research

3.1.1. Research Tool

The researchers of the study developed a questionnaire for research due to the lack of pre-existing questionnaire on efficacy of road safety teaching aids for preschoolers. The researchers identified the basic features that the aids should have, and created questions that collect information to determine if the effects exist and their sizes. Three experts were then invited to review the questions and to give feedback. The questionnaire has 12 questions using a five-point Likert scale with response options ranging from 5 being "extremely appropriate," 4 being "appropriate," 3 being "normal," 2 being "inappropriate" and 1 being "extremely inappropriate."

One hundred childcare professionals were selected for the pretest of the questionnaire. Of the participants, 44% fell between the ages of 21–30, 42% were aged 31–40, 9% were 41–50 and 5% were 51–60. In regard to the job categories of participants, 81% were edu-care givers, 15% were daycare staff, and 4% worked for after school programs. The test of homogeneity was used for testing whether each individual item-score and the total score highly correlated. If the correction coefficient (r) is lower than 0.35, it is a negative relationship, indicating the item is irrelevant and should be excluded from the questionnaire (Lin & Qiu, 2008). The results show that each item score highly related to the total score (see Table 2), so all items were used. Then 100 questionnaires

were sorted from high to low scores. Independent sample t-tests were performed and all items were retained as they demonstrated CR values greater than 3.5 (Wang, 1999).

Table 2. Homogeneity Test Results.

Items	*r*	CR	Note
1	0.40	5.02	Retain
2	0.72	10.29	Retain
3	0.74	10.04	Retain
4	0.76	13.66	Retain
5	0.77	13.36	Retain
6	0.68	9.67	Retain
7	0.70	8.62	Retain
8	0.72	7.96	Retain
9	0.69	7.98	Retain
10	0.74	9.02	Retain
11	0.76	8.85	Retain
12	0.76	10.37	Retain

Kaiser-Meyer-Olkin (KMO) was conducted to understand the strength of correlation between the items. KMO values closer to 1.0 are considered ideal (Wu, 2013). The KMO value of the questionnaire is 0.87. It was good enough for factor analysis to commerce. The Bartlett's test of Sphericity was also used to test the null hypothesis that the items are unrelated and not ideal for factor analysis. A statistically significance was found, rejecting the hypothesis and indicating sufficient common items in matrix (Wu, 2013). In factor analysis, principle component analysis (PCA) was used for extracting factor loadings with magnitudes above 0.3 and eigenvalues above 1, considered significant. Two significant factors were identified. The eigenvalue of the first factor (Factor I), named Functions of Picture Books and Teaching Aids, was 6.07 with the variance of 50.55% while the second factor (Factor II), Characteristic of Picture Book and Teaching Aids, had an eigenvalue of 1.17 with 9.75% variance. The combined explained variance was 60.3% (see Table 3). Additionally, Cronbach's alpha measures the reliability of the survey items. The value of 0.91 indicates the response value for each participant across the items are consistent.

Table 3. Results of Factor Analysis.

#	Statement	Factor I	Factor II
4	Picture books and teaching aids enable young children to learn traffic concepts.	0.87	
3	Picture books and teaching aids help young children know how to stay alert for traffic danger to protect themselves.	0.82	
5	Picture books and teaching aids allow young children to learn the concepts of classification and generalization.	0.78	
11	Picture books and teaching aids are carefully designed and made.	0.74	

2	Picture books and teaching aids help young children recognize traffic signs.	0.67	
10	Picture books and teaching aids help children improve their language comprehension.	0.63	
12	Picture books and teaching aids are practical and they easy for children to use.	0.57	
6	Picture books and teaching aids allow young children to improve social skills.	0.55	
9	The content of picture books and teaching aids attract children's attention.	0.54	
1	The content of picture books and teaching aids boost children's learning motivation.		0.78
8	Picture books and teaching aids are age appropriate.		0.76
7	The game has a variety of challenges, accessories and playing rules.		0.58
Eigenvalue		6.07	1.17
Variance		50.55%	9.75%
Cumulative Explained Variance			60.3%

3.1.2. Data Collection & Analysis

Thirty-four educare givers were recruited for the main study. The data collection process involved two key steps. First, the participants used traditional teaching aids (TTA) and completed the newly-developed questionnaire. Second, they used Innovative Traffic Safety Teaching Aids (ITSTA) and answered the questionnaire again. Table 4 and Table 5 present the mean scores and standard deviations obtained for Functions Subscale and for Characteristics Subscale.

Table 4. Mean Scores and Standard Deviations for Functions Subscale.

#	Statement	TTA		ITSTA	
		M	**SD**	**M**	**SD**
4	Picture books and teaching aids enable young children to learn traffic concepts.	2.7	0.7	4.8	0.33
3	Picture books and teaching aids help young children know how to stay alert for traffic danger to protect themselves.	2.7	0.76	4.85	0.36
5	Picture books and teaching aids allow young children to learn the concepts of classification and generalization.	2.76	0.7	4.85	0.36
11	Picture books and teaching aids are carefully designed and made.	2.76	0.65	4.85	0.36

#	Statement	TTA		ITSTA	
		M	SD	M	SD
2	Picture books and teaching aids help young children recognize traffic signs.	2.91	0.62	4.85	0.36
10	Picture books and teaching aids help children improve their language comprehension.	2.52	0.61	4.79	0.54
12	Picture books and teaching aids are practical and they easy for children to use.	2.94	0.64	4.79	0.59
6	Picture books and teaching aids allow young children to improve social skills.	2.85	0.70	4.88	0.33
9	The content of picture books and teaching aids attract children's attention.	2.85	0.65	4.88	0.41

Note: M = Mean; SD = Standard Deviation

Table 5. Mean Scores and Standard Deviations for Characteristics Subscale.

#	Statement	TTA		ITSTA	
		M	SD	M	SD
1	The content of picture books and teaching aids can arouse children's learning motivation.	3.15	0.66	4.74	0.51
8	Picture books and teaching aids can meet the age of children.	2.79	0.69	4.79	0.48
7	The picture books and teaching aids have diverse levels and rich accessories, providing a variety of ways to play.	2.85	0.70	4.88	0.33

The dependent sample t-test compares the scores for both sub scales from the same participants (Table 6). The p-value was 0.05. It was considered statistically significant to denote ITSTA have better functionality and characteristics than TTA do. According to Cohen (1988), a Cohen's d value of 0.2 represents a small effect size; a value of 0.5 represents a medium effect size and a value of 0.8 represents a large effect size. The d value indicates the ITSTA is medium size.

Table 6. Results of Dependent Sample T-test.

Subscale	M		SD		t-Value	Cohen's d
	TTA	ITSTA	TTA	ITSTA		
Functions	2.78	4.85	0.83	0.23	19.51	0.62
Characteristics	2.93	4.8	0.57	0.40	15.36	0.71

Note: TTA = Traditional Teaching Aids; M = Mean; SD = Standard Deviation

3.2. Qualitative Research

3.2.1. Interviews

Nine edu-care givers were invited for a semi-structured interview about their experience using Innovative Traffic Safety Teaching Aids (ITSTA). Prior to the interview, signed consent forms were collected. The interview was audio-recorded and

transcribed with permission from each participant. Codes and themes identified from interview data were visualized using a patented synthetic concept mapping in qualitative research proposed by Chaung (2016). The first participant's key and subordinate concepts were identified, ordered in hierarchical format, and connected with lines. The next step was to use the participant's map as the base to develop a more developed version of concept map with ideas from other participants (see Figure 1).

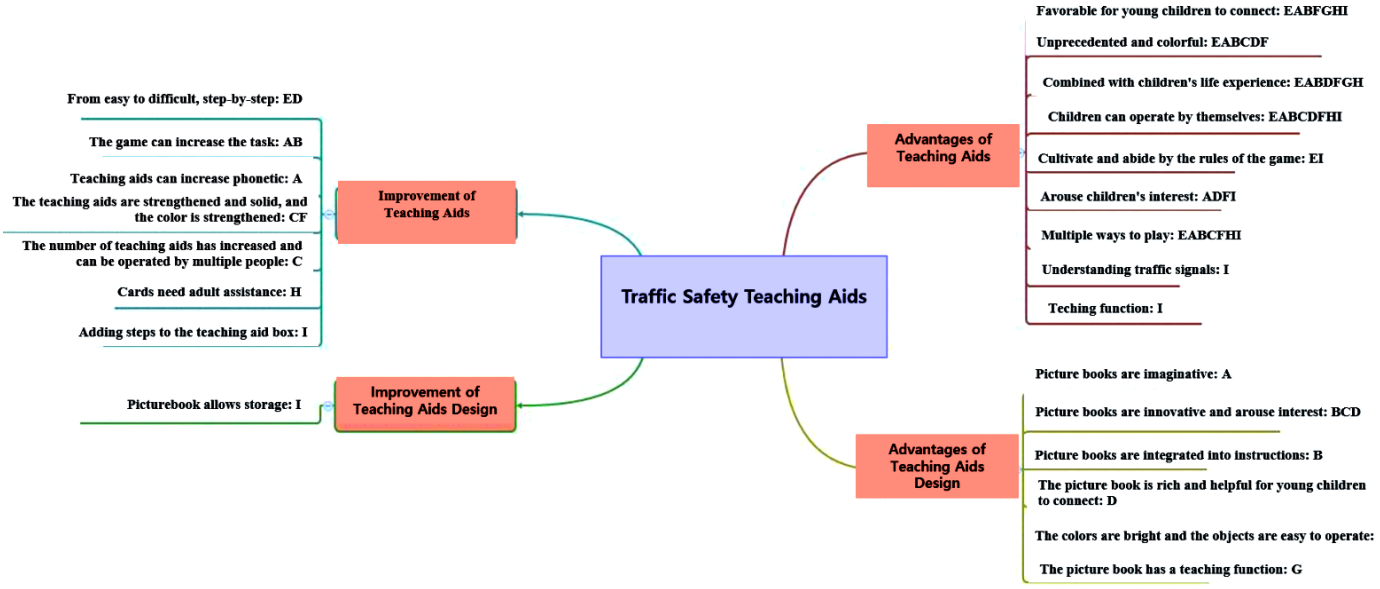

Fig. 1. Integrated Concept Map.

3.2.2. Kid-Friendly, Life-Related Product

Seven participants reported that the phonetic symbols and illustrations on playing cards help children to develop literacy skills that they learn at primary school. Most participants also believed that pictures, images of buildings and signs on the game map are some things that children see in everyday life. Their responses were:
"Reading customized picture books allows children to practice Pinyin." (Participant A)
"Children need assistance at most time playing the game. They wanted to play the game so they got more practice for pronunciation." (Participant B)
"Kids are excited when they are able to name the signs they see on the road." (Participant B)
"Children learn to match traffic vocabulary and symbols that they can see everyday." (Participant H)
"Created the features for the communities where the schools are located." (Participant E)

3.2.3. Uniqueness and Colorfulness

Five participants stated that the combos of color and fabric are carefully designed, and bright colors attract children's attention and stimulate their interest for playing the game. Participant A said, " Tools are in many different colors. The content relate to children's life;" Participant C mentioned that using teaching aids helps children to touch and discriminate different textiles and materials.

3.2.4. Functions of Teaching, Learner Autonomy and Mutual Respect

Two participants argue that ITSTA truly helps edu-care givers to teach road safety knowledge and to build road safety habits that keep their children safe. Participant F revealed that children learn about road safety faster than usual while playing the game. Participant I emphasized abundant learning opportunities provided by the game. Other participants believed that both ways of playing—playing solo or with a group. Playing the game alone develops their ability to learn independently. Children know how to learn and explore topics of interest. On the other hand, playing the game in groups and following its rules fosters mutual respect and communication. Children learn to understand fairness and to consider the feelings of others. The participant responses include:
"Children can play the game alone" (Participant D)
"Number of players for the game is one to four. A child can play alone or find other kids to play with." (Participant H)
"Guide children to follow the rules or create new rules together." (Participant E)

4. Conclusion

ITSTA, Innovative Traffic Safety Teaching Aids, was designed and tailored to effectively teach children about road safety. Compared to traditional teachings aids, ITSTA is better in both functions and features. It is also easy for children to use, and it can be adapted by educare givers for fostering specific academic and social skills.

5. Patents

This product was patented for special design. The legal right shows that the study and its product development process are original and novel. Patent information: Chaung, Y.-J., Hung, L.-L., Chen, M.-Y.,.& Cheng, Y.-H. (2024). Teaching aids. Design No. D230949, Taiwan, 2024.4.21-2038.8.1.

Author Contributions: Y. J. Chaung —literature review, research design, questionnaire administration, reliability and validity, and statistical analysis. Y.-H. Cheng, L.-L. Hung, & M.Y. Chen —picture book illustration, teaching aid ideas, questionnaire design, product production, and conducting interviews. H.-C. Chen —proofreading. N.-J. Chen — Establishment of reliability and validity of questionnaire, instruction for use picture book: Ning-Jung Chen. All authors have read and agreed to the published version of the manuscript.

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