

# THE VALIDATION OF NOVEL GAME FOR CHILDREN – STRUCTURED SPATIAL SKILL EDUCATIONAL VIDEO GAME

MRS MADHUMATHI K MPT (PAEDS NEURO)

Assistant Professor, School of Physiotherapy, Vels Institute of Science Technology and Advanced Studies  
Thalambur, Chennai, Tamilnadu, India.

DR. P. SENTHIL SELVAM MPT (ORTHO) PH.D

HOD, School of Physiotherapy, Vels Institute of Science Technology and Advanced Studies.  
Thalambur, Chennai, Tamilnadu, India.

DR. S. S. SUBRAMANIAN, MPT (ORTHO) PH.D

Principal, Sree Balaji College of Physiotherapy, Chennai, Tamilnadu, India.

DR. JIBI PAUL MPT, PHD

Faculty of Physiotherapy, Dr. MGR Educational and Research Institute.

## Abstract

**Introduction:**The play integrated learning is one of the pedagogies of teaching in the early childhood education. The attention of the children in the classroom increases when the teaching is blended with games-based learning. The digitalized version of the same game with incorporated curriculum concepts and academic outcome based will further increases the motivation of the children. The Structed spatial skills training educational video game is designed under the factor of spatial skills improvement, academic based and child-oriented game. The novel games should be validated before it comes for the clinical trials.

**Methods:**A survey is carried with a sample size of twenty physiotherapist who have experience in the paediatric fields for about 10-15 years. The questionnaire which consist of 25 question is developed to check whether the game is related to spatial skills (Q1 – Q 8) , has academic outcomes (Q 9 – Q 14) and it is child-oriented game (Q 15- Q 25).Each survey question used 5-point scale (Strongly Agree, Agree, Undecided, Disagree, Strongly Disagree) to measure a respondent's agreement on the questions related three attributes of the structured spatial skills educational video game.

**Results:** The descriptive statistics showed that majority of the subjects were agreed or strongly agreed to all the questions related to Spatial Skills, Academics and Child Orientation of the structured spatial skills training educational video game. The results of hypothesis test showed that the mean values of total score of all the three attributes were greater than the respective end points.

**Discussion:** These results confirm that the structured spatial skills educational video game is a valid learning tool and can be used as a method of pedagogy of learning among the students.

**Keywords:** game-based learning, learning, spatial skills, validation.

## I.Introduction

Digital games once thought to be a source of entertainment has now changed to be the source of teaching and learning. It is the human-computer interaction where the people with disabilities can also make the accessibility(1). It supports the learning in terms of “conceptual understanding” (2). Playing video game itself increases the spatial skills of the children, if the game includes the characteristics of spatial skills, academics syllabus and child-oriented game it will furtherreinforce the cognitive development. The spatial ability is defined as “the capacity to understand and remember the spatial relations among the objects”(3). The spatial ability are related to the reading, writing and maths skills of the individual but this skills is not evaluated and mostly it will be missed in the measurement(3). Numerous educational games are designed, this video game is designed on the concept of therapeutic intervention which can be used by both typically and atypically developed children. Structured Spatial Skills training educational game is designed under the spatial skill concept. It has seven games and three levels with increasing the challenges.

The games are as follows: Maze, Puzzle, Mental rotation, matching shapes, Identifying objects and Spatial language. Each child will have specific login ID and password, another therapeutic fact is the time factor is controlled. The entire game can be played only for 40 minutes in a day, three times in a week and game will be automatically locked after twenty-four play session. All these specifications are monitored from the remote server. To make the game to be even easier and fun full it has easy understanding hints, instruction, scoring method, mild colours, sound, the cartoon characters Sai and Sri. It also has motivation popups, mind map, game flow and scoring system. The novel games should be validated before going to the use of clinical trials. The objective of the study is to validate the structured spatial skills educational video game as a method of pedagogy of learning among the students. This type of game is necessary to make the learning and teaching easier not only in early childhood education but will be taken to the next grades of the children. **Null Hypothesis, H<sub>0</sub>:** The structured spatial skills educational video game is not valid learning tool and cannot be used a method of pedagogy of learning among the students. **Alternate hypothesis, H<sub>1</sub>:** The structured spatial skills educational video game is a valid learning tool and can be used a method of pedagogy of learning among the students. **Research Questions for validating the game are as follows.** Whether the spatial skills will be improved if the game is played by the child, whether the game is related to academics, Whether the game is child oriented.

**Method and materials** - The purpose of the study is to validate the structured spatial skills educational video game as a method of pedagogy of learning among the students. To validate this video game, a survey had been conducted with a **sample of 20 physiotherapists** with 10 to 15 years of experience in Paediatric Field. The survey questionnaire contains 25 questions, of which first 8 questions are related to **Spatial Skills** (to check whether the spatial skills will be improved if the game is played by the child), followed by 6 questions from Question 9 to 14, which are related to **Academics**, while the remaining 11 questions are to check whether the game is **Child Oriented**.

For the purpose of analysis, each study variable or question has been renamed suitably as shown in the following table:

Table 1: List of questions and its variable name

LIST OF QUESTIONS	Variable Name
1. Playing maze will improve spatial skills	Maze
2. Playing puzzle will improve spatial skills	Puzzle
3. Playing mental rotation will improve spatial skills	MentalRotation
4. Playing blocks will improve spatial skills	Blocks
5. Playing matching shapes will improve spatial skills	MatchingShapes
6. Playing identifying objects will improve spatial skills	IdentifyObjects
7. Playing spatial language will improve spatial skills	SpatialLanguage
8. Maze, puzzle, mental rotation, blocks, shapes, identification of objects, spatial language are related to the spatial skills	RelatedSpatialSkills
9. This game can be introduced as the pedagogy method of learning	PedagogyMethod
10. The SSST Edu game is related to academics	Academics
11. The SSST Edu game is related to mathematics	Mathematics
12. The SSST Edu game is related to spatial skills	SSST_SpatialSkills
13. The SSST Edu game is academic outcome based digital game	SSSTAcademicOutcome
14. The SSST Edu game has all the features of digital educational games for children	SSST_DigitalEduGame
15. The child is attentive throughout the game	ChildAttentive
16. The games motivates the child to play	ChildMotivates
17. The game is purely child centred	ChildCentred
18. The game is playable by the child	ChildPlayable
19. The game is fun filled	ChildFunFilled
20. The scoring motivates the child to play	ChildScoringMotivates
21. The game is easily understandable by the child.	ChildUnderstandable
22. The success notification makes the child to be happy and play further	ChildSuccessNotification
23. The game is therapy focused hand eye coordination play	ChildTherapyFocused
24. The game has the increasing level of challenges	ChildChallenges
25. The hints and instructions will make the child to play easily	ChildHintInstructions

SSST Edu game: Structured spatial skills training educational game.

The questionnaire totally contains Age and Gender of Physiotherapists and also 25 questions to measure three attributes of Structured spatial skills educational video game as a method of pedagogy of learning among the students. Those three attributes are **Spatial Skills, Academics and Child Oriented**.

Each survey question used 5-point scale (**Strongly Agree, Agree, Undecided, Disagree, Strongly Disagree**) to measure a respondent's agreement on the questions related to the above said three attributes of the structured spatial skills educational video game. To analyse the respondents' level of agreement on each question, the 5-point scale has been recoded with numerical

values as follows: **1 = Strongly Disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, 5 = Strongly Agree.** **Descriptive Statistics includes** Frequency Distribution of Demographic Variables – Age and Gender, Summary of responses to each survey question using 5 Point Likert Scale, Descriptive Statistics of each measure/attribute – Spatial Skills, Academics, and Child Oriented. **Inferential Statistics includes Spatial Skills:** To test whether the spatial skills will be improved if children play the game (i.e., To test whether the mean score of “Spatial Skills” is greater than 32), **Academics:** To test whether the game is related to Academics (i.e., To test whether the mean score of “Academics” is greater than 24), **Child Oriented:** To test whether the game is child oriented (i.e., To test whether the mean score of “Child Oriented” is greater than 44)

The age and gender distribution tables show that majority (90%) of the Physiotherapists involved in this study belongs to the age group of 36-40 years, while 60% are female and 40% are male. The questions related to SPATIAL SKILLS, almost all the subjects (100%) have responded that they Strongly Agree with the first 8 questions which are related to the improvement of SPATIAL SKILLS due to various features of the game. The 6 questions related to Academics for which at least 70% of the subjects have responded that they Agree or Strongly Agree with the questions related to Academics. For question related to Mathematics (Question No. 11), 30% of the subjects were responded as ‘Undecided’ and the remaining 70% were Agree or Strongly Agreed. Similarly, for question related to Academic Outcome (Question No. 13), only 10% of the subjects were responded as ‘Undecided’ and the remaining 90% Agreed or Strongly Agreed. For the remaining 4 questions, all the subjects were either ‘Agreed’ or ‘Strongly Agreed’ that the Game is related to Academics. The 11 questions related to **Child Oriented** for which at least 55% of the subjects have responded that they Agree or Strongly Agree with the questions related to Child Oriented. Even though, for some of the questions, the response was ‘Undecided’, the percentage of subjects responded as ‘Undecided’ is less than 50% and majority of the subjects have responded as either Agree or Strongly Agree with each of the question related to “whether the game is child oriented”.

Table 2: Descriptive Statistics of each measure/attribute – Spatial Skills, Academics, and Child Oriented

Descriptive Statistics					
	N	Minimum	Maximum	Mean	SD
SPATIAL_SKILLS	20	40.0	40.0	40.0	0.0
ACADEMIC_RELATED	20	22.0	30.0	27.0	3.0
CHILD_ORIENTED	20	41.0	55.0	48.9	6.1

From the above table, we see that the mean score of Spatial Skills is 40 (SD = 0), while the mean score of Academic Related is 27 (SD = 3.0) and the mean score of Child Oriented is 48.9 (SD = 6.1).

**Inferential Statistics:**

**Spatial Skills: To test whether the mean score of Spatial Skills is greater than 32.**

**Hypotheses:** Null hypothesis,  $H_0$ : The mean score of **Spatial Skills** is not greater than 32 (i.e.,  $\mu = 32$ ). Alternate hypothesis,  $H_0$ : The mean score of **Spatial Skills** is **greater** than 32 (i.e.,  $\mu > 32$ ). One-Sample t-test is applied at the level of significance  $\alpha = 0.05$

Table 3: Result of the inferential statistics of spatial skills

	N	Mean	SD	End Point (i.e., Population Mean)
SPATIAL_SKILLS	20	40.0	0.000	32.0

From the above result, we can see that the mean score of **Spatial Skills** is 40 with the standard deviation of 0. This clearly shows that all the questions under this attribute are having the same value as 5 (i.e., Strongly Agree) due to which t-test cannot be conducted as the standard deviation is zero. However, since the mean value is 40 which is the maximum possible value for this attribute, the null hypothesis is rejected at 5% level of significance. Hence, the evidence is sufficient to conclude that the mean score of **Spatial Skills** is **greater** than 32.

**Academics: To test whether the mean score of Academics is greater than 24.****Hypotheses:**

Null hypothesis,  $H_0$ : The mean score of **Academics** is not greater than 24 (i.e.,  $\mu = 24$ ). Alternate hypothesis,  $H_0$ : The mean score of **Academics** is **greater** than 24 (i.e.,  $\mu > 24$ ). One-Sample t-test is applied at the level of Significance:  $\alpha = 0.05$

Table 4: Result of the inferential statistics of academics

	N	Mean	SD	End Point (i.e., Population Mean)	SE	t	P-value
ACADEMICS	20	27.0	3.03	24.0	0.68	4.43	0.000

From the above result, we can see that the mean score of “**Academics**” is 27 with the standard deviation of 3.03. In addition, the value of test statistic is  $t = 4.43$  and the p-value of the test statistic is 0.000, which is less than 0.05. Since the p-value

of the test statistic is less than the level of significance (0.05), we reject the null hypothesis at 5% level. Hence, the evidence is sufficient to conclude that the mean score of **Academics** is **greater** than 24.

**Child Oriented: To test whether the mean score of Child Oriented is greater than 44.**

**Hypotheses:** Null hypothesis,  $H_0$ : The mean score of **Child Oriented** is not greater than 44 (i.e.,  $\mu = 44$ ). Alternate hypothesis,  $H_a$ : The mean score of **Child Oriented** is **greater** than 44 (i.e.,  $\mu > 44$ ) One-Sample t-test at the level of Significance:  $\alpha = 0.05$

Table 5: Result of the inferential statistics of child-oriented

	N	Mean	SD	End Point (i.e., Population Mean)	SE	t	P-value
CHILD_ORIENTED	20	48.9	6.12	44.0	1.37	3.58	0.001

From the above result, we can see that the mean score of “**Child Oriented**” is 48.9 with the standard deviation of 6.12. In addition, the value of test statistic is  $t = 3.58$  and the p-value of the test statistic is 0.001, which is less than 0.05. Since the p-value of the test statistic is less than the level of significance (0.05), we reject the null hypothesis at 5% level. Hence, the evidence is sufficient to conclude that the mean score of **Child Oriented** is **greater** than 44.

The descriptive statistics showed that majority of the subjects were agreed or strongly agreed to all the questions related to Spatial Skills, Academics and Child Oriented of the structured spatial skills training educational video game. In addition, the level of agreement for each question was found to be high (i.e., agree or strongly agree) for all the questions and very few have responded as ‘Undecided’. The hypothesis test was conducted to see whether the total score is significantly more than the desired end points for each attribute. The results of hypothesis test showed that the mean values of total score of all the three attributes were greater than the respective end points. These results confirm that the structured spatial skills educational video game is a valid learning tool and can be used as a method of pedagogy of learning among the students.

## Discussion

The Edugame is one type of video game that are designed to improve the skill that is implemented in learning(4). Several studies shown that the Edugame will enhance the following cognitive process like, “perceptual skills, visual and spatial abilities, memory, attention, and reaction time. The child oriented games are designed in such a way that it involves simple movements, technical criteria which are easy to follow and easy protocol to be followed(4). The result of the study shows that SSST educational video game is a valid learning tool. The validation of the game is done under three different attributes, the spatial skills, academics and child-oriented game. The game has designed with the concept of improving spatial skills which is correlated to academics especially in the improvement of the mathematics skills of the children, Mazes are problem solving task, and require complex cognitive process which includes attention, visuospatial, visuo-constructional, and executive function. The player have the start and end point to finish the goal, it is non-verbal and easy to understand(5). According to Verdine et al. the puzzle and spatial skills are highly correlated specific to elementary school aged children (6). Solving jigsaw puzzle needs mental rotation, spatial perception and visualization. Mental rotation needs spatial reasoning, it is the ability of a person to rotate the 2D or 3D objects in a specific degree. A Hertani et al. (2019) stated that the spatial experience is important in improving the mental rotation (7). Matching objects requires the visualization of the correct image with the reference images. The block are usually used as a part of play in the preschool and it is used in the basic mathematical development (8). Building blocks uses various colours, shapes and size which will act as a visual treat and enhances the early learning Guyton (2011). In older children the block will help in problem solving skills. Game shapes are related to learning and improving cognitive skills(9). Umit Demir (2020) done a study to find the effect of games based educational software on the learning of students with intellectual disabilities. 34 students with intellectual disabilities were selected from special education vocational school in Canakkale, Turkey. They are divided into experimental and control group, the experimental group received five weeks blended learning with game-based education software training program and the control group received traditional teaching method. The result showed that the experimental group had significant improvement in the academic score when compared with the control group. Spatial language “support the spatial ability” and measure variety of spatial skills (10). Katrina Ferrara et al, (2011) assessed the effect of spatial language in block play and found out that the interaction with the blocks and guided play by using spatial language makes learning easier and suggested it could be used as educational intervention (10). The child growing with the child computer interaction, the change in growth, style of living are seen (11). The game should be designed keep in mind the following aspects according to the development of the child. The amount of time spent, access, the quality of media, guidance, feedback, content of the game, engagement, challenging activity, novelty, self-awareness, goals, feedback, problem solving, efficiency – steps to complete task, effectiveness – completing the task, Learnability, memorability – ease of recollection, and utility – lesser to greater number of operations (11). The best results of use of video game in the learning is seen in the areas of maths, physics, and arts like social sciences, biology and logic. The effect of the game is clearly seen in the games designed with specific content and objective (12). Marquest et al. (2013) found out that the learning transition and performance of the students occurred when they gave solution to puzzle, with interactive multimedia and web applications. It also increased the students interest to solve the problem (13). Depending upon the previous literatures it suggests that the seven different games (Maze, Puzzle, Mental Rotation, building blocks, identifying objects, matching shapes and spatial language) used in SSST educational video games are related to spatial skills which is supported by the rejection of null hypothesis at 5% level of significance and the mean score of spatial skills are

greater than 32. The mean score of academics is 27, with standard deviation of 3.03, t value of 4.43 and pvalue of 0.000. The null hypothesis is rejected. So, this game can be used as the intervention in the education which mostly improves the “academics” learning process, mathematical skills, reading and writing skills. The mean score of “**Child Oriented**” is 48.9 with the standard deviation of 6.12,  $t = 3.58$  and the p-value is 0.001, which is less than 0.05. Since the p-value is less than the level of significance (0.05), the null hypothesis is rejected at 5% level. The SSST Edu game is fun filled, it motivates the child to play, gives feedback, provide hints and instructions for better understanding.

**Conclusion:**

In the era of digitalization, teaching and learning gained access through the digital platform. The design of this novel educational game is purely meant to be playable by the child, academic oriented which specifically designed on the spatial skills. The importance of the spatial skills is often forgotten in assessing and in curriculum. In future this skill should be practically incorporated in both academics and as an assessing tool. The sample size is small, it can be increased, and more attributes can be added to see the validation of the game.

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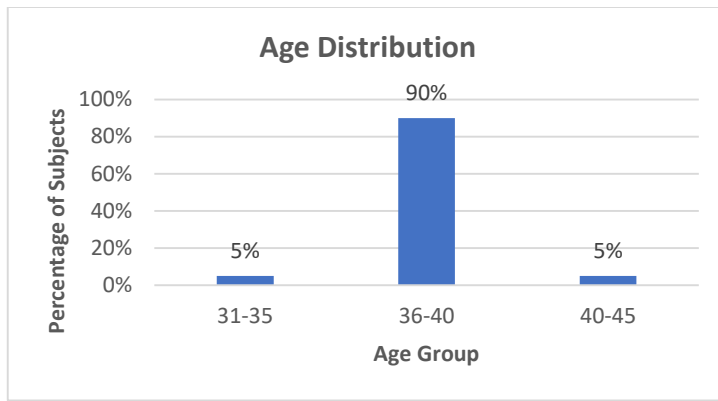
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**Appendix**

**Analysis - Descriptive Statistics**

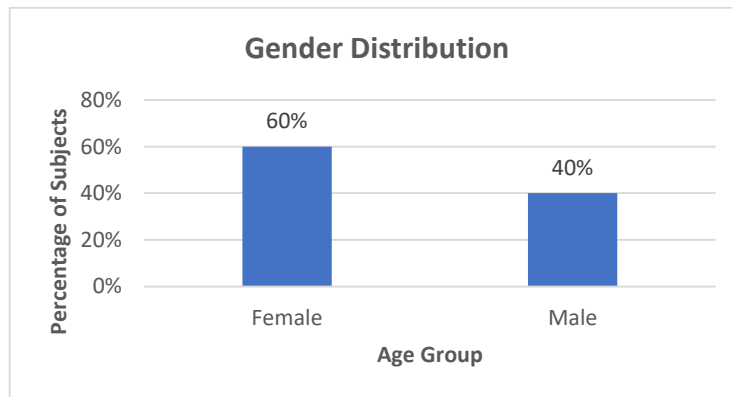
**Age Distribution**

Age	Frequency	Percent
31-35	1	5.0
36-40	18	90.0
40-45	1	5.0
<b>Total</b>	<b>20</b>	<b>100.0</b>



**Gender Distribution**

Gender	Frequency	Percent
Female	12	60%
Male	8	40%
<b>Total</b>	<b>20</b>	<b>100%</b>



**Summary of responses to each survey question using 5 Point Likert Scale**  
**Summary of responses to each survey question on SPATIAL SKILLS**

<b>Maze</b>	<b>Frequency</b>	<b>Percent</b>
5: Strongly Agree	20	100%
<b>Puzzle</b>	<b>Frequency</b>	<b>Percent</b>
5: Strongly Agree	20	100%
<b>Mental Rotation</b>	<b>Frequency</b>	<b>Percent</b>
5: Strongly Agree	20	100%
<b>Blocks</b>	<b>Frequency</b>	<b>Percent</b>
5: Strongly Agree	20	100%
<b>Matching Shapes</b>	<b>Frequency</b>	<b>Percent</b>
5: Strongly Agree	20	100%
<b>Identify Objects</b>	<b>Frequency</b>	<b>Percent</b>
5: Strongly Agree	20	100%
<b>Spatial Language</b>	<b>Frequency</b>	<b>Percent</b>
5: Strongly Agree	20	100%
<b>Related Spatial Skills</b>	<b>Frequency</b>	<b>Percent</b>
5: Strongly Agree	20	100%

**Summary of responses to each survey question on ACADEMICS**

<b>Pedagogy Method</b>	<b>Frequency</b>	<b>Percent</b>
4: Agree	9	45%
5: Strongly Agree	11	55%
<b>Total</b>	<b>20</b>	<b>100%</b>
<b>Academics</b>	<b>Frequency</b>	<b>Percent</b>
4: Agree	9	45%
5: Strongly Agree	11	55%
<b>Total</b>	<b>20</b>	<b>100%</b>
<b>Mathematics</b>	<b>Frequency</b>	<b>Percent</b>
3: Undecided	6	30%
4: Agree	5	25%
5: Strongly Agree	9	45%
<b>Total</b>	<b>20</b>	<b>100%</b>
<b>SSST_SpatialSkills</b>	<b>Frequency</b>	<b>Percent</b>
4: Agree	6	30%
5: Strongly Agree	14	70%
<b>Total</b>	<b>20</b>	<b>100%</b>
<b>SSST_Academic Outcome</b>	<b>Frequency</b>	<b>Percent</b>
3: Undecided	2	10%
4: Agree	7	35%
5: Strongly Agree	11	55%
<b>Total</b>	<b>20</b>	<b>100%</b>
<b>SSST_Digital EduGame</b>	<b>Frequency</b>	<b>Percent</b>
4: Agree	8	40%
5: Strongly Agree	12	60%
<b>Total</b>	<b>20</b>	<b>100%</b>

**Summary of responses to each survey question on Child Oriented**

<b>Child - Attentive</b>	<b>Frequency</b>	<b>Percent</b>	<b>Child - Understandable</b>	<b>Frequency</b>	<b>Percent</b>
3: Undecided	2	10%	4: Agree	8	40%
4: Agree	7	35%	5: Strongly Agree	12	60%
5: Strongly Agree	11	55%	<b>Total</b>	<b>20</b>	<b>100%</b>
<b>Total</b>	<b>20</b>	<b>100%</b>			
<b>Child - Motivates</b>	<b>Frequency</b>	<b>Percent</b>	<b>Child - Success Notification</b>	<b>Frequency</b>	<b>Percent</b>
3: Undecided	5	25%	3: Undecided	6	30%
4: Agree	5	25%	4: Agree	3	15%
5: Strongly Agree	10	50%	5: Strongly Agree	11	55%
<b>Total</b>	<b>20</b>	<b>100%</b>	<b>Total</b>	<b>20</b>	<b>100%</b>
<b>Child - Centred</b>	<b>Frequency</b>	<b>Percent</b>	<b>Child - Therapy Focused</b>	<b>Frequency</b>	<b>Percent</b>
4: Agree	8	40%	3: Undecided	1	5%

5: Strongly Agree	12	60%
<b>Total</b>	<b>20</b>	<b>100%</b>

<b>Child Playable</b>	<b>Frequency</b>	<b>Percent</b>
4: Agree	7	35%
5: Strongly Agree	13	65%
<b>Total</b>	<b>20</b>	<b>100%</b>

<b>Child Fun Filled</b>	<b>Frequency</b>	<b>Percent</b>
4: Agree	7	35%
5: Strongly Agree	13	65%
<b>Total</b>	<b>20</b>	<b>100%</b>

<b>Child -Scoring Motivates</b>	<b>Frequency</b>	<b>Percent</b>
3: Undecided	9	45%
4: Agree	1	5%
5: Strongly Agree	10	50%
<b>Total</b>	<b>20</b>	<b>100%</b>

4: Agree	9	45%
5: Strongly Agree	10	50%
<b>Total</b>	<b>20</b>	<b>100%</b>

<b>Child Challenges</b>	<b>Frequency</b>	<b>Percent</b>
4: Agree	6	30%
5: Strongly Agree	14	70%
<b>Total</b>	<b>20</b>	<b>100%</b>

<b>Child - Hints Instructions</b>	<b>Frequency</b>	<b>Percent</b>
3: Undecided	5	25%
4: Agree	5	25%
5: Strongly Agree	10	50%
<b>Total</b>	<b>20</b>	<b>100%</b>