

## Spatial Visualization Ability of Technical Students with Special Needs

Maizam Alias <sup>a</sup>, Bazlina Basarahim <sup>b</sup>,

<sup>a</sup> Universiti Tun Hussein Onn Malaysia

<sup>b</sup> Kolej Komuniti Bandar Darul Aman

### Abstract

Previous studies indicate that spatial visualisation ability is a predictor for success in technical education. Although a large amount of literature can be found on it, literature that focuses on technical students with special needs is very limited. The purpose of this study was to investigate the spatial visualisation ability of hearing-impaired students in post secondary technical educational institution. One hundred and thirty five hearing impaired students and 135 normal students from three polytechnics under the Ministry of Higher Education Malaysia were sampled for the study. A questionnaire was used for gathering demographic data and the Purdue Spatial Visualisation Ability Test was used for measuring spatial visualisation ability of participants. The results showed that the hearing-impaired students have lower spatial visualisation ability compared to that of the normal students. No association between spatial visualisation ability and academic achievement was found among the hearing-impaired students. As a conclusion, hearing-impaired technical students have low spatial visualisation ability and their spatial visualisation ability is not associated with their academic achievements.

**Keywords:** spatial visualization, technical education; hearing-impaired students

### 1. Introduction

Technical education plays an important role by providing technical and professional expertise needed by Malaysia towards achieving the developed nation status [1]. Providing technical education is however very costly thus, ensuring that every learner graduate in the minimum stipulated duration is important for cost effectiveness. With increasing participations from learners with special needs in technical education programmes, more focused initiatives are required to ensure equally successful completions among these groups.

Previous studies on spatial visualization ability (SVA), "...the ability to mentally manipulate, rotate, twist, or invert a pictorially presented stimuli" [2] show that SVA is a good predictor of success in technical education and career (Scribner, 2005). Most of these studies however, involve the general population and very little on people with special needs. As a result, there is not much known on the SVA of special learners particularly special learners in the technical field. Therefore, there is a need to study the SVA among special learners to better understand how much SVA contribute to their academic success in the technical discipline. The relevance of SVA is more important as this ability can be developed through instructions. Thus, if SVA is found to be contributing to success in technical discipline among special learners, efforts to improve SVA can be made which would help towards their academic success.

The purpose of this study was to determine the relationship between SVA and academic success among special learners in the technical discipline. It is expected that the finding would be useful in providing a better understanding of the role of SVA among special learners in general and special learners in technical discipline in particular. Knowledge gained can serve as guidance in designing suitable learning experiences among special learners towards successful completion of technical programme.

#### 1.1. Predictors of spatial visualization ability

SVA has been associated with many factors and one of it is past experience. Past experiences in spatial activities have been associated with varying degree of spatial visualization ability [3]. It is therefore expected that academic programme that requires frequent students' participations in spatial activities would be better than others at developing SVA. Based on this premise it could be argued that academic programme is a potential predictor of SVA.

Gender bias has also been observed in SVA in the general population. Males have been consistently shown to be better than females in SVA in the general population [3]. However, studies on students in technical fields have not shown consistent findings on gender difference in SVA. For example, in one study [4], males were found to be better than females while in another study [5], males and females have similar SVA. In short, spatial task can positively

affect SVA while ender may not be a differentiating factor.

## 2. Problem statement

In recent years, the MoHE has introduced special programmes for special students, i.e. hearing-impaired students in polytechnics as part the government initiatives to have inclusive education. Special learners were enrolled in selected programme in three polytechnics. Students were taught exactly as normal students by lecturers who were trained in sign language. Reading sign language requires spatial perception which is part of spatial ability. It is expected that special students are good in SVA due to their constant use of spatial cues. This is however not yet known and thus one of the objectives of this study is to assess the SVA of special students and to determine if SVA is a predictor of their academic success. Some questions on SVA among hearing impaired students that are of interest are as follows:

- i. What is the SVA of hearing impaired students? Is it any different than hearing students?
- ii. Is there a difference in SVA between males and females?
- iii. Is there difference in SVA between students of different technical programmes?
- iv. Is SVA a predictor for academic success for hearing impaired students?

## 3. Methodology

### 3.1. Population and Samples

The population of the study was hearing impaired students who were enrolled in post-secondary technical institutions. The samples were hearing-impaired students ( $n = 135$ , Males=64, Females=71) from three polytechnics under the MoHE that offer special education namely, Johor Bahru Polytechnic (JBP), Ungku Omar Polytechnic (UOP) Sultan Salahuddin Abdul Aziz Shah Polytechnic (formerly known as Shah Alam Polytechnic or PSA). Similar number of normal students (Males 38, Females=97) was also recruited as participants to be the comparison group. Recruitments of participants were achieved with the help of lecturers in these polytechnics. Lecturers were given the selection criteria which were to recruit as many hearing impaired students as possible and to select an equal number of hearing students. The distribution of samples is shown in Table 1.

**Table 1 Distribution of sample according to polytechnics**

HI		H	
<i>n</i>	(%)	<i>n</i>	(%)

PJB	93	68.9%	93	68.9%
PSA	23	17.0%	23	17.0%
PUO	19	14.1%	19	14.1%
<b>Total</b>	<b>135</b>	<b>100.0%</b>	<b>135</b>	<b>100.0%</b>

### 3.2. Instruments

Two data gathering tools were used in the study, questionnaires and The Purdue Spatial Visualization Test / Test of Rotation (PSVT-R). Questionnaires were used to gather data on gender, courses, semester of studies and cumulative grade point average. The Purdue Spatial Visualization Test / Test of Rotation (PSVT-R) was used to measure the SVA of participants. The Cronbch Alpha for the PSVRT-R is  $\alpha = .88$  which is comparable with [6] where,  $\alpha = .80$ .

### 3.3. Research procedure

The questionnaire was combined with the PSVT-R in one document and distributed to students with the helps of lecturers in the participating polytechnics. The instruments were collected after 45 minutes.

## 4. Results and discussion

### 4.1. Demography

A higher proportion of females were in the hearing group compared to the hearing impaired group (Table2). The high proportion of females for the hearing group came mostly from the hotel management and catering programme (Table 3).

**Table 2 Distribution of samples: Hearing status vs gender**

	HI		H	
	<i>n</i>	(%)	<i>n</i>	(%)
Males	64	47.4%	38	28.1%
Females	71	52.6%	97	71.9%
<b>Total</b>	<b>135</b>	<b>100.0%</b>	<b>135</b>	<b>100.0%</b>

**Table 3 Distribution of sample: Hearing status vs academic programme**

	HI		H	
	<i>n</i>	(%)	<i>n</i>	(%)
Fashion Des.	65	48.1%	0	0.0%
Hotel Man. & Catering	28	20.7%	93	68.9%
Civil Eng.	19	14.1%	19	14.1%
Mechanical Eng.	23	17.0%	23	17.0%
<b>Total</b>	<b>135</b>	<b>100.0%</b>	<b>135</b>	<b>100.0%</b>

Most students came from semester 1, 2 and 4 with only 20 students from semester 5 and 6 and they were from the hearing group (Table 4).

**Table 4 Distribution of students: Haring status vs semester of study**

	HI		H	
	<i>n</i>	(%)	<i>n</i>	(%)
Semester 1	15	11.1%	71	52.6%
Semester 2	82	60.7%	38	28.1%
Semester 4	38	28.1%	6	4.4%
Semester 5	0	0.0%	10	7.4%
Semester 6	0	0.0%	10	7.4%
<b>Total</b>	<b>135</b>	<b>100.0%</b>	<b>135</b>	<b>100.0%</b>

#### 4.2. Levels of SVA

The SVA score of the hearing impaired group is very poor ( $M=9.52$ ,  $S=6.16$ ). The SVA score of the hearing group is also equally poor but better than the hearing impaired group ( $M=12.71$ ,  $S=5.24$ ). The difference between the mean SVA scores of the hearing impaired and the hearing group is statistically significantly different,  $t(261.24) = 4.59$ ,  $p < .001$  based on the Welch *t*-test (independent *t*-test for unequal variance). The Welch test was used after it was confirmed that the groups' variances were not homogeneous, based on the Levene's test.

#### 4.3. SVA and gender

Similar scores on SVA were observed among the males ( $M=9.78$ ,  $S=6.52$ ) and females ( $M=9.28$ ,  $S=5.85$ ) in the hearing impaired group. The small difference was not statistically significant,  $t(133) = .47$ ,  $p=.64$ . The finding of no difference is inconsistent with [3] but consistent with [5]. The finding in [3] was based on the general population while the finding in [5] was based on technical students. It is therefore highly plausible that there is no gender difference in SVA for hearing impaired students in the technical field.

In the hearing group, higher scores on SVA were observed among the males ( $M=14.39$ ,  $S=6.21$ ) compared to females ( $M=12.05$ ,  $S=4.67$ ). The difference was statistically significant,  $t(54.201) = 2.103$ ,  $p=.04$ . This finding is inconsistent with that found in [5] which were on engineering students in polytechnics. The inconsistency could be due to programme of study rather than gender. This is because; many of the students in the current study are in the hotel management and catering programme while all of the students in the previous study [5] were studying civil engineering.

#### 4.4. SVA and academic programmes

Among the hearing impaired students, differences in SVA scores were observed between the four

academic groups (Table 5). A one-way ANOVA was used to test for mean SVA differences after it was determined that there were homogeneity of variances based on the Levene's test,  $F(3,131)=1.204$ ,  $p = .311$ . Differences in SVA mean scores were not found to be statistically significant,  $F(3, 131)=.593$ ,  $p=.62$ . In other words, students from different academic programmes have similar SVA.

**Table 5 SVA scores according to programmes**

	<i>n</i>	<i>M</i>	<i>SD</i>
Fashion Des.	65	8.97	6.04
Hotel Man. & Catering	28	9.68	6.55
Civil eng.	19	11.11	5.14
Mechanical Eng.	23	9.57	6.91
Total	135	9.52	6.16

Among the hearing students, differences in SVA scores were observed between the three groups that were enrolled in different academic programmes as shown in Table 6. A one-way ANOVA was used to test for SVA differences after it was determined that there were heterogeneity of variances based on the Levene's test. Differences in SVA mean scores were found to be statistically significant,  $F(2,132)=3.142$ ,  $p = .036$ .

**Table 6 Descriptive statistics on SVA according to academic programme**

	<i>n</i>	<i>M</i>	<i>SD</i>
Hotel Man. & Catering	93	11.94	5.20
Civil eng.	19	14.26	2.83
Mechanical Eng.	23	14.57	6.29
Total	135	12.71	5.24

Post-hoc test results indicate that only the hotel management and mechanical group was statistically significantly different (Table 7). Highly likely it is not the programme that is the issue here but could be gender because most students in the hotel management & catering are females.

**Table 7 Results of Post-hoc test**

(I)	(J)	(I-J)	Std. Error	Sig.
Hotel man. & catering	Civil eng.	-2.33	1.295	.075
	Mechanical	-2.63(*)	1.199	.030
Civil Eng.	Hotel man. & catering	2.33	1.296	.075
	Mechanical	-.30	1.596	.850

\* $p < .05$

#### 4.5. SVA and Academic Achievement

Only 120 hearing impaired students and 64 hearing students reported their CPA and these data were used to compute the Pearson correlations between CPA and SVA.

Correlations between CPA and SVA were weak among the hearing impaired students  $r(118) = .282$ ,  $p = .002$  but statistically significant. Since the correlation is statistically significant, SVA can be a predictor of success among hearing impaired students.

The correlation between CPA and SVA for hearing students is practically non-existent  $r(62) = .004$ ,  $p = .97$ . The finding however is inconsistent with previous studies. The fact that most of the students were in hotel management and catering may have some bearing on it. Previous studies on technical students have mostly been done on engineering students. It is possible that SVA does not predict performance in hotel management and catering students.

#### 5. Conclusion

This study was an exploratory study, the first of its kind involving hearing impaired students in post secondary technical institutions in Malaysia. It sets out to determine if special students have different SVA to hearing students and does SVA predicts their academic performance.

Overall, it is worth noting that technical students in general have low SVA with poorer SVA among hearing impaired students. For the hearing impaired students, academic programmes do not appear to be a predictor of SVA. For the hearing students, some academic programme may predict their SVA.

SVA was found to be a predictor for hearing impaired students but not for hearing students in the study. Considering that SVA is a predictor of success among the hearing impaired students, efforts can be made to improve their SVA so that they can better succeed in their learning. Future studies could look into ways and means to improved SVA of hearing impaired students.

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