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SPATIAL VISUALIZATION ABILITY AMONG APPAREL DESIGN STUDENTS

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ABSTRACT

The purpose of this study was to identify the spatial visualization ability among Apparel Design students by using specific spatial visualization tests. Based on previous studies, a number of students who enrolled in apparel design course found it difficult to transfer schematic two-dimensional (2D) to three-dimensional objects (3D), or vice-versa (Armstrong, 2006; Gitimu, 2005). Students admitted that it was difficult to visualize the graphical 3D objects in the 2D sketch. Thus, the aim of this study was to determine students' performance and strategies in responding to spatial visualization tests using the Apparel Spatial Visualization Ability Test (ASVT) and the Use of Strategy Questionnaire (USQ). A total of 99 Apparel Design students at Universiti Putra Malaysia (UPM) were selected. In general, the study found that the respondents have moderate spatial visualization ability. Based on the findings, the authors suggest the curriculum of Apparel Design course at the university level should take into account aspect of spatial visualization ability for students in order to produce more creative and prolific designers for our fashion industry. Thus, the admission criteria for Apparel Design students should be based on the students' scores of ASVT test and interview results.

KEYWORDS: Apparel Design, Apparel Spatial Visualization Ability Test, Fashion industry, Spatial Visualization

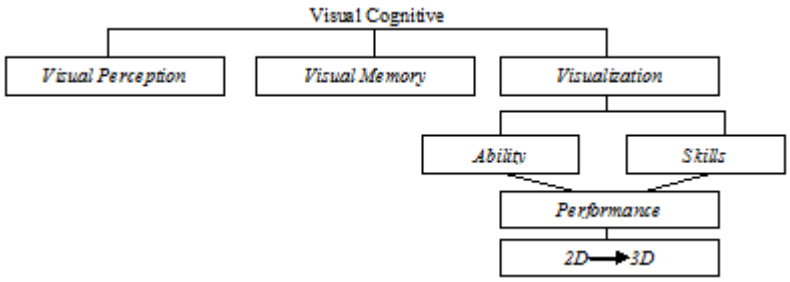
INTRODUCTION

Spatial visualization ability is an important aspect needed in the clothing industry career. The importance of this ability as a success predictor in many technology fields has been proven through previous studies (Linn & Petersen, 1985; Sorby, 2005; Strong & Smith, 2002; Smith, 2009). All students in the field of fashion have spatial visualization ability to determine their success in this field. In this regard, the main challenge for educators in the field of fashion is to prepare the students in the world of clothing design in the future. However, this ability is less mastered by students, where students are found to be too dependent on the guidance and help of the teacher in the whole design production and sewing processes. Previous studies show the negligence in the effort of identifying the achievement of this capability among students until it made them to withdraw from their field (Alias, Black & Gray, 2002; Gitimu et al., 2005; Lubinsky, 2010; Sorby, 2005; Titus & Horsman, 2009). Piaget and Inhelder's (1971) Spatial Cognition Theory, Kossyln's (1981) Spatial Cognition Theory and Workman and Caldwell's (2007) Spatial Cognition Model reveal the existence factors of individual difference such as the ability to process information, age, gender, training and experience, which can contribute to the differences in the achievement of the individual spatial visualization abilities. Overall, due to the existence of negligence in the effort to

identify the level of spatial visualization ability among students, as well as factors of individual difference that contribute to the differences in this ability, therefore, a study should be conducted to determine the achievement levels of fashion and clothing students in the spatial visualization ability based on training, experience and strategies used to answer the issues in this ability.

Visual Cognitive by Willey

Hierarchy of Visual Learning by Wiley (1990) present three stages, each stage has certain levels that must be taken by an individual before achieving the maturity level in visual. The first stage of Visual Learning hierarchy is known as the Visual Cognitive processes which are to understand, remembering, creating and editing visual information mentally. Cognitive Visual also has three levels of visual perception, visual memory and visualization. Visual perception is a mental ability to understand visual information; Visual Memory is the ability to store information mentally and recall, while the visualization is the ability to create and edit visual information. This study refers only to spatial visualization ability in Visual Cognitive Model by Willey. Spatial visualization is a skill of the individual ability to build mental images involving multiple intelligences. While McGee (1979) also argues that spatial visualization ability is the cognitive ability which is the mental skill to imagine a perspective view of an object. For that reason, the relationship with Willey Visual Cognitive Model of this study was to examine the spatial visualization ability in the field of apparel design. Spatial visualization ability in the field of apparel design is the ability to process and interpret 2D objects and draws on a piece of paper and can also chart patterns (Flat Pattern) and reflects in the form of 3D. Figure 1 shows the model of Willey Cognitive Visual has been modified. Visualization skills and visualization abilities are needed to improve the performance of 2D drawings to 3D objects and vice versa.



Source: The hierarchy of Visual Learning. Engineering Graphics Journal, 54, 30-35

Figure 1: Modification of Visual Cognitive Model Willey (1990)

A person involved in the field of fashion design should be creative, innovative, pursue the latest fashion trends and developments in order to help them visualize the concept of every fashion design. The process of designing a garment or in clothing chart pattern requires high spatial visualization ability. Spatial visualization ability requires a leap of imagination style as a key element in the process and manipulates an object in students' mental. Students in this field need to create fictitious two-dimensional (2D) before moving on to three-dimensional (3D). Design two-dimensional exchange (2D) to the finished garments to 3D is a success in using the cognitive ability to test the level of spatial visualization ability (Kim & Uh, 2002). Students as well need to be creative, understand the basic patterns of clothing and can change the view or form of a design from 3D to 2D (flat pattern) dress pattern or vice versa. There will also be sketching the form of patterns, determine the size and able to determine the number of pieces required once saw a sketch or real clothing. This skill is required to estimate the amount of fabric needed as well as the cost of production, chart pattern, the sewing, sewing methods with specific process, and the degree of difficulty to match the stitching and fabric with clothing design. However most of the students enroll in the program of apparel design find it difficult to interpret schematic

two-dimensional (2D) to three-dimensional objects (3D) but convert 3D objects into 2D outline (Armstrong, 2006; Gitimu, 2005). Students are difficult to understand the graphical 2D and 3D objects in which the main problem in 3D objects reflect the 2D sketch. The objective of this study was to discover students' performance and strategies in response to spatial visualization tests using the Apparel Spatial Visualization Ability Test (ASVT) and Use of Strategy Questionnaire (USQ).

Spatial Visualization Ability in Apparel Design

Davis (1980) Aldrich (2007) states that a designer must be able to sketch a drawing patterns and imagine how would the design will turn out to be, in addition to be able to see the sketch of a design or model of real clothes and then visualize, to estimate the shape and size of patterns that are required to reflect 3D picture from 2D sketches to manipulation and alteration of clothing piece it must reflect the pattern or design style accordingly (Workman, Caldwell & Kallal, 1999). Even when sketching, a fashion designer must interpret them as a 3D sketch, as an example of a conical sleeve, when the pattern in the form of 2D drawings forms a trapezium (Workman & Lee, 2004). Research was conducted using the Apparel Spatial Visualization Test (ASVT) to observe spatial visualization ability of students in the field of fashion. Fashion Design includes design, sewing, draping, cutting, cutting, drawing, chart patterns, and fundamentals in the design, production and material costs. All components of teaching require the student to understand the graphic language to process, apply, improve, solve problems and develop spatial ability. The ability to interpret, recognize, and understand the symbol, label punch, mark notches, grain fabric, the aspect of form, line curve is a very important skill to distinguish Workman and Zhang (1999). Spatial visualization ability is needed in the process of making clothing patterns including mental synthesis and mental movement for instance the arm reflection plate, the rotation of the pleat, folding and non folding patterns in each piece (Gitimu, et al., 2005).

In addition, problem-solving skills are also an integral and necessary during the process of chart patterns which require a high cognitive power. And design focus on individual skills to use their imagination. Most of the fashion design students can only sketch a variety of different styles of dress, matching colors on paper only in the form of 2D drawings only. As a study by Arasinah (2012) found that students who have the experience, more training in the field of fashion and artistic may brush up their talent by taking sewing booking possess better visualization ability. High spatial visualization ability can be seen from the creation and quality of clothing and fashion design sketches produced by them. There are also students who cannot visualize the creation in the form of 2D to 3D design and difficult to interpret (Gitimu, 2005). This may be due to the lack of spatial visualization ability which requires descriptive skill, imagine and communication skills through the symbols in the sketch. Spatial visualization ability is one important element for success in graphic design, architecture, technical, science, creative arts, engineering, which is applied to describe, manipulate any information received in the learning and problem solving (Strong & Smith, 2002; Humphreys, Lubinski, & Yao, 1993; Alias et al., 2002). Spatial visualization ability is often associated with the experience, strategies and training received and used to solve a problem in the design. All aspects of spatial visualization ability are a combination of a suitable match between students' learning styles in the way they were taught (Khoza & Workman, 2009).

The Use of Strategies and Training in Apparel Design

Study by Workman and Lee (2004) and Gitimu and Workman (2008) and Workman (2008) found that the majority of students who answered item in ASVT using the strategy review with certain features, giving emphasis and refers to the patterns and sketches. The results also showed advanced fashion design courses have students with low spatial visualization ability and majority of them use to speculate without thinking strategies to solve the test. The findings by Workman and Lee (2004) Gluck and Fitting, (2003) also found that when students solve their spatial tests using strategy

which is to emphasis and reference, review, guessing, pay attention, look to match certain features, see the equation, see differences in the pattern parts and sketches and use their existing knowledge before this respect the basic dress pattern. While Saczynski, Willis and Schaie, (2002), Strong and Smith (2002) also states that students use different strategies to solve spatial tests to measure their spatial visualization ability. Apparel Designing program is a course intended to enhance students' ability to draw and read graphic language. Students often have difficulty to visualize two-dimensional shape of a clothing design patterns, however, they picked up skills through continuous training (Armstrong, 2006; Orzada & Kallal, 2001).

Workman and Caldwell (2007) has conducted studies and tests Paper Folding Test and Apparel Spatial Visualization Test (ASVT) to a total of 128 who took the CAD course (Computer Aided Design), Flat Pattern and Beginning Clothing Construction. The study found that students enrolled in different courses showed that spatial ability is different, because this level of training received as well varies. This is because the level of training received also varies. Gitimu et al., (2005) have used the same test and found that students vary in ability among students with high levels of training and low level of training. As the qualitative findings by Arasinah (2012) through observation and interviews revealed that while students use a similar strategy during the sketching style of clothing and chart patterns, but in terms of creation and quality of the design is different, this due to the training and experience received by the students also varies according to the course. Strategies used by students while sketching fashion design and pattern chart refers to the style of clothing and certain features, existing experience, reflect and pay attention. Sixth semester students have the ability to better spatial visualization because they have the experience and training in fashion during the Diploma in Fashion Design from the final semester.

Consequently training that is followed by the students is to interpret a visual method which is a specific component as part of the curriculum in most universities. Curriculum in the field of fashion design should be based on specialized knowledge that is used to solve problems in apparel design. Effective and appropriate strategies needed to highlight more knowledge about the strategies used to solve problems in spatial visualization. This strategy can help develop students' spatial visualization ability. Further research in this area should continue to work to measure the effect of special training is provided to an institution's fashion design curriculum can expand students' spatial visualization skills (Workman & Lee, 2004). Training in this study refers to the level of training received, whether the student is classified as students in Apparel Management 2 or Apparel Management 3. Strategy is one of the alternative methods to see which cognitive styles and abilities strategies used vary based on their visualization capabilities. The more experience and training received by the students, the easier the students in problem solving in spatial test and design field (Olkun, 2003; Sorby, 2005; Gitimu & Workman, 2008; Titus & Horsman, 2009).

METHODOLOGY

This study is a descriptive survey using a questionnaire to obtain quantitative data. Descriptive study is to look at individuals, groups, institutions, methods and materials so that they can describe, compare, distinguish, classify and analyze the events being studied. This design was chosen because the researchers wanted to identify the performance spatial visualization ability of students in ASVT. A total of 99 students of Domestic Science Education at the Faculty of Educational Studies, Universiti Putra Malaysia were chosen as a sample. These students have enrolled the Apparel Management II course (n = 59) and Apparel Management III course (n = 40). The sample has also passed the Apparel Management Course I.

The ASVT is the instruments that measuring the spatial visualization ability that related to the apparel design and product development. The selection of the correct solution is needed in transforming the design from 2D to 3D. The participants must choose one out of five clothes designs that fit a given pattern. The ASVT contains 20 items, 2D pattern pieces accompanied by a sketch of the front view of the five sets of 3D garment. 20 items are ordered from simple to complex. ASVT has been developed by the Workman et al., (1999) with overall alpha value of 0.79 - 0.89. While content validity of the instrument is proved by scores in the training in apparel design courses (Orzada & Kallal, 2001; Workman et al., 1999). The ASVT measure visualization ability that requires students to be able to imagine the mental folding and non- folding, matching, pattern pieces combine to form a complete pattern and change some pieces of two-dimensional pattern of three-dimensional garments.

The USQ test was taken from the study Workman and Lee (2004) and has been translated into Malay. USQ test consists of seven strategies that A = Emphasis & Refer, B = Matches, C = previous knowledge, D = Guessing, E = Check & Note / Similarity, F = the difference, G = Specific Features. Students are asked to indicate the strategy used in response to each item in ASVT (Gitimu & Workman, 2008). Both USQ and ASVT are used by students concurrently. Table 1 shows the interpretation of level of achievement for spatial visualization ability by Mohd Safarin and Mohd Sukri (2007).

Table 1: Interpretasi of Level of Achievement for Spatial Visualization Ability

Score (percentage)	Interpretation of Level of Achievement for Spatial Visualization
81-100	Excellent
61-80	Good
41-60	Moderate
0-40	Weak

Source : *Mohd Safarin & Mohd Sukri (2007)*

FINDINGS AND DISCUSSIONS

Table 2 shows the performance of spatial visualization ability of two groups of Apparel Management II and III. The findings showed that 58 students from Apparel Management II mostly answer correctly for question 13 (98.3%). While for Apparel Management III for question 7, 39 students answered correctly (97.5%). The students in Apparel management II found that the questions 4 and 9 are the most difficult, which is a total of 46 people (78%). While group III Apparel Management students find item 5 is the most difficult question a total of 37 (92.5%). The findings of the overall performance of the tests conclude that Apparel Management II has a correct answer by 50.84% while Apparel Management III has a correct answer of 49.5%. To conclude, the result indicates there are no increments of visualization ability among students even after they passed the Apparel Management II and III.

Table 3 shows the strategy used by students to complete the tests in ASVT for the group of students in Apparel Management II. The most commonly used strategy is strategy E of the check and note / similarity which is 147 people. The least used strategy is the strategy C, which is the previous knowledge which consists of 51 people. The students only use four strategies to answer the question two and question five. Students use all seven strategies to answer the questions 6, 7, 13, 14,15,17,18 and 19. This shows that the students use all the seven strategies to answer questions 13. Question 13 is also the simplest questions and the students get the most correct answer is 58 (See Table 2).

Table 2: ASVT Performance Tests

Item	Apparel Management II (*n=59*)				Apparel Management III (*n=40*)			
	Correct		Incorrect		Correct		Incorrect	
	F	***%***	***f***	***%***	***f***	***%***	***F***	***%***
S1	21	35.6	38	64.4	15	37.5	25	63.5
S2	19	32.2	40	67.8	7	17.5	33	82.5
S3	55	93.2	4	6.8	36	90	4	10
S4	**13**	**22**	46	78	8	20	32	80
S5	14	23.7	45	76.3	**3**	**7.5**	37	92.5
S6	43	72.9	16	27.1	28	30	12	70
S7	54	91.5	**5**	**8.5**	**39**	**97.5**	1	2.5
S8	38	64.4	21	35.6	23	57.5	17	42.5
S9	**13**	**22**	46	78	11	27.5	29	72.5
S10	22	37.3	37	62.7	16	40	24	60
S11	52	88.1	7	11.9	37	92.5	3	7.5
S12	19	32.2	40	67.8	11	27.5	29	72.5
S13	**58**	**98.3**	1	1.7	38	95	2	5
S14	32	54.2	27	45.8	15	37.5	25	63.5
S15	24	40.7	35	59.3	22	55	18	45
S16	21	35.6	38	64.4	20	50	20	50
S17	23	39	36	61	14	35	26	65
S18	20	33.9	39	66.1	15	37.5	25	63.5
S19	35	59.3	24	40.7	23	57.5	17	42.5
S20	24	40.7	35	59.3	15	37.5	25	63.5
Overall		**50.84**		**49.16**		**49.5**		**50.5**

n=99

The conclusion of the study indicates there is no increment in visualization ability among students even if they already passed the Apparel Management II and Apparel Management III. The performances of spatial visualization ability for both groups were moderate (Mohd Safarin & Mohd Sukri, 2007) and not very much different. Although the achievement of the overall performance of aptitude tests in ASVT for Apparel Management II is better than the Apparel Management III, this result contradicts with the findings by Armstrong (2006); Orzada and Kallal (2001); Arasinah (2012) which states that the spatial visualization ability will increase when the students picked up through constant training. While this study support the findings Workman and Caldwell (2007); Gitimu et al., (2005) found that students enrolled in different courses at the same time the level of training received also vary, so the spatial abilities will be different.

This will likely be able to demonstrate the lack of focus given on the aspect of this ability in the curriculum of fashion and clothing manufacturing. The importance of this ability may not have been explicitly described among the students (Alias et al., 2002; Gitimu et.al, 2005). In line with this, Khoza (2003) also noted that the aspect of the spatial visualization cognitive ability is still given less emphasis in the field of design and tailoring. Lubinski (2010) also stated that the ability of spatial visualization is an essential ability in learning and career but is often ignored. Therefore, fashion and clothing education field requires the effort to explicitly emphasize the cognitive ability that is really needed for this field namely the spatial visualization ability. Focusing on the development of the students' spatial visualization ability, as well as creating awareness for the students on the achievements of their spatial visualization ability will help them develop this ability (Sorby, 2005; Titus & Horsman, 2009). This is important to ensure the success of the students in the field of design and tailoring in the future (Workman et.al., 1999).

This may be because they cannot visualize the invention in the form of 2D to 3D design, lack of spatial visualization ability to reflect, imaginative and communication skills through the symbols in the drawings as specified by Gitimu (2005): Strong and Smith (2002); Humphreys et al., (1993); Alias et al., (2002). This ability is required in the

design and garment making and students need these skills to suit the particular line of work which they would endeavor upon graduation. The field of apparel design requires spatial skills so that students can visualize each design is cast in the form of 2D to 3D switch so that each design is made more meaningful when activated.

Table 3: The Use of Strategies Based on ASVT Questions (Apparel Management II)

Item	Strategies														Total Corr Answer
	A		B		C		D		E		F		G		
	f	*%*	*F*	*%*	*f*	*%*	*f*	*%*	*F*	*%*	*f*	*%*	*F*	*%*	
S1	10	47.6	5	23.8	2	9.5	-	-	3	14.3	1	4.8	-	-	21
S2	**10**	**52.6**	**4**	**21.1**	**-**	**-**	**-**	**-**	**2**	**10.5**	**-**	**-**	**3**	**15.8**	**19**
S3	7	12.7	31	56.4	6	10.6	-	-	6	10.6	-	-	5	9.1	55
S4	4	30.8	1	7.7	2	15.4	2	15.4	3	23.1	-	-	1	7.7	13
S5	**1**	**7.1**	**2**	**14.3**	**-**	**-**	**-**	**-**	**6**	**42.9**	**5**	**35.7**	**-**	**-**	**14**
S6	**8**	**18.6**	**8**	**18.6**	**7**	**16.3**	**3**	**7**	**10**	**23.3**	**3**	**7**	**4**	**9.3**	**43**
S7	**10**	**18.5**	**14**	**25.9**	**5**	**9.3**	**1**	**1.9**	**15**	**27.8**	**1**	**1.9**	**8**	**14.8**	**54**
S8	5	13.2	8	21.1	-	-	4	10.5	11	28.9	3	11.9	7	18.4	38
S9	2	15.4	3	23.1	3	23.1	-	-	4	30.8	-	-	1	7.7	13
S10	5	22.7	1	4.5	1	4.5	-	-	6	27.3	5	22.7	4	18.2	22
S11	16	30.8	5	9.6	3	5.8	-	-	21	40.4	1	1.9	6	11.5	52
S12	5	26.3	4	21.1	2	10.5	-	-	3	15.8	1	5.3	4	21.1	19
S13	**14**	**24.1**	**7**	**12.1**	**6**	**10.3**	**5**	**8.6**	**15**	**25.9**	**5**	**8.6**	**6**	**10.3**	**58**
S14	**6**	**18.8**	**5**	**15.6**	**2**	**6.3**	**3**	**9.4**	**9**	**28.1**	**6**	**18.8**	**1**	**3.1**	**32**
S15	**3**	**12.5**	**1**	**4.2**	**4**	**16.7**	**2**	**8.3**	**6**	**25**	**7**	**29.2**	**1**	**4.2**	**24**
S16	-	-	3	14.3	2	9.5	-	-	7	33.3	7	33.3	2	9.5	21
S17	**3**	**13**	**7**	**30.4**	**2**	**8.7**	**1**	**4.3**	**3**	**13**	**5**	**21.7**	**2**	**8.7**	**23**
S18	**4**	**20**	**2**	**10**	**1**	**5**	**2**	**10**	**4**	**20**	**5**	**25**	**2**	**10**	**20**
S19	**12**	**34.3**	**4**	**11.4**	**3**	**8.6**	**4**	**11.4**	**6**	**17.1**	**5**	**14.3**	**1**	**2.9**	**35**
S20	3	12.5	2	8.3	-	-	2	8.3	7	29.2	6	25	4	16.7	24
Overall	**128**		**117**		**51**		**29**		**147**		**71**		**62**		

n=59: Strategy: A = Emphasis & Refer, B = Matches, C = Previous knowledge, D = Guessing, E = Check & Note / Similarity, F = The difference, G = Specific Features

Table 4 shows the strategy used by students to solve ASVT test for the group Apparel Management III. The most commonly used strategy is the strategy B which is matching, of 90 people. The least used strategy is the strategy of guessing or D which is 13 people. The students only use two strategies to question five only. While 4 strategies to answer questions 1, 2, 4, and 13. Besides, students use all seven strategies to answer questions 7, 8, 10, 11,14,15,16 and 20. Question 7 also is the simplest questions and the students get the most correct answer is 39 (See Table 2). Question five is the most difficult questions that only 3 people who get correct answers and the students are only using two strategies. Both groups of students have between 4 to 7 strategies when solving spatial tests as findings by the Workman and Lee (2004) Gluck and Fitting, (2003) also found that students use to *emphasize and refer strategy, checking, guessing, pay attention, match to see certain features, see the similarities, the differences in the parts of the pattern and sketches and use existing knowledge* with respect to the basic pattern of garments. The performance of spatial visualization ability of both groups of students performs better when they use seven different strategies. This supports findings by Saczynski et al., (2002): Strong and Smith (2002).

All of these strategies are to measure students' spatial visualization ability. As stated by Khoza and Workman (2009) related to spatial visualization ability with experience, strategies and training received which is used to solve a problem in the design. By the content of the courses in fashion design should be based on specialized knowledge that can be used to solve cognitive problems and the use of force in apparel design. Use the right strategies, appropriate, and effectively enable the students to solve problems in design in order to develop their spatial visualization ability.

Therefore, further research may be conducted to determine the effect of training given in the curriculum program of training institutions in order to fashion students spatial visualization skills can be developed (Workman & Lee, 2004).

Table 4: The Use of Strategies Based ASVT Questions (Apparel Management III)

Item	Strategies														Total Corr Answer
	A		B		C		D		E		F		G		
	f	*%*	*F*	*%*	*F*	*%*	*f*	*%*	*f*	*%*	*f*	*%*	*F*	*%*	
S1	9	60	2	13.3	2	13.3	-	-	2	13.3	-	-	-	-	15
S2	**2**	**28.6**	**2**	**28.6**	**-**	**-**	**-**	**-**	**2**	**28.6**	**1**	**14.3**	**-**	**-**	**7**
S3	1	2.8	16	44.4	8	22.2	-	-	3	8.3	5	13.9	3	8.3	36
S4	1	12.5	3	37.5	-	-	-	-	3	37.5	1	12.5	-	-	8
S5	**-**	**-**	**2**	**66.7**	**-**	**-**	**-**	**1**	**33.3**		**-**	**-**	**-**	**-**	**3**
S6	**9**	**32.1**	**6**	**21.4**	**3**	**10.7**			**5**	**17.9**	**2**	**7.1**	**3**	**10.7**	**28**
S7	**5**	**12.8**	**11**	**28.2**	**2**	**5.1**	**1**	**2.6**	**5**	**12.8**	**5**	**12.8**	**10**	**25.6**	**39**
S8	5	21.7	5	21.7	1	4.3	1	4.3	1	4.3	3	13	7	30.4	23
S9	2	18.2	3	27.2	-	-	-	-	1	9.1	3	27.3	2	18.2	11
S10	4	25	3	18.8	1	6.3	1	6.3	4	25	2	12.5	1	6.3	16
S11	10	27	4	10.8	8	21.6	1	2.7	3	8.1	9	24.3	2	5.4	37
S12	1	9.1	-	-	4	36.4	2	18.2	3	27.3	-	-	1	9.1	11
S13	**2**	**13.3**	**4**	**26.7**	**2**	**13.3**	**-**	**-**	**-**	**-**	**7**	**46.7**	**-**	**-**	**15**
S14	**9**	**23.7**	**10**	**26.3**	**4**	**10.5**	**1**	**2.6**	**4**	**10.5**	**4**	**10.5**	**6**	**15.8**	**38**
S15	**3**	**13.6**	**5**	**22.7**	**1**	**4.5**	**1**	**4.5**	**2**	**9.1**	**7**	**31.8**	**3**	**13.6**	**22**
S16	1	5	6	30	1	5	2	10	4	20	1	5	5	25	20
S17	**1**	**7.1**	**1**	**7.1**	**4**	**28.6**	**-**	**-**	**3**	**21.4**	**3**	**21.4**	**2**	**14.3**	**14**
S18	**2**	**13.3**	**2**	**13.3**	**1**	**6.7**	**-**	**-**	**-**	**-**	**3**	**20**	**7**	**46.7**	**15**
S19	**3**	**13**	**3**	**13**	**3**	**13**	**1**	**4.3**	**-**	**-**	**10**	**43.5**	**3**	**13**	**23**
S20	2	13.3	2	13.3	1	6.7	2	13.3	4	26.7	2	13.3	2	13.3	15
Overall	**82**		**90**		**46**		**13**		**82.3**		**70**		**57**		

n=40:Strategy: A = Emphasis & refer, B = Matches, C = Previous knowledge, D = Guessing, E = Check & Note / Similarity, F = The difference, G = Specific Features

CONCLUSIONS AND RECOMMENDATIONS

The results showed that various combinations of strategies used to answer each item in ASVT. Different strategies have been selected by the same students to solve different problems. Since the use of strategies influence the performance of spatial visualization tasks in apparel design, future research may need to examine how to train students to select and use appropriate strategies. Small sample size limits the results of the study based on population. Therefore, future research could use larger sample includes fashion design students at all levels of training institutions to test the USQ test strategy. This research shows that students using the 4 to 7 strategies to answer item in ASVT. The result showed that students using all the seven strategies during the ASVT test performed high in spatial visualization ability according with the test scores. Overall, both groups of students studied had moderate spatial visualization ability even though students in Apparel Management II have the ability to better spatial visualization than the students in Apparel Management III. Students who have had experience should possess higher spatial visualization ability. Thus it is necessary to look into factors that contribute to the low of spatial visualization among students in Apparel Management III. Therefore, this study provides a very important contribution in providing information to students to choose a strategy to solve the problem in designing. The educators in the field of fashion should also be creative and initiative to enhance students' ability in the teaching process. Teaching and learning process in this area should be implemented by using a concrete teaching aids so that students with higher levels of low spatial visualization ability not only can imagine the painted object, but can hold and manipulate itself an object before reflecting on the drawings. Based on these findings the author suggests the curriculum of Apparel Management course at the university level taking into account aspects of spatial visualization ability for students to designing a more high value and can contribute to the fashion industry. The enrollment criteria for selection of Domestic

Science Education degree program should be based on students who have a history of fashion at the school and students must tested by their spatial visualization ability through the ASVT during interview sessions.

REFERENCES

1. Aldrich, W. (2007). Fabric, form and flat pattern cutting (2nd ed.). Singapore: Blackwell Pub.
2. Alias, M., Black, T. R., & Gray, D. E. (2002), "Effect of instructions on spatial visualization ability in Civil Engineering students", International Education Journal, Vol.: 3, No.:1, pp. 1-12.
3. Arasinah Kamis. (2012). Kebolehan visualisasi spatial pelajar Sains Rumah Tangga khusus dalam bidang rekaan fesyen (*In Malay*), In Rosini Abu, Anis Zakaria, & Nor Faradillah Piee @ Shafiee, Aliran Pedagogi dan Penyelidikan dalam Pendidikan Ekonomi Rumah Tangga. Serdang, Selangor: Penerbit Universiti Putra Malaysia, 55-76.
4. Armstrong, J. H. (2006). Pattern making for fashion (4th ed.). New York: Harper Collins.
5. Davis, M. (1980), "Visual Design in Dress". Englewood Cliffs, NJ: Prentice Hall, In. DesMarteau, K., Speer, J. (2004), "Entering the Third Dimension", Apparel, Vol.: 45, No.: 5, pp. 28-33.
6. Gitimu, P. N., Workman, J. E., & Anderson, M. A. (2005), "Influence of training and Strategical information processing style on spatial performance in apparel design", Career and Technical Education Research, Vol.: 30, No.: 3, pp. 112-129. doi: 10.5328/CTER30.3.147
7. Gitimu, P. N., & Workman, J. E. (2008), "Identification of strategies used for solving items on the apparel spatial visualization test", Clothing & Textiles Research Journal, Vol.: 26, No.: 1, pp. 57-65. doi: 10.1177/0887302X07304125
8. Gitimu, P. N. (2005). Spatial task performance in apparel design: Influences of strategy, strategical information processing style, and training. Doctoral dissertation, Southern Illinois University at Carbondale. Retrieved May 2011, from http://gateway.proquest.com/openurl%3furl_ver=Z39.88-2004%26res_dat=xri:pqdiss%26rft_val_fmt=info:ofi/fmt:kev:mtx:dissertation%26rft_dat=xri:pqdiss:3204661
9. Gluck, J., & Fitting, S. (2003), "Spatial strategy selection: Interesting incremental information", International Journal of Testing, Vol.: 3, No.: 3, pp. 293-308. doi: 10.1207/S15327574IJT0303_7
10. Hin, L. C. (2007). Kaedah penyelidikan pendidikan pendekatan kuantitatif dan kualitatif. *(In Malay).* Selangor, Malaysia: Mc Graw Hill.
11. Humphreys, L., Lubinski, D., & Yao, G. (1993), "Utility of predicting group membership and the role of spatial visualization in becoming an engineer, physical scientist, or artist", Journal of Applied Psychology, Vol.: 78, No.: 2, pp. 250-261.
12. Khoza, L. S., & Workman, J. E. (2009), "Effects of Culture and Training on Perceptual Learning Style and Spatial Task Performance in Apparel Design", Clothing & Textiles Research Journal, Vol.: 25, No.: 1, 62-79. doi: 10.1177/0887302X07309635
13. Kim, I., & Uh, M. (2002). Apparel making in apparel design. New York: Fairchild Publication.
14. Kosslyn, S. (1981), "The medium and the message in mental imagery: A theory", Psychological Review, Vol.: 88, No.: 1, pp. 44-66.

15. Linn, M., & Petersen, A. (1985), "Emergence and characterization of sex differences in spatial ability : A meta-analysis", Child Development, Vol.: 56, pp. 1479-1498.

16. Lubinsky, D. (2010), "Spatial ability and STEM: A sleeping giant for talent identification and development", Personality and Individual Differences, Vol.: 49, pp. 344-351. doi:10.1016/j.paid.2010.03.022

17. McGee, M. (1979). Human spatial abilities. New York: Praeger.

18. Mohd Safarin Nordin & Mohd Sukri Saud. (2007). Kajian Awal Terhadap Kebolehan Ruang Pelajar-Pelajar Pengajian Kejuruteraan di Sekolah-sekolah Menengah Teknik *(In Malay),* Paper presented at the 1st International Malaysian Educational Technology Convention, Senai, Johor Bahru.

19. Orzada, B., & Kallal, M. J. (2001), "Relationship of spatial visualization skills to style of processing preferences", In, R. E. Griffin, & J. Lee (Eds), "Exploring the visual future: Art, design, science, & technology: Selected readings of the International Visual Literacy Association", pp. 363-367.

20. Olkun, S. (2003). Making connections: Improving spatial abilities with engineering drawing activities. International Journal of Mathematics Teaching and Learning. Retrieved June 2010, from http://www.cimt.plymouth.ac.uk/journal/sinanolkun.pdf

21. Saczynski, J. S., Willis, S. L., & Schaie, K. W. (2002), "Strategy use in reasoning training with older adults", *Aging* Neuropsychology and Cognition, Vol.: 9, No.: 1, pp. 48-60.

22. Sorby, S. A. (2005), "Developing 3-D Spatial Visualization Skills For Engineering Students", Australasian Journal of Engineering Educatio, Vol.: 13, No.: 1, pp. 1-11.

23. Strong, S., & Smith, R. (2002), "Spatial visualization: Fundamentals and trends in engineering graphics", Journal of Industrial Technology, Vol.: 18, No.: 1, pp. 1-5.

24. Titus, S., Horsman, E. (2009), "Characterizing and improving spatial visualization skills", Journal of Geoscience Education, Vol.: 57, No:. 4, pp. 242-254.

25. Willey, S. E. (1990), "An Hierachy of Visual Learning", Engineering Graphics Journal, Vol.: 54, pp. 30-35.

26. Workman, J. E., & Caldwell, L. F. (2007), "Effects of Training in Apparel Design and Product Development on Spatial Visualization Skills", Clothing and Textiles Research Journal, Vol.: 25, No.: 1, pp. 42. doi: 10.1177/0887302X06296871.

27. Workman, J. E., Caldwell, L. F., & Kallal, M. J. (1999), "Development of a test to measure spatial abilities associated with apparel design and product development", Clothing and Textiles Research Journal, Vol.: 17, No.: 3, pp. 128-133. doi: 10.1177/0887302X9901700303.

28. Workman, J. E., & Zhang, L. (1999), "Relationship of general and apparel spatial visualization ability", Clothing and Textiles Research Journal, Vol.: 17, No.: 4, pp. 169-175. doi: 10.1177/0887302X9901700401.

29. Workman, J. E. & Lee, S-H. (2004), "A cross-cultural comparison of the apparel spatial visualization test and paper folding test", Clothing and Textiles Research Journal, Vol.: 22, No.:1, pp. 22-30. doi: 10.1177/0887302X0402200104.