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Designed by Katherine Dix

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Flinders University (Education)
Bedford Park, South Australia
Phone: 08-8201 2807,
Fax: 08-8201 3184,
reaburn.reynolds@flinders.edu.au

Prof John Keeves
Flinders University (Education)
Bedford Park, South Australia
Phone: 08-8201 2392,
Fax: 08-8201 3184,
john.keeves@flinders.edu.au

Online Editor

Ms Katherine L. Dix
Flinders University (Education)
Bedford Park, South Australia
Phone: 08-8201 2105,
Fax: 08-8201 3184,
katherine.dix@flinders.edu.au

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Effect of Instructions on Spatial Visualisation Ability in Civil Engineering Students

Maizam Alias
Department of Technical and Vocational Education, Tun Hussein Onn University College of Technology, Malaysia *maizam_alias@hotmail.com*

Thomas R. Black
School of Educational Studies, University of Surrey, United Kingdom

David E. Gray
School of Educational Studies, University of Surrey, United Kingdom

The aim of this study was to test whether manipulative and sketching activities could influence spatial visualisation ability in engineering students. A pre- and post-test quasi-experimental design was employed using two intact classes of civil engineering students from Malaysian polytechnics. The treatment group (n = 29) manipulated objects and learnt to sketch from observation and imagination during their structural design class, while the control group, (n = 28) had their regular structural design class. The treatment group achieved a statistically significant gain in spatial visualisation ability compared to the control group. A statistically significant difference was neither found between gender irrespective of types of instruction nor for the interaction effect. It was concluded that the spatial activities enhances students' spatial visualisation ability and both male and female engineering students benefited equally from the intervention.

Teaching and learning, spatial activities, structural design,
spatial visualisation ability, civil engineering

INTRODUCTION

Spatial visualisation ability is a subset of spatial ability - one of the factors of human intelligence structure. Spatial visualisation ability has been defined as, "…the ability to mentally manipulate, rotate, twist, or invert pictorially presented stimulus objects." (McGee, 1979, p. 893). This multi-faceted ability helps engineers including civil engineers to conceptualise links between reality and the abstract model of that reality. For example, in the analysis of a loaded beam structure, the deflected shape of the beam is the reality and the mathematical equation chosen (often unseen in a computer design package) to represent this deflected shape is the abstract model of that reality. A civil engineer needs first to have an intuitive understanding of the interactive relationships among structural components before he could begin to predict the deflected shape, which leads to the identification of the abstract model. This intuitive understanding is also essential to civil engineers in another way. It helps them in visualising, predicting, designing and checking for the worst possible combination of loads on a given structure. In the design of a reinforced concrete design for example, the ability to visualise aids the engineer in the prediction of critical loading conditions, which is necessary in reaching an adequate reinforcement design.

Spatial visualisation ability has also been found to be essential to a student's success in some engineering related subjects such as calculus (Winkle, 1997), mathematics, (Battista,

Wheatley and Talsma, 1989), engineering drawing (Sorby and Baartmans, 1996a) and computer-aided design (Sorby, 1999). Early indication for a positive relationship between this ability and structural design has also been found. Alias (2000) carried out a learning task analysis on the design of a reinforced concrete column - an area that demands a wide variety of structural design skills - and discovered that spatial skills are pre-requisite to the learning of column design suggesting that spatial visualisation ability may be essential to the success of structural design.

Overall, spatial visualisation ability may be critical to learning and problem solving in civil engineering especially to the learning of subject matter that demands spatial strategies such as structural design, engineering mathematics and soil mechanics. There has also been some suggestions that spatial ability is relevant to problem solving that is not dependent on spatial strategies proposed by Roberts, Gilmore and Wood (1997). Roberts, et al. proposed that in cases where non-spatial strategies are required, spatial ability influences the degree to which a problem solver is able to develop and evaluate these strategies.

In summary, spatial visualisation ability appears to be necessary to problem solving in engineering related areas that requires spatial as well as non-spatial strategies. Therefore, a better understanding of this ability should be potentially beneficial to the engineering education and profession.

FACTORS CONTRIBUTING TO DIFFERENCES IN SPATIAL VISUALISATION ABILITY

Differences in spatial visualisation ability and its acquisition have been attributed to a number of variables, including cognitive development, spatial experiences, gender and aptitude.

Cognitive development

According to Piaget and Inhelder (1971), a person's cognitive development determines the potential of what he/she could achieve. Four stages of cognitive development have been suggested, that is, (i) the sensori-motor stage, (ii) the pre-operational stage, (iii) the concrete operational stage, and (iv) the formal operational stage. A person who is at the concrete operational stage "…always starts with experience and makes limited interpolations and extrapolations from the data available to his senses" (Piaget in Phillips, 1969, p. 104). On the other hand, a person at the formal operational stage does not need to experience in order to generate and evaluate propositions. As such, a formal operational thinker can be expected to make use of a variety of spatial possibilities and to have better spatial skills compared to those who have yet to reach this stage. According to Piaget and Inhelder (1971), children start to develop their formal operational skills at the age of 13; reaching their maximum potential by the age of 17, suggesting that students in post secondary education are formal operational thinkers. However, later studies have shown a high percentage of post-secondary students who have yet to reach the formal operational stage (Killian, 1979; Reesink, 1985). This has significant implications for teaching even in higher education, since reaching the formal operational stage is a result of a combination of maturation and experience. While maturation may come with age, experience is most likely to be the consequence of education.

Experiences

Spatial experiences - acquired through life experiences or formal education - have been suggested to contribute to differences in spatial visualisation ability. Deno (1995) finds that spatial experiences in non-academic subjects are correlated to spatial visualisation ability in engineering students. He also finds indications of differential effects of spatial experiences on

gender. For example, playing with construction block type of toys is found to be a good predictor of male ability while activities that are visual and less tactile are good predictors for females. This has implications for children growing up in non-technological societies who lack play experiences and toys common in more developed countries.

Ben-Chaim, Lappan and Houang (1988) find that spatial activities that require the subjects to construct, evaluate and sketch models of buildings created from cubes could enhance spatial visualisation ability. Lord (1985) also observes an increase in spatial visualisation ability in his subjects of college students after undergoing planes through solids type of interventions. So did Seddon, Eniaiyeju and Jusoh (1984) who find that his group of 19 to 30 year old subjects benefits from instructions on orthographic projections.

Since spatial visualisation ability is a multifaceted ability, any attempt to improve the ability may influence the acquisition of one aspect of it while not the others as demonstrated by Zavotka (1987). Zavotka finds that while her students improve on their orthographic projection skills after following a program on computer animated graphics, they however, do not improve on their mental rotation skills. She finds that the students' performance on the mental rotation measure is significantly affected by the sequence of the films that are shown to them, that is, wire-frame to solid or vice versa. Interestingly, Braukmann and Pedras (1993) find that different spatial activities do not necessarily bring about a difference in performance on spatial ability. They find that using traditional drafting equipment is as effective as a using computer aided design in enhancing spatial skills in engineering students.

It appears that providing diverse spatial activities may be the key to enhancing overall spatial visualisation ability as illustrated by Sorby and Baartmans (1996a). Sorby and Baartmans prescribed diverse spatial activities to their engineering students, ranging from manipulation of concrete models to computer visualisation activities, and find that they improve greatly in their spatial visualisation ability as measured by The Purdue Spatial Visualisation Test.

In conclusion, the findings from previous studies support the hypothesis that spatial visualisation ability is affected by spatial experiences and the effect could be on overall or some aspects of the ability depending on the types of experiences. The impact of different types of spatial activities on spatial ability was taken into account in the design of teaching and learning activities for this study.

Gender

Findings from past studies indicate possible relationship between spatial visualisation ability and gender. For example, Vandenberg and Kuse (1978) and Hamilton (1995) find that males' perform better than females' on spatial mental rotation tasks, an indicator of spatial visualisation ability. Ben-Chaim, et al., (1988) also find that prior to instruction, boys in middle school were better in their spatial visualisation ability compared to girls although these differences disappeared after instruction on spatial skills.

However, some research findings are showing evidence for superior performance by certain groups of females. For example, Eisenberg and McGinty (1977) find that groups of female university students who enrolled in two types of mathematics program (i) calculus, and (ii) business statistics, performed better on the spatial visualisation measure compared to their male counterparts. The performances of the groups enrolled in the (iii) remedial mathematics, and (iv) mathematics for elementary school teachers program were however reversed.

As there is no clear relationship between gender and spatial visualisation ability, gender was considered as a potential source of confounding in the study.

Aptitude

Studies have also indicated some form of relationship between aptitude (general intelligence) and spatial visualisation ability. Aptitude has been shown to affect choice of strategy (Kyllonen, Lohman and Snow, 1984) and choice of strategy has been shown to affect performance on spatial tests, as indicators of spatial ability (Schultz, 1991). In brief, aptitude is related to spatial visualisation ability. Therefore, aptitude was also treated as a source of confounding in the study that needed to be controlled.

METHODOLOGY

Research questions and statistical hypotheses

Three research questions were investigated.

1. Could spatial visualisation ability of civil engineering students be improved through spatial activities consisting primarily of object manipulations and free hand sketching?
2. Is there a difference in spatial visualisation ability between males and females engineering students?
3. Do these spatial activities affect males and female students differently?

The three null-hypotheses were:

a) there will be no statistically significant difference between the experimental and control group in their mean gain scores on the Spatial Visualisation Ability measure irrespective of gender;

b) there will be no statistically significant difference between males and females in their spatial visualisation ability mean gain scores as measured by the Spatial Visualisation Ability measure irrespective of treatments; and

c) there will be no statistically significant interactions between gender and treatments.

Research variables

The dependent variable was the gain score on the test instrument that is, the difference between the post-test score and the pre-test score. The independent variables were gender (male and female) and types of learning program (prescribed specific spatial activities and not prescribed).

Research design and procedure

A quasi-experimental design method, as intact classes, were used, with pre and post-tests, with one group as a control was adopted for the study. Pre-tests on spatial visualisation ability were administered to both groups following which, the experimental group carried out some spatial activities as part of their structural design class over a period of one week. At the same time, the control group followed their normal structural design class. At the end of the week, spatial visualisation ability post-tests were administered to both groups. The short interval between the pre- and post-test was an advantage as it removed maturation effects from being a source of confounding.

Research Population

The population for the study was the civil engineering diploma students in Malaysian polytechnics. Malaysian polytechnics are post-secondary institutions, which train technical personnel in the three major areas of engineering, civil, mechanical and electrical engineering. These polytechnics offer 2-year certificate and 3-year diploma programs to secondary school leavers (age 16+). Diploma recipients of polytechnic engineering programs may either seek employment as assistants to engineers or further their studies to become engineers themselves. For this reason, the polytechnic diploma program is designed to be the equivalent of the first-year degree program in Malaysian universities to enable the graduates not only to seek employment but also to further their studies in engineering.

Although no spatial ability studies have been carried out on polytechnic students prior to this study, they were expected to have some spatial visualisation skills, which they acquired through the drafting courses taken in their earlier semesters. The engineering drafting course however, was designed primarily to develop draughtsmanship skills (Malaysian Ministry of Education, 1991) in these engineering students.

In this study, we aimed to discover whether a few hours of spatial activities involving object manipulations and free hand sketching could further improve spatial visualisation ability of these civil engineering students.

Research Sample

The experimental group was a class of civil engineering diploma students from Ungku Omar polytechnic while the control was the corresponding class from Port Dickson polytechnic. The average age of the experimental and control groups were 21.7 years and 21.5 years respectively. The proportions of males and females in both groups were similar and consistent with the ratio for all civil engineering students.

As shown by previous studies (Killian, 1979) secondary school leavers could still be pre-operational thinkers. Therefore, it was logical to assume that the samples were a combination of formal operations and concrete operations (or transitional thinkers. Nevertheless, a proportion of the non-formal to formal operations thinkers was expected to be comparable in both groups. This was a consequence of the random placement procedure of students into polytechnics practised by the Ministry of Education. Consequently, non-comparable groups with respect to formal or non-formal operations thinkers were not anticipated to be a source of confounding.

Teaching and learning materials

The learning activities prescribed for the study were designed with Piaget's learning theory in mind, that is, a person learns progressively from the concrete to the abstract. Although the major application of Piaget's theory of learning and stage theory was to children, it is also equally applicable to adults (Sutherland, 1999).

The purpose of these activities was to develop generic spatial visualisation skills as well as structural engineering specific skills. Initially, subjects used building blocks as aids to visualisation. Subjects also sketched objects (constructed from blocks) from observation and imagination. The generic activities were adapted from Izard (1990), Baartmans and Sorby (1996), Sorby and Baartmaan (1996b) and Lappan, Phillips and Winter (1984). The structural engineering specific activities consisted of manipulations of beam models, which were developed after a consultation with a civil engineering lecturer (C. Howard, personal communication, April, 1998*)* and sketching of structural diagrams, which were derived from

Brohn (1990). The overall emphasis was on concrete activities, which have been shown to benefit both formal operational and pre-operational thinkers.

Instrumentation

The spatial visualisation ability instrument was specifically designed for the study. To give a comprehensive measure of spatial visualisation ability, the instrument employed three types of spatial tasks: cube construction tasks, engineering drawing and mental rotation tasks. For each test item, subjects were instructed to choose one from four alternatives. Examples of the items are illustrated in Figures 1, 2 and 3. The instrument consisted of 28 items, 10 on the first task (Section I), 11 on the second task (Section II) and seven on the third task (Section III). The instrument had a Kuder-Richardson 20 (KR20) coefficient of 0.70 and a concurrent validity of 0.74 with the Vandenberg Mental Rotation Test (Vandenberg, 1971). The KR20 coefficients for Sections I, II and III were 0.55, 0.43 and 0.53 respectively. The validity of these tasks as measures of spatial visualisation ability has been established in other studies.

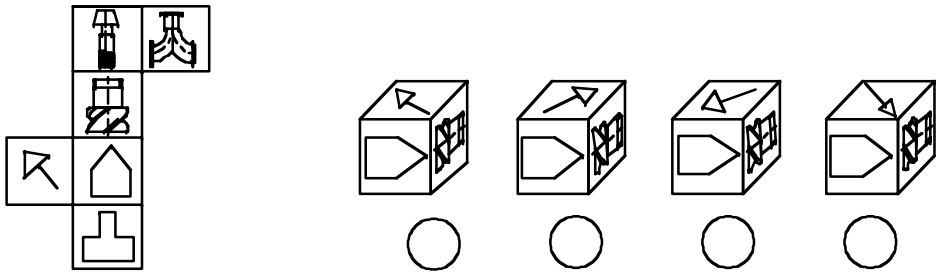

Figure 1. An example of a cube construction item

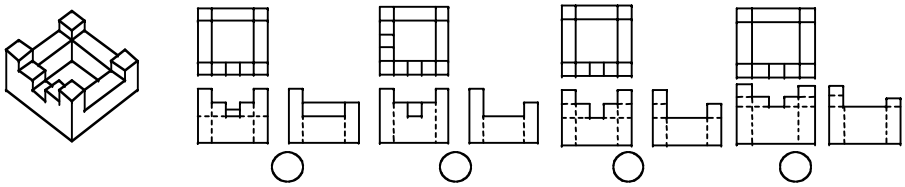

Figure 2. An example of an engineering drawing item of Type 1

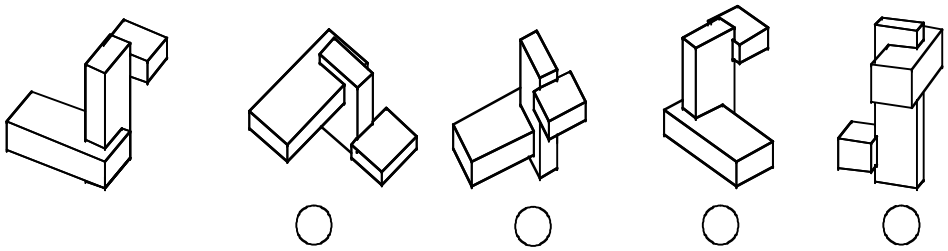

Figure 3. An example of a mental rotation item

RESULTS

Table 1 displays the means $\bar{x}$, standard deviations s on the overall test instrument and sample sizes n employed in the study. The unequal sample sizes were a consequence of using intact classes of students.

Table 1. Means $\bar{x}$, standard deviations *s*, on the spatial ability instrument and the corresponding sample sizes *n*

		Control	Experimental	Gender main effect
Female	$\bar{x}$ =	3.00	3.36	3.21
	s =	1.77	2.94	2.46
	n_f =	8	11	19
Male	$\bar{x}$ =	3.00	5.28	4.08
	s =	3.01	2.4	2.94
	n_m =	20	18	38
Treatment main effect	$\bar{x}$ =	3.00	4.55	3.79
	s =	2.68	2.73	2.8
	n =	28	29	57

The null hypotheses of no difference in means of the gain scores between groups and within groups were tested using an analysis of variance (ANOVA). A statistically significant difference was found between the means of the gain scores of the experimental and the control group (Table 2) indicating that the difference was unlikely to have occurred by chance alone although the statistical power was only 0.53. The assumption is that all extraneous variables were controlled for and therefore, the treatment was the likely cause of the difference. Statistical significance is not found for the results on the gender main effects or the interaction effect between gender and treatment.

A *post-hoc* analysis was not carried out on the result, as there was no statistically significant interaction.

Table 2: A two way ANOVA on the SVATI gain scores using worksheet in Excel from Black (1999)

	SS	***df***	***MS(s^2est)***	***F***	***$F_{critical}$***	***α***	***Outcome***
Gender	9.55	1	11.40	1.44	4.02	0.05	n.s
Treatment	34.30	1	29.96	5.16	4.02	0.05	p<0.05
Interaction	12.20	1	12.73	1.84	4.02	0.05	n.s
Within	352.34	53	6.65				
Total	408.43	56					

Results on the individual group of spatial task

As explained earlier, the spatial visualisation instrument employed three types of spatial tasks, each of which were postulated to require slightly different solving strategies or skills. Analysing the subjects' performance on the individual group of tasks may be advantageous as it may yield information on the types of spatial skills that benefit most from the prescribed spatial activities and information on the relationships between gender, type of skills and learning gains, if any.

Means and standard deviations on the cube construction items are displayed in Table 3. Clearly, the differences between the means for female and male groups irrespective of treatment are very small and unlikely to be statistically significant.

Table 3: Means $\bar{x}$, standard deviations *s*, on the cube construction items and sample sizes *n*

		Control	Experimental	Gender main effect
Female	$\bar{x}$ =	1.38	0.55	0.96
	s =	1.69	0.92	1.45
	n_f =	8	11	19
Male	$\bar{x}$ =	0.70	1.28	0.99
	s =	1.60	2.27	1.98
	n_m =	20	18	38
Treatment main effect	$\bar{x}$ =	0.89	1.00	0.97
	s =	1.65	1.99	1.81
	n =	28	29	57

The difference between the means of the gain scores for the control and the experimental groups irrespective of gender is also very small and unlikely to be statistically significant. There is however, some indication of dis-ordinal interaction effect between gender and treatment as indicated by the large variations among the means in the first four cells.

However, testing the null hypotheses of no difference in means of the gain scores for the interaction effect using ANOVA does not give a statistically significant result ($p > 0.05$). Statistical significance is also not found for the treatment main effect and for the gender main effect.

On the engineering drawing items (results displayed in Table 4), the difference in means of the gain scores across treatments irrespective of gender is relatively large giving an indication of a main treatment effect. The difference between gender means irrespective of treatments is also relatively large indicating a possibility for a statistically significant difference between means for genders.

Table 4: Means $\bar{x}$, standard deviations *s*, on the engineering drawing items and sample sizes *n*

		Control	Experimental	Gender main effect
Female	$\bar{x}$ =	0.50	2.00	1.25
	s =	1.41	2.49	2.19
	n_f =	8	11	19
Male	$\bar{x}$ =	1.50	2.83	2.17
	s =	2.35	2.01	2.27
	n_m =	20	18	38
Treatment main effect	$\bar{x}$ =	1.21	2.52	1.71
	s =	2.15	2.20	2.25
	n =	28	29	57

As expected, a statistically significant result was found for the treatment main effect as shown in Table 5 with a statistical power of 0.55. Surprisingly, statistical significance was not found for the gender main effect or the interaction effect.

Finally, no statistical significance was found on the mental rotation items for all the hypotheses tested.

Table 5: A two way ANOVA on the gain scores for the engineering drawing items using worksheet in Excel from Black (1999)

	SS	*df*	*MS(s^2est)*	*F*	$F_{critical}$	α	*Outcome*
Gender	10.46	1	10.46	2.36	4.02	0.05	n.s
Treatment	21.12	1.00	21.12	4.76	4.02	0.05	p<0.05
Interaction	1.48	1	1.48	0.33	4.02	0.05	n.s
Within	235.26	53	4.44				
Total	268.32	56					

DISCUSSION

The positive effects of teaching and learning on spatial visualisation ability found in this study are consistent with those from previous studies where similar teaching interactions had been used (Lord, 1985; Ben-Chaim, et al., 1988; Tillotson, 1984; Seddon, et al., 1984; Sorby and Baartmans, 1996a).

The absence of gender related differences in this study is however, in contradiction with previous research findings, which show poorer performance of females compared to males on spatial visualisation ability tasks (Ben-Chaim, et al., 1988; Eisenberg and McGinty, 1977; Allen and Hogeland, 1978). One possible explanation is that the types of spatial tasks employed in the present study were not the ones that tend to elicit gender differences. Most reported findings on gender differences are on the mental rotation tasks (Hamilton, 1995; Vandenberg, 1978) while findings on other types of spatial tasks are inconsistent. Alyman and Peters (1993) for example, find that out of nine spatial tasks – tasks involving everyday objects and settings - males only perform better on two, one of which is a mental rotation task and the effect size was less than 0.100. Therefore, even if females are weak in executing mental rotation of whole objects, they may be good in executing other spatial visualisation processes. The spatial visualisation ability instrument, which consisted of three types of spatial tasks, may have provided the female subjects with the opportunity to demonstrate the full spectrum of their spatial visualisation skills and thus performed equally well as the male subjects.

Another possible explanation is similarity in the types of spatial experiences of females and males in the study. Since females in this study were students who chose to study civil engineering – a male dominated field – it is likely for them to have some shared characteristics, such as shared spatial experiences. For example, similar spatial experiences early in life between males and females in this study, which leads to equivalent level of spatial ability, may have dictated their courses preference, which might explain the absence of gender-related differences in spatial visualisation ability of the samples. Furthermore, the females in the present study had had similar skills training (reading and interpreting engineering drawings as their male counterparts, in contrast to the females in the previously cited studies. This training might have wiped out or reduced considerably the initial difference in spatial skills if it existed. In brief, most probably there is no difference in spatial visualisation ability between males and females engineering students in the study.

On the individual components of the ability instrument, statistical significance was only found for the treatment main effect on the engineering drawing items. This is not surprising, as the

subjects were familiar with engineering drawing. Therefore, the prescribed spatial activities may have facilitated the development of the most appropriate spatial strategies leading to better performance on the given tasks.

Lack of treatment effect on the cube construction items was, however, contrary to expectations. Nevertheless, the reliability of this particular instrument is only 0.55, so the finding must be treated with caution.

Similarly, lack of statistical significance in any of the hypotheses tested for the mental rotation items was also unexpected. Several factors could have contributed to this outcome. First, there was lack of shared characteristics between the teaching and learning materials and the test items. The learning materials consisted of relatively simple objects (constructed from building cubes) with square and non-slanting surfaces, while the test items were representations of complex objects, some with slanting and non-rectangular surfaces. Reported gains in mental rotation skills are mostly acquired through transfer tasks that were very similar to the practice tasks (Seddon and Shubber, 1985; Shubbar, 1990).

Secondly, implicit teaching of mental rotation skills, a component of spatial visualisation ability, could also be the cause for the lack of gain in mental rotation. For example, although it was expected that the subjects should be able to predict changes in the perspective view upon rotation of an object, subjects were not instructed to observe these changes during training. For example, during the sketching exercise, they were not asked to draw views of objects other than those seen from the standard views.

Thirdly, lack of gain could also be due to lack of mastery of depth cues. According to Seddon and Eniaiyeju (1986), the ability to visualise the effects of rotation transformations on diagrams of 3-dimensional structures is dependent on mastery of depth cues, which are the relative size cue, overlap cue, foreshortened line cue and the distortion of angles cue. Depth cues were however, not taught in the study and only three depth cues, that is, the distortion of angle cue, the overlap cue and the foreshortened line cue were used for the test items. The relative size cue was not provided, as that would be inconsistent with the engineering drawing convention.

Lastly, the low instrument reliability must also be considered, as the reliability of this particular component of the spatial ability instrument is only 0.53.

LIMITATIONS

The study is a field study that attempted to investigate the inter-relationships between learning and psychological variables in an engineering educational setting and was the first of its kind in Malaysia (Education Planning and Research Division, 1999). Naturally, it was a complex and challenging piece of research to carry out and it was no great surprise to us that the limitations only became apparent as the research progressed. For example, the sample sizes were less than ideal for the factorial design method adopted for the data analysis. The impact of the small samples was made worse by the unequal sample sizes between the male and female samples. However, the unequal sample sizes were unavoidable as the study employed intact classes of students where the smaller proportion of females to males is typical in any civil engineering population.

The short duration provided for training on spatial skills was also less than ideal. It is expected that longer teaching and learning duration could resolve the questions on gender by enhancing the prospect of greater effect size.

CONCLUSION

This study set out to establish causal relationships between teaching and learning of spatial skills and spatial visualisation ability. Although the improvement in the components of the spatial visualisation ability was varied, with the largest gain being on the engineering drawing tasks and the least on the mental rotation tasks the study did show that spatial visualisation skills in general were improved after the teaching and learning activities. The finding was deemed educationally significant although the gain in skills for the experimental group was not large that is, 1.6 marks (5.8%) higher than the control group. This gain highlights the role of concrete spatial activities in the development of spatial visualisation ability in engineering students. May be, more concrete activities should be provided to engineering students to give them the basis for imagination, as what one does not see or experience one cannot imagine.

More importantly, if spatial visualisation ability is accepted as being important to problem solving and learning in engineering, engineering educators need to place more emphasis on the development of these skills in their engineering students. For example, spatial skills training should be integrated across the curriculum, which would increase students' awareness of its importance thus optimising the conditions for positive skills transfer. Remedial lessons should also be made available to those who have poor spatial visualisation ability as normally practised with those who are weak in the mathematical and analytical skills.

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Barriers to Hiring Students with Disabilities in the Workforce

Caven S. Mcloughlin
Kent State University *caven@kent.edu*

To determine factors that influence hiring, 120 employers and potential employers of workers with disabilities in NorthEastern Ohio, USA, were interviewed by psychologists to identify the characteristics of individuals with disabilities that influence hiring decisions. Significant differences exist between those employers with and those without experiences in hiring workers with disabilities in their respective assessments of workers' dependability, performance levels, and fellow workers' likely reactions. Employers with and those without experience in hiring workers' with disabilities expressed a strong desire for additional information regarding incentives for hiring and information that might ease their task in employing persons with disabilities. Implications for workforce readiness and transition into independent adulthood supported by employment are discussed.

Employer perceptions, workplace barriers, transition

INTRODUCTION

Employment offers a major, positive, life-change for those who otherwise would be served by agencies throughout their lives. However, only a minority of persons with disabilities currently are afforded integrated and competitive employment experiences. Historically, persons with disabilities have been largely underemployed or unemployed (Mcloughlin, Garner, and Callahan, 1987). Nonetheless, it has repeatedly been noted that employment is itself a beneficial activity. Employment is the cornerstone of an independent life. The value of other independent living skills may, for persons with disabilities, be diminished if they cannot earn an income sufficient to support independent living (Stowitschek and Salzburg, 1987, p. 1). Current initiatives to improve the school-to-work transition for people with disabilities stem, at least partially, from the recognition of the importance of productive employment for an independent adult life.

Considerable knowledge exists about how to instruct persons with disabilities to carry out work tasks conclusively indicating that the majority of people with disabilities can work competitively, with performance levels approximating those of nondisabled workers. Yet, equally certainly the majority of workers with disabilities fail in competitive employment for social rather than work-performance reasons (e.g., Bellamy, Rhodes, Mank and Albin, 1988; Rusch, 1986; Wehman, Moon, Everson, Wood and Barcus, 1988).

Some human service agencies have unwittingly perpetuated a belief that those with disabilities constitute surplus individuals who are simply incapable of contributing productively to the labour force, or to society. Unfortunately, only a minority of human service agencies have a mission of demonstrating that clients can be productive in a profit-centred business environment. Consequently, their clientele too frequently have been restricted to non-competitive, maintenance- oriented, segregated environments. In turn, some

employers join these agency personnel in holding beliefs that restrict work opportunities for persons with disabilities. Thus, belief systems do limit the fuller incorporation of disabled personnel as workforce employees. Nonetheless, some employers' concerns are reasonable. The degree to which these employer perceptions, real or imaginary, delimit the ability of potential employees in gaining workforce opportunities deserves investigation, and the resultant findings may be used as a guide when intervening to change the workforce preparation programs for individuals with disabilities.

This research was founded on existing knowledge from national surveys of employer's perspectives about new hires. The foremost survey was conducted by the Committee for Economic Development (an independent research and educational organization of 200 business executives and educators) which was reported in the summary report: *Investing in Our Children – Business and Public Schools* (CED, 1985). No instances of comparable large scale research have been initiated in the past 15 years, and in the CED workforce update titled: *The Employer's Role in Linking School and Work*, scant consideration was given to students with special education backgrounds. It appears as though recent economic downturns have resulted in less attention being given to this segment of the workforce. Unfortunately, the original CED report did not address the issue of placing persons with disabilities into the workforce. Nevertheless, their work illuminates employer's general concerns about employability issues. The major findings of the CED survey of 1500 employers on hiring practices and requirements were:

(a) employers in all sizes of businesses place far greater importance for entry level success on positive attitudes toward work than on specific job-related skills (they rank as most important: striving to do work well, priority setting, and working well with others);

(b) hiring-personnel have similar priorities about entry level applicants;

(c) individual attributes held to be important for entry level success are broadly similar for small and large companies; and

(d) unlike large businesses, smaller enterprises rarely had any ongoing relationship with secondary schools' vocational programs engaged in preparing their future workforce.

This research study investigated the factors that 120 Ohio employers consider when contemplating hiring disabled workers. Barriers to fuller employment were discerned from direct interviews of employers broadly representing Ohio's diversified economy. Using a custom-designed interview schedule, employers completed a face-to-face interview with a psychologist skilled in collecting, clarifying, and interpreting verbal and non-verbal information from respondents.

METHOD

A draft survey format questionnaire intended to elicit responses about common employer concerns was reviewed and critiqued by outside consultants, and a pilot study to refine the instrument was conducted by three senior-level psychologists. In addition, a grid was prepared on which the employer was asked to show ways in which disabled people both resembled and differed from those without disabilities. The goal was to develop a structured interview with identifiable response categories that also allowed for open-ended responses. We specifically avoided abstract, non-behavioural, adjectival descriptors and placed emphasis on clarifying employer's perceptions about employment roadblocks to full employment.

Responses were organized according to Personal Construct Theory (Kelly, 1955), the thesis of which is that the real entities, situations and events of the world are viewed as a series of

schema created by each individual in terms of aggregate experience. In our study, the purpose was not to determine the specific construct patterns of each employer type, but to assume the existence of such organizational frameworks and to assess their impact on perceptions of individuals with disabilities as actual versus potential employees. The procedure follows the work of several researchers (e.g., Adams-Weber, 1979; Neimeyer and Fukuyama, 1984; Reynolds and Jantzen, 1987). Reynolds and Jantzen (1987), for example, determined that experienced individuals tend to rate people more at the extreme ends of a scale of personality characteristics, while those without experience tend either toward non-commitment, or follow stereotypes in those dimensions where predeterminations are common. Adams-Weber (1979) found that as constructs of the rater are more differentiated it is easier to grasp diverse points of view.

Piloting the Protocol

Twelve pilot interviews were designed to elicit a maximum number of open-ended responses, and as a guide for the purpose of selecting those items to be used in the final version of the questionnaire for 108 further employer interviews. The pilot group comprised employers with three or more years of experience with at least three employees with disabilities (including representatives of each of the following employer groups: Education, light and heavy industry, banking, fast-food, supermarket, amusement park, utility, and small business).

Priority ranking's of constructs dealing with employees with disabilities were identified. From the most potent of these constructs a set of bipolar Likert-type ratings was produced. The final version of the survey instrument was site-tested, and final modifications were incorporated. External consultants assisted in determining the final version used in the data collection stage. The final instrument's format paralleled the pilot version, except that the repertory grid was replaced with a set of 12 bipolar opposite characteristics (e.g., Noticeable through to Not Particularly Noticeable), with instructions that employers be asked to break with a pencil mark a continuous non-scaled line drawn between the extremes. This break-point was later measured to determine the relative closeness to either pole (where the line was divided into 100 equal size units). Thus, a line broken 17/100 units along the 'Noticeable' dimension would be rated 17 per cent, for example. This approach is more sensitive to differences between groups (such as those noted in the previously cited work of Reynolds and Jantzen, 1987, and Adams-Weber, 1979) where subtle differences in perceptions between groups would not be recorded with a procedure such as the Likert approach that allows only five gradations of ranking. Thus, we incorporated a minor modification to the standard Likert procedure. This modification does not constrain the respondent into a discrete number of alternatives; rather, it allows the respondent to make an estimate of relative proximity to one of two bipolar alternatives.

Final Version Administration

We contacted an additional 108 employers in North Eastern Ohio, USA, representing a broad range of occupations including those with experience of hires with disabilities (N=48), and those without such experience (N=60). These businesses comprised an opportunity or convenience sample, in so far as they were selected by the psychologists scheduled to complete the interviews as meeting a proportional quota of business types (from the Ohio Chamber of Commerce Business Directory), and also as having a contact employed at that location known personally to the psychologist. We hypothesized that personal acquaintanceship with a potential interviewer would make for the greatest degree of candour from employers, and also that the existence of a contact would increase opportunities for gaining access to a business owner or manager willing to be questioned about a potentially

sensitive topic. This arrangement appeared to be functional in that no interviews were refused once the personal contact was made with the prospect. No quota was determined for a number of business with and without experience of employees with disabilities. In each case, arrangements were made for an interview with the owner (in small businesses), or the individual with responsibility for hiring (in larger companies). Each interviewer was assigned five to eight employers, provided with instructions, location, contact techniques, and inclusive dates set aside for the interview stage.

Interviewers questioned employers who had experiences with workers with disabilities (a criterion of 'at least three workers within the prior three years'), and those who had no supervisory experience of workers with disabilities. Interviewees made the judgment about whether or not they had experience of workers with disabilities, and as such they provided their own definition of what constituted a disability.

Data analysis and interpretation identified response types, distinguished between issues that were of importance to those without such experience from those with experience of workers with disabilities (to compare myths with realities). Investigation was made of all items that were potentially open to multiple interpretations, with further contacts to determine the actual intent of the interviewee (as determined by interviewer). Categorizations were determined, and unclassifiable responses were eliminated. Perceptions of employers with experience of workers with disabilities were compared to those without such experience using the tenets of Personal Construct Theory. A basic assumption was that the former group would perceive the worker with disabilities as more similar to non-disabled individuals, than would the latter group.

RESULTS

The results of this investigation include several dimensions.

1. Interview responses compare the reactions of employers who had had experience with hiring people with disabilities (HD) with those who had no such experience (NHD) were analysed statistically.

2. Response-content to compare HD and NHD responses was examined. These data, taken together, provide an overview of the nature and extent of problems as well as potential for the employment of individuals with disabilities in the workforce, especially when the positive reactions of the HD are compared with the negative expectations of the NHD.

3. Negative responses of HD were analysed. Such information provided clues to the employers' perceptions of actual problems that the disabled worker brings to the workplace (i.e., realities as opposed to unfounded myths). These data are useful in the vocational preparation for individuals with disabilities.

4. The relative significance of response patterns was examined. Responses were ranked in terms of the intensity with which opinions were held.

5. Significant differences between those with and those without experience of employing workers with disabilities were analysed. A review of response-types revealed a somewhat unexpected outcome. While experienced employers expressed many positive reactions, as expected, those who had never had any experience with disabled workers also offered a surprising number of positive comments. Although the majority of reactions of those without experience were negative, there were sufficient positive statements to draw a number of significant and optimistic conclusions.

Summary of Results

For a significant number of employers without experience in hiring workers with disabilities, their failure to be a hiring agent appears based on their lack of awareness of how to go about securing such individuals as employees. This pattern showed up clearly in their responses to questions dealing with how individuals with disabilities might come to be employed by their company. Of those with experience, one-half (50.7%) indicated that in locating appropriate new hires they would make use of human service agencies, while of those without experience, only 28.4 per cent even seemed aware of that avenue. A similar lack of information also showed up in NHD employers' response to questions about governmental and social service financial incentives and other supports that were available to assist employers in securing new hires. For other NHD employers, it was clear that their positive attitudes were insufficient to overcome their misgivings. Both situations are amenable to effective educational programming through sensitive educational intervention and attitude clarification.

Among those who have had experience with workers with disabilities (HD employers), 81 per cent (69 of 85) of responses were predominantly positive to the question: "Describe some of the effects you think disabled workers (have had/might have) on your company". Among those without experience (NHD employers) 53.0 per cent (35 of 66) of responses were predominantly negative. Typical differentiations between the groups involved the issues: absenteeism, attitude toward work, quality of product, and interaction with other employees. Employers experienced with workers with disabilities showed consistent satisfaction with the impact that such employees had brought to their organizations. Although a few negative comments were made, the majority of respondents praised workers with disabilities for their cooperation and generally good work habits. By contrast, those without experience of workers with disabilities believed that customers and other workers would find individuals with disabilities to be offensive in some undefined way.

Experienced employers made comments such as:

> *All have made significant contributions to their work, unrelated to disability, filling bone-fide openings.*
>
> *Extra work effort on part of disabled employee.*
>
> *The excellent quality of their work affected others.*
>
> *High producer, hard worker.*
>
> *Cooperation, punctuality.*
>
> *Dependable, eager to work, prompt.*
>
> *Has helped owners and management come to a greater understanding and appreciation of the disabled.*
>
> *Set an example that a person could have a disability and still do a good job.*

Inexperienced employers' anticipations of problems included:

> *Possibly taking someone else away from their job to assist the disabled employee.*
>
> *If they weren't capable of doing work, it would interfere with efficiency of work.*
>
> *Additional training time. Inefficient.*
>
> *Possible inability to work alone...lack of (others') patience in accepting their physical appearances or speech differences.*
>
> *Some customers may not want to see a disabled person.*
>
> *Offensive.*
>
> *Some clients might be uncomfortable.*

Customers may be offended by a disabled person as they were when I hired a black employee.

In an effort to determine some of the ways in which an employer may have developed attitudes toward people with disabilities in general, one question asked:

Can you recall any incident that has shaped your attitude toward workers with disabilities, or people with disabilities in general?

As with other questions, a variety of positive and negative experiences were reported both by those who have never employed a person with a disability, and by those who had.

Examples of negative experiences among those who have not hired disabled workers include:

Friend with son who is disabled who had difficulty with employment.

When I was 19 and a waitress, a deaf couple always tried to speak when ordering food. I could not understand them and usually wound up ordering the wrong items and they would get irate.

When I worked with an educable mentally retarded person in a hairdressers' she ruined a customer's hair, had to quit. It was a long time before the reputation of salon was re-established.

Difficulty with how you should behave towards them, it's awkward sometimes.

One example from the group who had hired workers with disabilities included:

One almost got run over because couldn't hear the engine. I'm not willing to work with the disabled again.

All other responses (37 from HD, 22 from NHD) were either positive or neutral. The general consensus was that individuals with disabilities can and do make a consistent effort to act in a positive manner. More importantly, experience with such individuals generally creates an overall positive attitude.

Positive responses, confirming the benefits of hiring disabled individuals, included such comments as:

I've hired the disabled through the Targeted Jobs Tax Credit Program and the employees are still working and doing well.

Hired an individual who coordinates services for the disabled; he brought awareness for their plight, and appreciation of them as individuals.

Coming in contact with disabled in other jobs made me realise disability needn't affect work potential.

Positive attitude after seeing how they performed in the work setting.

I know a man who lost both legs, has never given up, still works hard.

The clear and consistent message of such comments is that the opportunity to become familiar with individuals experiencing disabilities usually results in the acceptance of such persons as competent, ambitious, and anxious to succeed.

Beyond the effect that disabled workers might have on the company, and by way of looking more closely at areas in which problems were anticipated, employers were asked:

Describe some of the effect employees with disabilities (might have or have had) on other employees.

As with the issue of impact on the company, both those with experience and those without saw many positive outcomes from the hiring of workers with disabilities. Both types of

employer anticipated numerous positive aspects to hiring workers with disabilities; there are interesting differences in the pattern of negative comments across groups.

Negative responses from experienced employers:

> *Resentment from employee getting injured all the time.*
>
> *Work wasn't being completed by the disabled worker resulting in more work for others.*
>
> *It was felt that special consideration was being given...Other employees no longer wanted to help them because they needed so much time and took others away from their jobs.*

Negative responses from NHD employers:

> *Favouritism feeling on the part of some employees that the disabled worker is getting special consideration or treatment.*
>
> *Greater workload. Other employees would have to compensate for what disabled could not do.*
>
> *May have to go out of way and take time to help him. Taking more time with them.*
>
> *Greater load of responsibility for employees.*
>
> *Increased cost of health insurance.*
>
> *Dissension in union classification.*

A factor common to both employer groups was that of actual or potential resentment by other employees. Once again, there is a need to address this issue both in vocational preparation, and in providing programs for co-workers designed to assist them in understanding and accepting workers with disabilities. The relative importance of the resentment-factor is illustrated by the fact that it was by far the most common concern expressed by those without experience (41.7% of responses), while among all those interviewed with experience only 8 per cent voiced such concerns.

By contrast, considerable enthusiasm was expressed regarding how workers with disabilities have had, or potentially could have, a morale-raising impact. Such workers are seen as representing positive examples not only through demonstrating their commitment, but also by (subtly and unintentionally) causing others to recognize their own imperfections.

A critical issue involves worker-types that employers find acceptable, as well as those who are especially difficult to place in specific operations. Thus, three related questions were asked:

> *Would you consider hiring employees with disabilities?*
>
> *Are there any disabilities that you feel would be unsuited to your type of business?*
>
> *What are some of the important skills and/or attributes that you would use as criteria for employing an individual with disabilities?*

The order in which disabilities were considered disqualifying was: Severe impaired sensory integrity (40%, 51 responses); severe intellectual limitations (23%, 52 responses); and physical limitations as in being wheelchair bound (22%, 41 responses). The balance of the responses was spread across a wide range of disabling factors.

Responses to the question regarding desired attributes yielded a surprising 32 per cent of responses (93 of 288) stressing skill level capacity to do the job successfully, while factors such as cooperative attitude (3%), honesty (3%), and other personality characteristics were deemed of lesser significance. Midway between extremes were factors such as enthusiasm, dependability, verbal and other communication skills, and appearance. My reaction to these results is one of considerable caution. There is, ostensibly, a contradiction between the expressed concern on other questions about the ability of employees with disabilities to

cooperate with fellow workers, and this pattern which practically ignores the issue. Two interpretations suggest themselves. First, it may be that during an interview, a respondent, having voiced concern on that issue on an earlier question, makes an assumption from that point on a cooperative attitude is a presumed. More reasonable, however, is the probability that for many employers a competent worker is worth the interpersonal problems that may be encountered. This issue deserves pursuit in future research efforts.

One question was designed to take advantage of the fact that the interviewee was in the best position to offer suggestions regarding the many otherwise unaddressed factors that employers may consider. We asked:

> *Are there other things we should know about the factors that make employers more or less likely to offer employment to a worker with disabilities?*

Once again, responses fell into a number of relatively difficult-to-define categories. Prominent among them was the proposal that both employers with, and without, experience of individuals with disabilities in the workforce should be better educated about the process of locating and hiring employees with disabilities. Twelve per cent commented on problems navigating government regulations, accessing incentives, and other perceived interference.

Statistical Analyses

A series of 14 bipolar descriptions of individuals with disabilities as employees was completed by both employer groups. Of these 14 pairs of opposites, six produced highly significant differences (two at $p<0.05$, four at $p<0.01$). In one instance (predictability of behaviour), a significant difference was found for employers from the manufacturing sector but not for other employer groupings. In all cases, those with experience in employing individuals with disabilities provided the more optimistic interpretations.

The four greatest differences (those at $p<0.01$) may be considered as a group. They include issues of *potential hazard, hindrance to others, dependability*, and the general category of *good versus poor job candidate.* A second sort included the four scores that were most extreme. Issues in this category related to *absenteeism, function, appearance*, and *predictability of behaviour*. With the exception of the manufacturing group on the *predictability of behaviour* item, none of these factors showed a significant difference between experienced and inexperienced employers as a complete grouping. However, in all instances, responses were toward the positive pole (i.e., more desirable), providing further evidence that negative views of workers with disabilities as employees (either actual or potential) represent a minority opinion.

The spread of scores for every category was extreme, with standard deviations ranging from the low 20s to the high 30s (across the scale calibrated in 100 equal units) suggesting that attitudes are widely disparate, and that a great deal of information is needed for an accurate view of the potential of individuals with disabilities as workers. This general finding was also borne out of the anticipated fact that across all groups the variance was smaller for the scores of the employers with experience of disabled workers than for those without this experience.

Global Observations

Taken together, the specific information provided by the questionnaire items and the constructs determined by inspection, a number of useful factors were identified from analyses of the respondents' comments.

- Employers, when approached by sensitive interviewers, were willing to share feelings and experiences about working with individuals experiencing disabilities.

- Those responsible for hiring have quite specific notions about what they seek. Where weaknesses have been experienced, or were believed to be the case, employers were firm in their conviction that such characteristics or qualities must be avoided at all costs.

- There was no categorical rejection of persons with disabilities as a class of potential workers. Objections, where they existed, were typically based on prior unfortunate experiences (both 'on' and 'off' the job). Employers' stereotypical beliefs appeared potentially amenable to change. Their attitudes, while robust and fairly well established were largely based on rational interpretations. Thus, they were potentially susceptible to change through additional information, education or experience.

- The private employment sector could, potentially, include very many specific employment opportunities for workers with disabling conditions unavailable elsewhere.

- Private sector employers were alert to their need to be educated about strategies and incentives involved in hiring employees with disabilities. Overall, they appeared, whether or not already experienced in hiring disabled workers, open to receive education and other attitude-altering experiences.

- A substantial proportion of employers who had experience of workers with disabilities would gladly extend this proportion of their workforce if appropriate strategies were made available to them. Employers were, for the most part, anxious to receive additional information about workers with disabilities. They made it clear that under the 'right conditions' they saw no deterrent to adding more such workers to their payroll.

- For greater employment of individuals with disabilities into the workforce, it appeared vital that worker-placement systems be created, incorporating a sensitive match between employee and employer.

- Some barriers to the further incorporation of disabled individuals into the workforce were real (e.g., some safety considerations). However, employers stated that many of these initial disincentives could readily be overcome with creative problem-solving and job-reconstruction.

- Selected barriers to the further incorporation of individuals with disabilities into the workforce were the results of myth*s* (e.g., that the public would show revulsion if assisted by a worker with a disability). It was clear that employers themselves were a prime and potentially persuasive source for disabusing those of their colleagues, largely employers without experience of disabled workers, who held these misconceptions. Experienced employers were able to report that many ostensibly negative factors (e.g., attendance, unreliability, etc.) were not serious long-term problems.

- For workers with disabilities, there were many more problems potentially leading to termination associated with social skill issues, predominantly maladaptive responses, behavioral excesses, or a failure to act in socially appropriate ways, than there were failures due to skill deficits.

- Many successful programs already existed for incorporating workers with disabilities into the workforce. These programs were, for the most part, located in national or regional mega-corporations. The lessons learned by these employers did not need to be reinvented.

DISCUSSION

The implication for these results and impressions for locations other than the setting in which the data were collected needs to be considered. While it is clear that (a) nomenclature describing workforce operations and expectations differ across national settings; and (b) governmental and social service supports vary even within national settings let alone across nations, there is no extant research that supports any contention that differences exist in employers' perceptions about persons with disabilities serving the workforce, based on geography.

In the absence of data to the contrary, it is posited that the trends described here are potentially universals in terms of employer's expectations, the myths they maintain, and the strategies that might be enacted to modify the existing barriers to fuller employment for persons with disabilities.

Several potential approaches exist for meeting the goal of fuller employment for persons with disabilities:

a) awareness-heightening presentations to community and trade association meetings where employers are assembled;

b) consultation with employee unions/associations in order to educate employers about their concerns regarding potential union resistance;

c) consultation with line-supervisors through job-coaching and job-analysis supports;

d) development of multi-media products emphasizing success stories relative to the employment of workers with disabilities;

e) consultation with employers' accounting personnel on financial incentives available to those affording employment to persons with disabilities; and

f) some limited placement and referral to employers wishing a match with potential disabled employees. The intended result is the development of remedial, compensatory or educational and behaviour-change strategies for overcoming the barriers identified by these employers.

There is a clear need for shared responsibilities between the fields of business and educational or vocational rehabilitation. Both arenas have expertise that can contribute to developing enhanced national productivity. Whenever this can be done with concomitant improvement to the lifestyles and prospects for persons with disabilities the benefit is manifold. Without shared enterprise between the worlds of business and education or vocational rehabilitation there will be continued waste and inefficiency. With some of the roadblocks in potential employers' perceptions now identified, matching remedial and compensatory strategies may be developed to ensure maximum placement in employment for individuals with disabilities.

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What characteristics and processes define a school as a learning organisation? Is this a useful concept to apply to schools?

Halia Silins
Flinders University, School of Education *Halia.Silins@flinders.edu.au*

Silja Zarins
Flinders University of South Australia

Bill Mulford
Flinders University of South Australia

The concept of secondary schools as learning organisations was being examined as part of a research project involving South Australian and Tasmanian secondary schools. Learning organisations were defined as schools that: employ processes of environmental scanning; develop shared goals; establish collaborative teaching and learning environments; encourage initiatives and risk taking; regularly review all aspects related to and influencing the work of the school; recognise and reinforce good work; and, provide opportunities for continuing professional development. A survey of 2,000 teachers and principals was conducted using items representing these seven dimensions. The data were analysed and confirmatory factor analysis using LISREL was employed to test the four measurement models generated. The discussion clarifies the characteristics and processes recognised as existing in secondary schools that relate to the reconceptualisation of schools as learning organisations and addresses the usefulness of this approach.

Organisational learning, Secondary Schools as learning organisations,
Confirmatory factor analysis, Teacher and principal survey

INTRODUCTION

> Human learning in the 21st century will be as different from human learning in the 20th century as the micro-chip and neural networks are from the valve." (Lepani, 1994, p. 3). As we approach the new millennium the scope and pace of change seem to be accelerating in all areas of human existence. We have to move with it or ahead of it if we are not to be left behind. Schools are feeling this tidal wave of change in ways that "have left many educators – consciously or otherwise – confused, exhausted and disillusioned. (Deal, 1990, p.131)

Change **can** be seen as evolutionary and dynamic with an emphasis on continuous learning and adaptation (Dixon, 1994; Fullan, 1991; Fullan and Miles, 1992). The challenge for schools is to adopt change strategies that provide internal stability while moving ahead. This challenge may be able to be met in education and elsewhere by focusing on a change strategy where learning comes to be seen as "the single most important resource for organizational renewal in the postmodern age" (Hargreaves, 1995). In this strategy, the school functions as a learning organisation in order to continue to improve performance and build capacity to manage change (Corcoran and Goertz, 1995) in an environment where schools are becoming increasingly borderless.

DEFINING THE LEARNING ORGANISATION

The concept of a learning organisation originated in systems thinking and is typified by Senge's (1990) model of the five disciplines of a learning organisation.

Systems thinking integrates knowledge from across the disciplines, focuses on wholes rather than parts, goes beyond events to their underlying structure and leads to experiencing the interconnectedness and inter-relationship of things.

Personal mastery drives people to expand their ability to achieve their goals. Since "organisations learn only through individuals who learn" (Senge, 1990, p.139), individuals must be able to learn continuously and improve so that the lifelong learning of adults is just as respected as the goal of fostering lifelong learning in students (Isaacson and Bamburg, 1992).

Mental models refer to the subconscious, taken for granted beliefs that limit thinking about how the world works for example, the mental model that students are vessels for teachers to fill constrains our ability to change. Mental models determine not only how use is made of the world but how people act and what they perceive. They are theories-in-use (Argyris, 1982). Bringing mental models to awareness and re-examining them in the light of espoused beliefs brings about change.

Team learning is a critical discipline because "teams, not individuals, are the fundamental learning unit in modern organizations" (Senge, p.10). Senge argues that if teams learn they become a microcosm for learning throughout the organisation. Teams learn through an iterative process of movement between practice and performance. Most important organisational decisions are made in teams. Cooperative learning for students is encouraged but teachers are not provided with the time, structures, cultural norms nor language to promote team learning. Most staff development programs support the learning of individuals.

Shared vision emerges from people who truly care about their work, who possess a strong sense of personal vision and who see the collective vision as one that can encompass the personal visions of all. It aligns what we do with what we say we want. Senge calls this the rudder that can keep the organisation on course during times of stress, and stress is epidemic in most schools today.

Senge (1990) posits that learning organisations are characterised by valuing and developing these five disciplines and that the basic meaning of a learning organisation is one that is "continually expanding its capacity to create its future" (p.14).

There is no single generally accepted definition of a learning organisation. Leithwood and Aitken (1995, p.63) define a learning organisation as,

> a group of people pursuing common purposes (individual purposes as well) with a collective commitment to regularly weighing the value of those purposes, modifying them when that makes sense, and continuously developing more effective and efficient ways of accomplishing those purposes.

The most commonly mentioned elements of a learning organisation can be summarised as: coordinated group effort towards commonly shared goals; active commitment to continuous improvement and to the diffusion of best practices throughout the organisation; horizontal networks of information flow to help bring together expertise as well as links with the external world; and, the ability to understand, analyse, and use the dynamic system within which they are functioning (Keating, 1995).

FOSTERING ORGANISATIONAL LEARNING IN SCHOOLS

Literature recognising the advantages of reconceptualising schools as learning organisations and advocating organisational learning has begun to accumulate (Cousins, 1994; Diggins, 1997; Fullan, 1993; Isaacson and Bamburg, 1992; Louis, 1994; Mulford, 1997; O'Sullivan, 1997; Stoll and Fink, 1996). However, systematic investigations of how schools might bring this about are still scarce.

Johnston (1998), using the Senge (1990) disciplines as a framework of analysis, conducted an investigation of Victorian secondary schools to discover to what extent they were developing as learning organisations. Four key characteristics were identified as being significant in the growth of schools as learning organisations. These were: the existence of inclusive collaborative structures; effective communication channels; integrated professional development programs; and, learning-focused leadership. Johnston recognised that two key areas remained to be addressed: the first is the need to design practical concrete strategies to promote organisational learning; and, the second is to identify suitable outcomes that can be measured in schools purporting to be learning organisations.

Leithwood, Leonard and Sharratt (1998) reported the results of synthesising evidence from three independent studies of conditions that foster organisational learning in elementary and secondary schools. Their findings related to school culture, structure, resources and leadership. They identified collaborative and collegial school cultures that included norms of mutual support, respect for colleagues' ideas, a willingness to take risks in attempting new practices, the exchange of honest and candid feedback, shared celebrations of successes, a strong focus on the needs and achievements of the students, informal sharing of ideas and resources, and continuous professional growth (p.262-263). The school structures that were found to support organisational learning were those that allowed for greater participation in decision making by teachers (p.263). Current and sufficient resources supporting professional development to promote school initiatives were a decided boost to the teachers' learning (p.263). Transformational forms of principal leadership were found to contribute significantly to school conditions fostering organisational learning processes as well as to organisational processes directly (p.267).

From an examination of the literature, seven dimensions that characterise schools as learning organisations were identified and these define what is meant by organisational learning.

Environmental scanning refers to the activities of the school that contribute to broadening the scope of the information, policy, theory and practice that is brought to bear on the school's development and decision making processes.

Vision and goals refer to the recognition of and commitment to a coherent and an agreed upon sense of direction that is forged and re-forged to guide a school's everyday actions and decisions as well as shape long term planning.

Collaboration refers to the extent that there is a climate of openness and trust which promotes collaboration, cooperation, support and involvement in the functioning of the school.

Taking initiatives and risks refer to the extent that school staff are open to change and feel free to experiment and take professional risks toward personal and whole school improvement.

Review refers to the extent that programs and practices are reviewed, evaluated and actioned.

Recognition and reinforcement refer to the extent that there is sincere recognition and valuing of effort, initiative and achievement.

Continuing professional development refers to the extent that encouragement, opportunity and resources are provided to enable all school staff to learn, develop and implement the knowledge, skills and attitudes needed to contribute to improving the school's performance as a whole.

Which dimensions of organisational learning characterise Australian secondary schools? In a recent review of the area where much rhetoric and little empirical work abounds, Cousins (1996) asked whether organisational learning was a unidimensional or multifaceted construct. In the process of identifying the dimensions operating in schools, Cousins' question is addressed by investigating the underlying structure of the organisational learning construct as defined by secondary school teachers and principals.

ORGANISATIONAL LEARNING: AN EMPIRICAL INVESTIGATION

For the study reported here, the data used have been drawn from a survey of secondary schools carried out in South Australia and Tasmania as part of a larger, federally funded, three-year collaborative research project titled Leadership for Organisational Learning and Student Outcomes (LOLSO). The project was supported by the respective state education authorities. The LOLSO Project was developed to investigate systematically the emerging reconceptualisation of schools as learning organisations. For the purposes of this research, organisational learning refers to the way the whole school staff, collaboratively and on a continuous basis, learn and put learnings to use. Is is argued that it is this collective, continuous learning initiative that results in a learning organisation.

The project surveyed teachers and principals from 50 South Australian secondary schools and 46 Tasmanian secondary schools to determine their perceptions of schools as learning organisations, their views on school management and the nature of principals' leadership. The aims, nature and scope of the larger project and the results of some of the preliminary investigations have been reported elsewhere (Silins and Mulford, 1998; Silins et al, 2000; Silins and Mulford, in press).

This study focuses only on the perceptions of schools as learning organisations. The questionnaire for this section was constructed using the seven dimensions defining schools as learning organisations that employed the processes related to environmental scanning, developing shared goals, establishing collaborative teaching and learning environments, encouraging initiatives and risk taking, regularly reviewing aspects related to and influencing the work of the school, recognising and reinforcing good work, and providing opportunities for continuing professional development. Teachers and principals responded to items representing these seven dimensions on a self-report five-point Likert scale ranging from strongly disagree (value 1) to strongly agree (value 5). Nearly 2,000 responses provided the information on staff perceptions of schools as learning organisations for analysis.

Data analysis

Exploratory factor analysis, using principal component analysis of responses on 40 organisational learning items and varimax rotation, indicated the most likely structure of the organisational learning construct. The seven-factor structure used to generate the questionnaire items was not supported by the observed data. A four-factor solution appeared to fit the data better and this measurement model was tested using a confirmatory procedure employing the structural equation modelling software, LISREL 8. LISREL output was

generated using 960 South Australian responses and cross-validated using 1022 Tasmanian responses for the following models:

a) 1 factor model,

b) 4 factor correlated model,

c) 4 factor correlated nested model.

RESULTS

Table 1 reports goodness of fit indices for evaluating the three models derived from LISREL and employed as criteria. The indices are: RMSEA (Root mean square error of approximation); GFI (Goodness of fit); AGFI (Adjusted goodness of fit); PGFI (Parsimony goodness of fit); and, CFI (Comparative fit). The four factor correlated nested model indicated the best fit for both the South Australian and Tasmanian data.

Table 1. Goodness of Fit Indices for 1-Factor, 4-Factor and 4-Factor Nested Models

Criteria	1-Factor Model	4-Factor Model	4-Factor Nested Model
RMSEA	0.088	0.085	.070
GFI	0.92	0.92	0.95
AGFI	0.91	0.91	0.94
PGFI	0.83	0.82	0.80
CFI	0.90	0.91	0.94

RMSEA improvement reflected by a lower value
GFI, AGFI, PGFI, CFI improvement reflected by a higher value

The results showed that there is both an underlying single factor (organisational learning) as well as four separate and correlated component factors. In terms of the question posed by Cousins (1996), the data show organisational learning as a unidimensional concept together with four factors. These four factors are depicted as: Trusting and collaborative climate; Taking initiatives and risks; Shared and monitored mission; and, Professional development.

Hajnel, Walker and Sackney (1998) reported conducting a factor analysis of an organisational learning behaviour scale with 15 items drawn from a larger project identifying school improvement initiatives and indicators of institutionalisation. They identified three underlying dimensions: collaboration, individual learning, and a sense of vision. Although their sample was too small to conduct the necessary confirmatory factor analysis to evaluate their model, the similarities of these dimensions to our four factors lends some strength to their model. Our results also support those that have asserted that collaboration and a sense of purpose characterise schools as learning organisations (Louis, 1994).

Table 2 provides operational definitions of the factors that form the organisational learning construct. The items defining the factors are listed in descending order of strength and significance of loadings associated with each factor. The loadings provided are for the 4-Factor Nested Model (the best model). The four factors that were identified are summarised in the statements that follow.

Trusting and collaborative climate refers to a school where collaboration is the norm. Teachers participate in most significant school-level policy decisions and help to establish the school's vision or goals. Discussions amongst colleagues are open and candid and information is shared with other members of the school community including parents. Staff are valued.

Taking initiatives and risks refers to staff being empowered to make decisions and feeling free to experiment and take risks. The school structures support teacher initiatives, the administrators promote inquiry and dialogue and are open to change.

Shared and monitored mission refers to a school culture that encourages critical examination of current practices and continuous learning for improvement. The school staff keep abreast of external events that may impact on their school. The curriculum is aligned with the school's vision and goals. Information from other schools and from professional associations is used to support learning.

Professional development refers to the engagement of staff in professional development. Professional reading is a source of learning and so are other schools. Developing skills of how to work and learn in teams is seen as important. External advice is sought as appropriate and school leaders provide all the support they can to promote professional development.

DISCUSSION

The results of this study demonstrate that teachers and principals do identify characteristics and processes in secondary schools that have much in common with contemporary notions of learning organisations. Analysis of their responses has provided evidence for the validity of applying the learning organisation construct to schools and has identified four factors that contribute to an understanding of how this construct is defined in secondary schools in South Australia and Tasmania. How useful is it to apply this concept to schools? Our data indicate that the characteristics and processes associated with learning organisations that have been explicated in the four factors can be used to differentiate between secondary schools in terms of their development as learning organisations.

In order to assess the extent to which secondary schools in the two States were operating as learning organisations, we compared our hypothesised seven dimensions (Environmental scanning, Vision and goals, Collaboration, Taking initiatives and risks, Review, Recognition and reinforcement, Continuing professional development) with the four factors that emerged from our empirical investigation (Trusting and collaborative climate, Taking initiatives and risks, Shared and monitored mission, and Professional development).

Elements of Environmental scanning, Vision and goals, and Review were identified by teachers and principals in their schools and contributed to defining Shared and monitored mission. Environmental scanning and Review were related to the monitoring of progress towards the school's goals which were aligned with the curriculum. The immediate concerns of secondary school teachers and principals centred on developing and improving their own programs and practice. There is a need to expand concerns to encompass the school as a whole. The development of systems thinking requires an understanding of the interconnectedness of the parts and their contribution to the direction in which the school is heading.

The dimensions of Collaboration and Continuing professional development were closely represented in secondary schools by the two factors of Trusting and collaborative climate and Professional development. The dimensions of Collaboration and Continuing professional development, within a learning organisation paradigm, permeated the hierarchical as well as the collegial organisational roles. Elements of the dimension, Recognition and reinforcement, were distributed across the two observed factors, Trusting and collaborative climate and Professional development. In practice, teachers (and principals) are, more often than not, left to develop their own sense of worth and gain private satisfaction from achieving personal goals. However, it is argued that staff need to experience satisfaction and rewards for engaging in and contributing to whole school issues.

Table 2. Four Factors Operationally Defined

(Items are listed in order of descending strength and significance of loadings for the 4-Factor Nested Model)

South Australia	Tasmania
Trusting and collaborative climate	**Trusting and collaborative climate**
• Teachers have the opportunity to participate in most significant school-level policy (0.34)	• There is a spirit of openness and trust (0.62)
• Sensitive issues can be raised for discussion (0.33)	• We value diversity of opinion (0.51)
• Discussions among colleagues are honest and candid (0.30)	• We have a coherent and shared sense of direction (0.50)
• The vision/goals were established collaboratively (0.29)	• Staff are valued (0.47)
• We have a coherent and shared sense of direction (0.25)	• Most staff are committed to our vision/goals (0.34)
• We actively share information with parents and community (0.25)	• There is open discussion of any difficulties identified through reviews (0.39)
• School structures encourage collaboration among staff (0.19)	• School structures encourage collaboration among staff (0.38)
• There is mutual support among teachers (0.16)	• Teachers have the opportunity to participate in most significant school-level policy (0.34)
• Staff are valued (0.15)	• The vision/goals were established collaboratively (0.34)
• There is a spirit of openness and trust (0.14)	• Discussions among colleagues are honest and candid (0.33)
• Most staff are committed to our vision/goals (0.12)	• Sensitive issues can be raised for discussion (0.28)
• There is open discussion of any difficulties identified through reviews (0.11)	• There is mutual support among teachers (0.28)
• We value diversity of opinion (0.07)	• There is ongoing professional dialogue among teachers (0.26)
• There is ongoing professional dialogue among teachers (0.01) *ns	• We actively share information with parents and community (0.23)
Taking initiatives and risks	**Taking initiatives and risks**
• Administrators empower staff to make decisions (0.40)	• School structures support teacher initiative and risk taking (0.70)
• People feel free to experiment and take risks (0.32)	• Administrators are open to change (0.59)
• School structures support teacher initiative and risk taking (0.21)	• People feel free to experiment and take risks (0.57)
• School leaders promote inquiry and dialogue (0.09)	• There are rewards for staff who take the initiative (0.46)
• Administrators are open to change (0.05)	• School leaders promote inquiry and dialogue (0.45)
• People openly assess the results of trying something new (0.05)	• Administrators empower staff to make decisions (0.38)
• There are rewards for staff who take the initiative (0.03) *ns	• People openly assess the results of trying something new (0.38)
Shared and monitored mission	**Shared and monitored mission**
• Curriculum is aligned with our vision/goals (0.36)	• We regularly monitor progress toward achievement of our vision/goals (0.62)
• We monitor the environment to find out what is happening that may impact on the school (0.34)	• We monitor the environment to find out what is happening that may impact on the school (0.54)
• We regularly monitor progress toward achievement of our vision/goals (0.25)	• Staff are engaged in continuous learning for improvement (0.48)
• Effectiveness of the teaching program is regularly monitored (0.22)	• We take time to reflect on and discuss our practice (0.40)
• We critically examine current practices (0.17)	• Curriculum is aligned with our vision/goals (0.40)
• Staff are engaged in continuous learning for improvement (0.16)	• We critically examine current practices (0.39)
• Good use is made of membership of teacher professional associations (0.12)	• Good use is made of membership of teacher professional associations (0.35)
• We take time to reflect on and discuss our practice (0.05)	• Effectiveness of the teaching program is regularly monitored (0.31)
• Most of us actively seek information that improves our work (0.01) *ns	• Most of us actively seek information that improves our work (0.25)
Professional development	**Professional development**
• Staff engage in ongoing professional development (0.46)	• I am able to have my professional development needs addressed (0.46)
• We learn from other schools (0.38)	• Professional development is closely tied to real school issues (0.45)
• There is a climate of continuous professional improvement (0.36)	• Groups of staff receive training in how to work and learn in teams (0.44)
• Good use is made of professional readings (0.29)	• Good use is made of professional readings (0.38)
• Groups of staff receive training in how to work and learn in teams (0.26)	• We learn from other schools (0.37)
• We make use of external advisers eg subject associations, project officers, consultants (0.23)	• We make use of external advisers eg subject associations, project officers, consultants (0.33)
• Administrators do all they can to encourage staff to develop professionally (0.20)	• Administrators do all they can to encourage staff to develop professionally (0.33)
• Staff learning is seen as important (0.17)	• Staff learning is seen as important (0.30)
• I am able to have my professional development needs addressed (0.16)	• Staff engage in ongoing professional development (0.29)
• Professional development is closely tied to real school issues (0.09)	• There is a climate of continuous professional improvement (0.21)

*ns indicates loading not significant

Working together with colleagues in teams to achieve group goals while not uncommon in schools is still not commonplace. Finding ways to link staff meaningfully across internal real

and imagined school boundaries is important if schools are to become learning organisations. Collaborative school climates are not easy to establish when teachers still work essentially as isolates interrupted by hurried social exchanges or by routine work-related matters.

Secondary teachers and principals are finding themselves involved in professional learning activities. School and curriculum reforms have necessitated regular review of practices and attitudes. It is difficult to resist the pressures of change and improvement especially with the introduction of performance appraisal and the demands of accountability. The goal of learning organisations, however, is not the spasmodic flurry of professional activity each time new demands are made of the school, curriculum or practices. Schools and their staff need to be ahead of the change game. The philosophy of a learning organisation must be that learning is a way of working just as it is a way of living.

We have applied the dimensions that characterise learning organisations to secondary schools and have found them to provide important insights into what schools need to do and what they need to become to meet the challenges of the future. Stoll and Fink (1996) have suggested that the difficult aspect of change for schools as organisations is "the problem of sustaining momentum" (p.150). To be relevant, schools must become learning organisations where the "rate of learning within the organization must be equal to, or greater than, the rate of change in the external environment" (Garratt, 1987, cited in Stoll and Fink). These are compelling reasons for schools to be organisations that learn: "organizations that have a sense of direction and a firm fix on current reality through scanning their contexts; who plan effectively, efficiently and flexibly; organizations in which continuous development and improvement are integral parts of their culture" (p.150).

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A backup choice or not? Pre-service graduate students' views of choosing teaching as a career in Taiwan

Hsiou-huai Wang
National Taiwan University *wanghs@ccms.ntu.edu.tw*

Bih-jen Fwu
National Taiwan University *janefu@ccms.ntu.edu.tw*

Recent teacher education reform in Taiwan allows regular universities to set up programs to recruit graduate students for teacher preparation. There have been assumptions that these students may take teaching as a backup career choice since they may have multiple career choices for their future. This study attempts examines the degree of decisiveness and enthusiasm for choosing teaching as a career by a group of 44 pre-service graduate students from a prestigious university in Taiwan. Based on data collected from in-depth interviews with these students, five sub-groups emerge: Devoted Educators, Responsible Teachers, Career Explorers, Pragmatists and The Uncommitted. As the majority of these students have decided to choose teaching as their primary future career, the backup choice assumption is challenged. Socio-cultural roots to this positive view of teaching are further discussed.

pre-service students, graduate students, career choice, teacher education, Taiwan

INTRODUCTION

Change in Teacher Education in Taiwan

Teacher education in Taiwan has undergone a major reform since the enactment of the Teacher Education Act in 1994. Prior to the reform, secondary school teachers were trained exclusively by single-purpose normal universities which recruited high school graduates to receive a 4-year training leading toward a bachelor's degree. Graduates from these institutions were guaranteed job placements by the government (Fwu, 1995; Lin, 1996). The new Act freed regular universities to establish teacher education (TE) programs also to train teachers. These TE programs recruited both undergraduate and graduate students, studying in various disciplines, to receive at least a 2-year teacher training course concurrently with their period of academic study. Upon graduation, students are conferred with both an academic degree and a teacher certificate. In a different position from their predecessors in the old system, these students have to compete for teaching jobs with other qualified candidates in an open market (Fwu and Wang, 2002a). Also unlike their predecessors, who tended to take teaching as their only career choice after they graduated from the single-purpose teacher training institutions, graduates from the new TE programs at regular universities appear to have multiple career choices than teaching since they obtain both an academic degree and a teacher certificate.

The TE Program at National Taiwan University

Following the *Teacher Education Act*, National Taiwan University (NTU), a top prestigious university in Taiwan, set up its Teacher Education Program (NTU-TE) in 1995 with a vision to produce a new generation of high quality teachers committed to their work (National Taiwan University, 1995; National Taiwan University, 2000). Each year, through an extensive screening process, the NTU-TE Program admits only 150 students from a large pool of academically able applicants from various undergraduate and graduate departments throughout the university. On average, a quarter of the intake are graduate students who, as noted, will receive at least a 2-year teacher education concurrently with their pursuit of master's or doctoral degrees (M.A., M.S. or Ph.D.) in their own academic fields. With their master's or doctoral degrees from a prestigious university, these so called top-of-the-cream students are likely to have a wider range of career choices, for example, in professional occupations in the science, engineering, legal or management fields, than, for example, average college graduates from other less prestigious universities. Following this argument, there have been assumptions that these students may take teaching as an alternative career choice rather than the only choice as was the case of traditional normal university students.

Teaching as a Backup Choice

In the field of teacher education, the issue of teaching as a backup choice for pre-service teachers has not been closely examined. Our review of previous literature found that most of the studies on teacher commitment have focused on in-service teachers, with work on their commitment to schools as a working place (Anderman, 1991; Leithwood, 1993; Reames and Spencer, 1998; Reyes, 1990; Riehl and Sipple, 1996; Tsui and Cheng, 1999) and teaching as a career (Byers, 1984; Duval and Carlson, 1993; Fresko, 1997; Ingersoll, 1997; Martinez-Pons, 1990; Reyes and Shin, 1995; Scott et al., 1998; Tyree, 1996). For pre-service teachers, research tends to focus on their motivations for entering TE programs rather than their commitment to teaching as a future career (Bennett, 1984; Bergsma and Chu, 1981; Hayes, 1990; Marso and Pigge 1986; Phillips and Hatch, 1999; Snyder et al., 1995). Moreover, studies on pre-service students tend to focus on undergraduate instead of graduate students (Rikard, 1999; Papanastasiou and Papanastasiou, 1998; Yeung and Watkins, 1998a, 1998b; Serow, 1994; Stiegelbauer, 1992; Young, 1995).

The paucity of research on how pre-service graduate students view teaching as a career seems to indicate that the issue of a backup choice might be a problem specific to the Taiwanese context under the new reform. For teacher educators in Taiwan, it is important to investigate how their students view teaching as a career of top priority or as a backup choice? This issue might be especially relevant to those who educate graduate-level students at prestigious universities. This study may also contribute to the general field of teacher education by further advancing understanding on a much-neglected issue.

RESEARCH METHODS

Selection of the Participants

All of the graduate students who finished the NTU-TE program in June, 2000 were included in the study. A total of 44 graduates were selected, with 15 male and 29 female students altogether. Three of the students were pursuing their doctoral degrees, while the other 41 had obtained their master's degrees. The students specialized in various fields of study, in the Schools of Sciences, Arts, Social Sciences, Agriculture, Engineering, and Public Health. Four of the students were married, the rest were single. They were aged from 25 to 34. Table 1 summarises the background characteristics of the participants.

Table 1. Background characteristics of participants

Gender	Male	15
	Female	29
Level of Study	Doctoral	3
	Master	41
School	Liberal Arts	9
	Social Sciences	8
	Science	9
	Engineering	4
	Medicine	2
	Public Health	2
	Agriculture	10
Marital Status	Married	4
	Unmarried	40

Interviewing Process

The two researchers are instructors on the NTU-TE Program. As most of the respondents took courses with the researchers during their period of study in the program, this acquaintance paved the way for a smooth initial contact. When invited for interview, all of the respondents agreed to participate in the research.

Based on our research questions, an interview guide was designed to include the following dimensions:

a) family background and schooling process;

b) motivation for graduate study;

c) motivation for entry into the TE Program; and

d) future career plan.

In-depth open-ended interviews, each lasting for 2 to3 hours, were conducted with each participant (Strauss and Corbin, 1990). In order to achieve consistency in asking questions and in interpreting the responses, the two researchers conducted the first eight interviews together. After a consensus on interviewing procedures and focuses had been reached, each researcher conducted interviews separately with half (18 for each) of the remaining 36 students. The 44 interviews were completed within a period of one month during the summer after the students' graduation from the TE Program. All the interviews were audio-taped with the participants' permission.

In this study, based mainly on the narratives of the participants as the major data source, two issues need to be considered in order to established the authenticity of the data. First, the nature of the relationship between the researchers and participants is the key to the conversational dynamic. Potential threats to the respondents may induce conscious distortions of intentions and render the data invalid. This kind of potential threat, possibly from the teacher-student relationship which the researchers originally had had with the respondents, however, did not exist at this point in the researchers' relationship with these students. At the time of the interviews, all of the respondents had finished their courses in the TE Program and the two researchers were not their instructors who "hold the power of giving them an A or B" in asking of them, "How much do you want to be a teacher?" Therefore, there was little need for the respondents to say something "pleasing to our ears."

Second, the researchers conducted interviews based on the life history approach, which stresses the holistic nature of one's life and in which each part is naturally interwoven (Josselson, and Lieblich, 1993; Sikes and Aspinwall, 1992). Researchers asked the respondents to retrospect and narrate their entire educational and career construction processes, from childhood up to graduate study in chronological order. In these narratives, their decisions to become a teacher and their enthusiasm with teaching were naturally interwoven into descriptions of other parts of their lives. In this way, researchers were able to collect information on relevant life events surrounding their exploration, motivations and their views of choosing teaching as a career, and we were relatively confident that they did express a full range of their thinking and reasons for becoming a teacher.

Data Analysis

All the interviews were taped and fully transcribed as the major source for data analysis. The analysis of this data focused on identifying important themes common to the respondents' views of choosing teaching as a career. To enhance the trustworthiness of this qualitative study, the researchers developed a process of data analysis using content coding (Miles and Huberman, 1994) to create and compare categories across individual cases (Strauss, 1987). In reading the transcriptions of each individual's narrative, the researchers grounded the codes in the respondents' actual languages by tracking all the terms and phrases they used to describe their motivations for and views of choosing the teaching career. Through debate and deliberation over the meaning of their narratives, the researchers were able to identify two key axes, decisiveness and enthusiasm, that differentiated the different aspects of the students' views of choosing teaching as a career, and the researchers classified this group of graduate students into five categories accordingly.

RESEARCH OUTCOMES

Based on the two axes of decisiveness and enthusiasm, this group of 44 students in the TE Program could be classified into five categories: Devoted Educator, Responsible Teachers, Career Explorers, Pragmatists and The Uncommitted.

Devoted Educators: Decisive and Highly Enthusiastic

Eleven students in the sample were determined to devote themselves to the teaching profession and were passionate about making a difference through educating the younger generation. Some of this group was motivated by a far-reaching vision for improving school effectiveness or the functioning of the system, others were mainly concerned with providing quality education for their own students as schoolteachers. The first group could be described as devoted visionaries, with the remaining eight as devoted teachers. Table 2 summarises the characteristics of these two groups of devoted educators.

The three devoted visionaries, Zong, Jian and Chang, expressed a high level of commitment to teaching motivated by high visions. Zong, a doctoral student in Atmospheric Sciences, aspired to become a teacher leader, or even a principal, who would motivate his future colleagues to improve teaching and change the school:

> *I love teaching Earth Sciences, but if you only focus on teaching your own students, you can only influence so many, but if you try to influence teachers, then, a far greater number of students will benefit—that's why I want to organize teachers to develop new instructional materials for students—I may someday become a principal who really leads teachers to grow.*

Jian, a Psychology doctoral student, had similar ideals for providing teachers professional training in guidance and counselling. Chang, a doctoral candidate in Mechanical Engineering,

bore a similar sense of mission, which sprang out from his own schooling experiences in moving up from the vocational track to the academic track:

> *I really want to help those underprivileged students in the vocational schooling track, because I myself was one of them. I want to see how we can improve the entire vocational education system in order to better serve these students' needs.*

It seemed that Zong and Jian focused more on improving of a school, and Chang targeted his mission on systemic reform.

Table 2. Characteristics of devoted educators

Name*	School	Field of Study	Level of Study	Gender	Marital Status
		Devoted Visionaries			
Chang	Engineering	Mechanical engineering	Doctoral	Male	Unmarried
Jian	Science	Psychology	Doctoral	Male	Unmarried
Zong	Science	Atmospheric Sciences	Doctoral	Male	Unmarried
		Devoted Teachers			
Jun	Science	Geology	Master	Male	Unmarried
Yaling	Liberal Arts	English Literature	Master	Female	Unmarried
Zhi	Science	Geography	Master	Female	Unmarried
Jing	Science	Fishery Sciences		Female	Married
Liang	Social Science	Dr. Sun Yat-sen's Thought	Master	Female	Unmarried
Cili	Agriculture	Forestry	Master	Female	Unmarried
Qiu	Social Science	Sociology	Master	Female	Unmarried
Yuling	Agriculture	Agricultural Chemistry	Master	Female	Unmarried

*To protect the anonymity of participants, pseudonyms are used.

The other eight students in this group, the devoted teachers, including Jun, Yaling, Zhi, Jing, Liang, Cili, Qiu, Yuling, have also decided to become teachers and have developed a great caring for students and a vivid enthusiasm for teaching. As Qiu said,

> *I love being with adolescents. In my mind, I see every student as a very different individual being…I will try my best to lift them up to a greater horizon to see the greatness and beauty of the world. I want to make a difference in their lives.*

Zhi, a Geography major, expressed her vivid passion for teaching:

> *I love teaching. It's like a performing art for me. I always feel energetic and fulfilled after I see students are motivated to learn. I try every way to make the lesson interesting, like, asking them to touch the earth, feeling the vibration of the earth and smell the scent of flowers…let them feel really close to Nature and cherish the wonder of creation.*

Most devoted visionaries and devoted teachers have developed a great interest in their own field of study. The three visionaries were so interested in their field of study as to pursue a doctoral degree in their own field. For many devoted teachers, transforming contents of their specialized field of study into quality teaching materials was an important incentive for them to enter teaching. Therefore, most of them emphasized the creative aspect of teaching by developing innovative instructional strategies different from the traditional mode of teaching. For example, Chang has been working for his doctoral dissertation on integrating mechanical engineering with creative instruction. Yaling has developed many activities to motivate students to speak in English in a highly interactive classroom environment, and Liang aspired to teach the boring and useless Civic Education in a creative way so that students are motivated to think critically about important social issues.

However, a difference lies between devoted visionaries and devoted teachers in their levels of applying professional knowledge to the educational context. While visionaries aspired to provide professional training for their future colleagues and even participate in the educational reform at a higher level, teachers focused on the application of knowledge mainly to teaching their own students. Another difference between these two groups lies in their demographic

background. While all of the visionaries were male students, most devoted teachers were female. It seems that gender difference might be an important factor in these students' construction of future career visions. Furthermore, the three male visionaries were all doctoral students, while all of the devoted teachers held only a master's degree. This difference in educational level might also contribute to the difference in the scope of concern these two groups had. In the Chinese tradition, a person with a higher level of education has generally been held in high regard and expected to exert considerable influence on public affairs, as expressed in the old saying, "*xue er you zhe shi*", "a learned person, or a person with a higher level of education, is expected to take a high position in the government". With a doctoral degree, these three students, Zong, Jian and Chang, might expect themselves to play a more important role in educational circles rather than just being school teachers.

In addition, two of the doctoral students, Zong and Chang, majored in science and technology. With their doctoral degrees, they could have gone into a much more lucrative career in the high-tech area than in teaching. It is their enthusiasm for education that has surpassed other external incentives and led them to develop an extremely strong commitment to education. This enthusiasm was in fact the result of a long process of career exploration with much deliberation and reflection on what they really want for their lives.

Responsible Teachers: Decisive and Fairly Enthusiastic

Sixteen graduate students in the study can be classified as responsible teachers, who, although having decided to become teachers, were apparently less enthusiastic than their more devoted counterparts in the previous group. For them, teaching appears more as a responsibility than as a calling. As Yintian expressed it,

> *I want to be a teacher because it will give me a stable living, however, I will not just hold the bowl and do nothing. I will be a responsible teacher, I will teach my students what I have learned and fulfil my duty as a teacher.*

Some students in this group were more inclined to stress the intrinsic attraction of teaching while others were more attracted by extrinsic motives as summarised in Table 3. Ru, Xin, Yixian, Yuling, Shu, Yao, and Ruifang indicated that they wanted to be teachers mainly because they loved children and hoped to gain a sense of self-fulfilment through teaching. As Ru said,

> *I agree with my parents that teaching is a proper job for a girl, because it offers stable living and the time flexibility to take care of the family. But I want to teach because it gives me a chance to express my creativity. In my practicum trial teaching, I tried to adapt the materials creatively to meet students' needs, and I found it interesting.*

On the other hand, Yintian, Geng, Yiying, Weiting, Jia, Xiao, Yuru, Shang, Guo, were more attracted to teaching by external incentives such as job security, benefits and time flexibility. As Xiao expressed it,

> *The major reason for me to become a teacher is that teaching is a much better job than all the other career choices I could have for the future. It is better paid, with long vacations, and once you get the job, you are in, no one can fire you…All these are things that attracted me, but…I know very well, besides these external things, I need some intrinsic rewards like, whether students like you, whether you can do something meaningful, to keep me going.*

It is interesting to note that most students in this group majored in hard-to-market fields such as Chinese, Sociology, Agriculture and Dr. Sun Yat-Sen's Thought. Perhaps due to the stringent job market, they expressed a keen sense of insecurity when they looked forward to their future. As Xiao expressed this feeling,

> *A lot of my friends regretted that they did not choose to enter the TE Program. After they graduated from college and worked for some time, they realised that teaching is the best choice.*

You know, a lot of graduate students in our dorm have been trying very hard to get into the TE Program but have not made it. Compared with them, I am the lucky one.

Table 3. Characteristics of Responsible Teachers

Name*	School	Field of Study	Level of Study	Gender	Marital Status
		Intrinsically Motivated			
Ru	Social Science	Dr. Sun Yat-sen's Thoughts	Master	Female	Unmarried
Xin	Liberal Arts	Chinese Literature	Master	Female	Unmarried
Yixian	Agriculture	Veterinary Medicine	Master	Female	Unmarried
Yuling	Engineering	Environmental Engineering	Master	Female	Unmarried
Shu	Agriculture	Plant Pathology	Master	Female	Unmarried
Yao	Medicine	Oral Biology	Master	Male	Unmarried
Ruifang	Social Science	Sociology	Master	Female	Unmarried
		Extrinsically Motivated			
Yintian	Science	Geology	Master	Male	Unmarried
Geng	Medicine	Physiology	Master	Male	Unmarried
Yiying	Science	Botany	Master	Female	Unmarried
Weiting	Social Science	Sociology	Master	Female	Unmarried
Jia	Liberal Arts	Chinese Literature	Master	Female	Unmarried
Xiao	Social Science	Dr. Sun Yat-sen's Thoughts	Master	Female	Unmarried
Yuru	Agriculture	Plant Pathology	Master	Female	Unmarried
Shang	Agriculture	Agricultural Extension	Master	Male	Unmarried
Guo	Agriculture	Agricultural Chemistry	Master	Male	Unmarried

*To protect the anonymity of participants, pseudonyms are used.

Perhaps because of this keen sense of the external competition and realistic considerations, this group did not develop such idealistic aspirations and strong devotion to teaching as did the devoted educators. For this group, teaching means the provision of a stable living and a proper social status. From this perspective, to obtain and maintain a teaching position is of paramount importance.

However, at the same time, most of them have developed a sense of satisfaction and fulfilment through their interaction with children in their past formal or informal teaching experiences. Some, such as Geng, found it delightful to get along with students through private tutoring, others, like Ru, thought it fulfilling to be creative in classroom teaching in their short-term practicum trial teaching periods. These experiences motivated them to look for intrinsic rewards. With these dual considerations, therefore, this group of students was attracted by both intrinsic and extrinsic motives in their decision to become a teacher. However, compared with the group of devoted teachers, they would not go beyond the normal range of duty expected for a teacher. They would not, as Weiting said, "Sacrifice my own leisure time or personal life to fulfil an idealistic goal". They would become a good teacher who fulfils a teacher's responsibilities.

Career Explorers: Indecisive and somewhat Enthusiastic

Unlike the previous two groups who have decided to pursue a teaching career for the future, this group of five students has not yet decided if teaching is what they really want. They are still in a state of exploration to see if they are fit for teaching or if they could make a difference through education. Table 4 summarises the characteristics of career explorers in two sub-groups described as idealistic and realistic.

Among this group of students, Meng and Yujing could be called idealistic explorers because both expressed enthusiasm for improving education while exploring ways in which to engage themselves in the educational enterprise, in which teaching was just one of the possibilities. As Meng said,

I really like thinking about educational issues and I want to take some action in the future. I am also convinced that if I want to make a difference to society, I should make it through education. It is the most fundamental way! But, what I would do after I graduate? I haven't decided yet. I may go on studying education, or teach in elementary school, or I may take jobs in other fields to make myself mature enough and ready for facing challenges in the education field.

Table 4. Characteristics of career explorers

Name*	School	Field of Study	Level of Study	Gender	Marital Status
		Idealistic Explorers			
Meng	Public Health	Public Health	Master	Female	Unmarried
Yujing	Science	Botany	Master	Female	Unmarried
		Realistic Explorers			
Yaru	Liberal Arts	History	Master	Female	Unmarried
Yingyin	Liberal Arts	English Literature	Master	Female	Unmarried
Yurui	Social Science	Sociology	Master	Female	Unmarried

*To protect the anonymity of participants, pseudonyms are used.

What made Meng and Yujing develop an idealistic vision of education is the opportunity to reflect on their own schooling experiences through taking courses in the TE program. These courses opened a window to a new horizon where they could begin to reflect upon their unhappy schooling processes caused by the negative practices of their former teachers, and so to further think about possible solutions for educational problems in the system. This burgeoning interest and enthusiasm in education triggered in them a desire to develop ideals for reform. Yujing planned to explore ways of contributing to education by joining a grass-roots educational reform group after she graduated, to see if it is an effective way to make a difference outside of the formal education system. To be a high school biology teacher and to continue in her research in botany is also a possible choice. Meng, a Health Policy and Management major, expressed her ambition for engaging in educational reform in which she may become a hope for others.

Compared with their idealistic counterparts, Yaru, Yingyin and Yurui demonstrated a less enthusiastic attitude toward education and took a more realistic approach to explore the possibility of being a teacher. All three of them would work as a teacher's assistant in school for the coming year to see if they are fit for teaching. As Yurui, a major in Social Work, said,

I am not sure if I am fit for teaching. I will try to see if I can find the answer during the coming year in school as a teacher assistant. If I found that teaching is not what I want, I will go back to the field of social work.

All three of them have developed great interest in their fields of study, History, English Literature, and Social Work. In the meantime, they were attracted to teaching to some extent through taking courses in the TE program. That is why they were swinging between further pursuit of their own field of specialty and a career as a secondary school teacher. Yaru and Yingyin had two career options in mind, teaching at the secondary school or pursuit of a doctoral degree in History or English Literature for teaching at college level as professors. During the coming year, they would try teaching out in the real school context and make their decisions.

Pragmatists: Decisive But Not Very Enthusiastic

This group of seven students decided to become teachers, but they were hardly as enthusiastic as the students in the previous three groups. They took teaching as a mere job in which they would only meet the minimum requirement as a teacher, without much caring for students, enthusiasm for teaching or ideals for educational reform. Teaching was meant to provide a stable living so that they might attend to other more important aspects of their lives such as

pursuit of a personal hobby or taking care of the family. External factors such as job security, time compatibility and benefits were their major concerns as presented in Table 5.

Table 5. Characteristics of pragmatists

Name*	School	Field of Study	Level of Study	Gender	Marital Status
		Self Concern			
Mao	Liberal Arts	History	Master	Male	Unmarried
Xuan	Liberal Arts	History	Master	Female	Unmarried
Yisen	Liberal Arts	Philosophy	Master	Male	Unmarried
Jinyang	Social Science	Dr. Sun Yat-sen's Thoughts	Master	Male	Unmarried
		Family Concern			
Zheng	Agriculture	Agricultural Chemistry	Master	Male	Married
Sheng	Science	Atmospheric Sciences	Master	Male	Married
Yoling	Public Health	Public Policy and Management	Master	Female	Married

*To protect the anonymity of participants, pseudonyms are used

For Mao, Xuan, Yisen and Jingyang, teaching was the best choice because their majors in History, Philosophy and Dr. Sun Dr. Sun Yat-Sen's Thought were hard-to-market subjects outside of school. As Jinyang said, "I am not especially fond of teaching; I don't think I will be an excellent teacher, but what other options do I have except teaching in school?" Moreover, all of them, majoring in Liberal Arts and Social Sciences, have cultivated an appetite for reading in their own fields of study, therefore, teaching, with its flexible time schedule and long vacation, was ideal for them to continue their interest. As Mao said,

> *I like reading very much, but I know that I am not made for the highly stressful academic life. I just want to have time to read whatever interests me. As a teacher, you have ample time to read in relaxation.*

Thus, students in this group seem to intend to make little effort in preparation or improvement of their teaching. As Yisen said, "Teaching is an easy job, you only have to read books to those kids, little preparation is needed and nobody will watch over you".

Similar to the above four students, Zheng, Sheng and Yoling regarded teaching as the best career option. However, unlike four others who are in their early twenties and just graduating from the graduate school, this group of older students have already spent many years on other jobs as technician, soldier and nurse, respectively, prior to their entry into the TE program. These experiences had convinced them that teaching appeared to be the best occupation compared with all the other options they might have. As Sheng said,

> *After many years struggling in the rigid and closed system in the military services, I strove my way up to studying in the graduate school and got entry into the TE Program. I am very happy that I have the opportunity to become a teacher. I can live a better life with a regular schedule and enjoy higher social status, because, you know, teachers receive more respect from people than military personnel do.*

For these three older students undergoing a mid-career change, compatibility of teaching with their family responsibilities was an important factor in their decision. Compared with their previous jobs, teaching also provides a better remuneration package to support the needs of their family. As Sheng, a father of two, put it,

> *As a teacher, I will have a much more regular schedule than a soldier, so I can spend more time with my wife and kids in the evening and on the weekend. Also, my daughter will be in the affiliated kindergarten of the school where I will work. This way, I can really take good care of her.*

Although this group of pragmatists had decided to become teachers, they seldom think about such issues as the nature of teaching, the role of a teacher, or the needs of the students. All these dimensions of teaching which were strongly emphasised by those much more

enthusiastic devoted educators and responsible teachers were absent in the narratives of this pragmatically-oriented group. Holding the job without much ideal or vision for teaching was their conspicuous characteristics.

The Uncommitted: Decisive and No Enthusiasm

This group of five students, presented in Table 6, ranked the lowest at the level of decisiveness and enthusiasm for teaching. They have decided not to take teaching as a job immediately after they graduate. They will either take teaching as a backup career choice or regard teaching as irrelevant to their future goals.

Table 6. Characteristics of the Uncommitted

Name*	School	Field of Study	Level of Study	Gender	Marital Status
		Backup			
Hua	Agriculture	Agricultural Extension	Master	Female	Unmarried
Weiru	Liberal Arts	Chinese Literaure	Doctoral	Female	Unmarried
Qiong	Engineering	Civil Engineering	Master	Female	Unmarried
		Irrelevant to Teaching			
Feng	Engineering	Mechanical Engineering	Master	Male	Unmarried
Zhao	Agriculture	Food Science and Tecnology	Master	Female	Unmarried

*To protect the anonymity of participants, pseudonyms are used.

For Hua, Weiru, and Qiong, teaching was regarded a low priority among their career choices, because they aspired for other more challenging jobs in business and engineering rather than the boring job of teaching. For Hua, a talented and versatile young woman, teaching appeared to be lacking the challenge she aspired for.

> *I am really afraid I may be suffocated in school. It sounds so boring, and schools seem to be a very closed environment. I think I am fit for something more challenging like a marketing salesperson or something like that. When I am getting old, or after I have a family, I may consider being a teacher.*

Qiong, an environmental engineering major, wishes for a job with an engineering consulting company to enhance her professional knowledge while she is fresh out from the graduate school. For this group of students, the boring job of teaching was something they might turn to after they had accomplished a glamorous career in their youthful years. Teaching was a backup choice for them in the future.

Unlike the above-mentioned three female students who looked upon teaching as a possible backup career, Feng and Zhao did not take teaching into consideration for their future careers. Both of them came to the TE Program with their own unusual motives. For Zhao, a Food Technology major, to be a gourmet specialist appeared more attractive to her than being a teacher. Being disaffected with her parents' child rearing, her reason for entering the TE Program was mainly to learn how to be a good parent so that she might not make the same mistakes as her parents did. For Feng, who found himself lacking interest in his major in mechanical engineering and felt attracted by the studies of humanities and social sciences, the main purpose to enter the TE Program was to discover what he might be interested in for further study. As the TE program provides various courses covering philosophy, sociology and psychology in education, it appeared to be a good starting place for exploring the general field of humanities and social sciences.

> *When I chose the science track in high school, I had no idea what I really wanted. I just followed the majority. As a male, you should study science and technology. But after four years of studying mechanical engineering, I found I had little interest in it and gradually I found I was more interested in studying history and sociology, so I applied for the TE Program to get a general sense of what humanities and social sciences are about.*

Through this exploration, he was finally able to develop a vague career direction by the time of graduation to be a scholar specializing in humanistic perspectives in science and technology. School teaching was not his choice at all.

CONCLUSIONS

Teaching is not a Backup Career

The recent teacher education reform in Taiwan has raised the issue that students from the newly-established TE Programs might take teaching as a backup choice. This concern may be especially relevant to graduate students from prestigious universities. This study investigates a group of graduate students from a prestigious university on their views of taking teaching as a career. The results show that most of the students do not take teaching as a backup choice. Out of a total of 44 graduate students, we found that 34 students (77%) (devoted educators, responsible teachers and pragmatists) have decided to pursue a teaching career. Teaching was not considered a second alternative for them. Among them, 27 students (devoted educators and responsible teachers) demonstrated considerable enthusiasm for teaching. It appears that this group of graduate students demonstrated a relatively high degree of decisiveness and enthusiasm with teaching at the point of graduation. Therefore, the backup choice assumption is not supported by our study.

It may seem that most participants in our study have expressed an overall positive voice about choosing teaching as their future careers. It is worth noticing that this positive and optimistic tendency is only voiced at a time when they are fresh out of graduate school and before they enter the real world of classroom teaching as a full-time teacher. It will be interesting to see if this positive inclination still prevails after they have taught for a few years. A follow-up study on this group of students is suggested.

Social and Cultural Roots to This Positive View

It is important to delve further into the social and cultural roots to this overall positive view of teaching held by this group of academically able graduate students. With their master's and doctoral degree from a prestigious university, most students in this study could have other career options besides teaching. Some may pursue a more lucrative profession such as high-tech engineers or researchers in some pioneering projects. Then it is important to know why teaching has a stronger appeal to them than other possible career options. In order to answer this question, it is necessary to delve into the broader social and cultural context that is specific to Taiwan. In Taiwan, teaching as a profession has enjoyed a relatively higher social status than that in many other countries (Fwu and Wang, 2002b). This favourable condition has resulted from a combination of the Chinese cultural traditions and beneficial government policies for teacher education.

Chinese traditions

In the Chinese traditions, teachers have been highly regarded. In the past, the teacher was not only regarded as a learned scholar (*jingshi*) who transmitted knowledge and skills essential for living, but also as a moral figure (*renshi*) who set an example for students to follow (Gao, 1999). These traditional values are still alive in Taiwanese people's minds today. Unlike the intellectually inferior image conveyed through the wide-spread saying in the West, "people who cannot do, teach", in Taiwan, teachers' intellectual capacity is valued. Several major studies found that 85 per cent of those surveyed think most teachers are well-rounded in subject matter knowledge and their role of disseminating knowledge is still highly regarded (Lin, 1980; Lin, 1992). In fact, there is a wide-spread belief that "those who are able, teach".

In addition, teachers are in general regarded as role models for the younger generation. Major surveys conducted in recent years found that, instead of being a babysitter for children as dubbed in many Western countries, teachers in Taiwan are still regarded as role models for students, expected to lead a proper life with good conduct (Lin, 1971, 1980, 1992). These positive role perceptions of teachers may contribute to the relatively high social status enjoyed by the Taiwanese teachers.

Favourable government policies

The high social status of teachers may also be attributed to favourable government policies that have attracted academically talented individuals into the teaching profession and retained them in the profession. Compared with other similar occupations, teachers have enjoyed a more generous remuneration and a package of benefits. Generally speaking, teachers' salaries are 25 per cent higher than those of regular college graduates who have similar qualifications (Ministry of Education, 1999; Yang, 1999). Teachers also enjoy a number of benefits, such as loans for housing, free health insurance and subsidies for children's education. They are paid a full-year (12 months) salary even though they do not work during the summer and winter vacations, on top of which they receive one and half months bonus at the end of the year. Teachers also enjoy a generous government-funded pension program. Furthermore, teachers' job security is well protected. Dismissal from the job rarely occurs except for occasions of severe misconduct (Fwu, 1995; Wu, 1997). It is generally accepted that these policies are the result of the respect for teachers that is deeply rooted in the cultural traditions of the Taiwanese society. All these role perceptions and educational policies may explain in part why many academically able graduate students in our study have chosen teaching as the primary career for their future.

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Two-level model of information technology adoption in local government of Bali

I Gusti Ngurah Darmawan
Flinders University, School of Education

John P. Keeves
Flinders University, School of Education *john.keeves@flinders.edu.au*

Recent advance in information technology has aroused much interest among policy-makers, the business sector, the media and the academic world in developed countries. However, very little is known about the obstacles to adopting information technology in developing countries, particularly the low-income economies. This research stems from the issues described above. A variety of factors may influence the adoption of IT in local governments. Those factors range from technological and institutional to personal, social and economic factors. These factors included not only the information on variables gathered at the employee level but also on questions regarding the characteristics of each organization involved in the study. Hence the data files contain information obtained at two different levels, namely individual level and organizational level. Therefore a two-level hierarchical linear model is used to examine the relationships among variables.

information technology, adoption, local government, two-level model, Bali

INTRODUCTION

The rapid changes in IT in the developed countries have serious managerial, financial, human resource implications for information management in developing countries (Bowonder, Miyake, & Singh, 1993). The shrinking of the world into a 'global village' (Gore, 1991) makes it difficult for the developing countries to insulate themselves from the changes occurring due to developments in IT. It is thus evident that developing countries need to understand the pervasive nature of changes initiated by new IT and the consequences of not keeping pace with the changes occurring in the developed world. Therefore, the formulation and implementation of comprehensive information technology strategies have become critical for the developing countries. This is accentuated by the fact that the resources to support the operation of IT are usually scarce (Lu & Farell, 1990; Shahabudin, 1990; Kahen, 1995).

A variety of factors may influence the outcome of implementing IT in local governments. Those factors range from personal to technological, institutional, social, and economic factors. Past research in innovation highlights the importance of individual factors, technological factors, organizational factors, and the environmental factors for successful adoption of innovation (Zaltman, Duncan & Holbeck, 1973;Tornatzky & Klein, 1982). Nevertheless, most studies do not provide an in-depth discussion and examination of the factors critical to the adoption and utilization of IT in developing countries. It is important that the local conditions of potential users are considered to the same extent as the technology because of their potentially important role in the implementation process. The nature and extend of the role would appear to require further investigation.

The data in this paper come from the study that examine various potential factors that might affect information technology adoption and implementation processes in the context of Bali's local government. A four-phase conceptual model of IT adoption and implementation process is formulated for this study by synthesizing various stages of innovation adoption process proposed by previous authors (Rogers, 1962, Hage & Aiken, 1970; Rogers & Shoemaker, 1971; Zaltman et al., 1973; Huff & Munro, 1985; Panizzolo, 1998). This four-phase adoption process consists of the initiation phase, adoption phase, implementation phase, and evaluation phase. At least four types of factors (environmental, organizational, technological, and human factors) are believed to affect each phase of IT adoption process directly or through the previous phase as a mediator.

This four-phase innovation adoption process can also be observed at several levels. Possible adopters of the technology are organizations, organizational units, organizational sub units, and individuals. In the overall study, two level of adoption are considered. The first level adoption, the organizational level adoption, starts when an organization begins to realize the need for strategic change and decides to incorporate IT. It ends with acquisition of the technology. This organizational level adoption involves the first two phases of the four-phase adoption process, namely the initiation and adoption phases. The second level adoption, the individual level adoption, commences with the acquisition of the technology, and finishes when the technology is utilized. This individual level adoption involves the last two phases of the four-phase adoption process, namely the implementation and evaluation phases. This paper focuses only on the first level of adoption, and uses the perceived level adoption as the outcome variable. At level-1, human factors and technological factors are used as potential predictors, and at level-2, the aggregate of these individual level variables are used to represent the organizational climates that may affect the outcome variable. In addition, organizational characteristics are also added to the potential level-2 predictors.

In investigating the relationships among variables, it is interesting to examine the direct effects on various predictors on the outcome variable. In addition, it is also no less interesting to understand the cross-level interaction effects that occur between level-1 variables and level-2 variables. In seeking an explanation of such effects, a procedure is employed, which is called hierarchical linear modelling. The need for such techniques has been pointed out since the late 1980s. Attempts are made to model social science data that conform to a nested structure (Bryk & Raudenbush, 1992). These techniques seek to take into account the hierarchical structure of the data obtained in social science research and are therefore now commonly referred to as applications of hierarchical linear modelling, abbreviated as HLM.

Thus, the purpose of this paper is to examine various potential relationships among variables at the individual level (level-1) and at the organizational level (level-2) on adoption as the outcome variable using two-level hierarchical linear modelling (HLM) procedures. The use of these procedures makes it possible to analyse variables at different levels simultaneously in order to find out various factors that may affect the outcome variable (the dependent variable). In addition to the direct effects at different levels, this approach also provides the interaction effects between variables at the two levels. The conceptual model for the two-level HLM of adoption is shown in Figure 1.

VARIABLES USED

However, HLM does not currently allow the formation of latent variables. Hence, principal component scores are calculated for each construct involved in the models using SPSS 10. As a result, variables are in standardized forms, which allow the direct comparison of coefficients of variables within the model (Pedhazur, 1997).

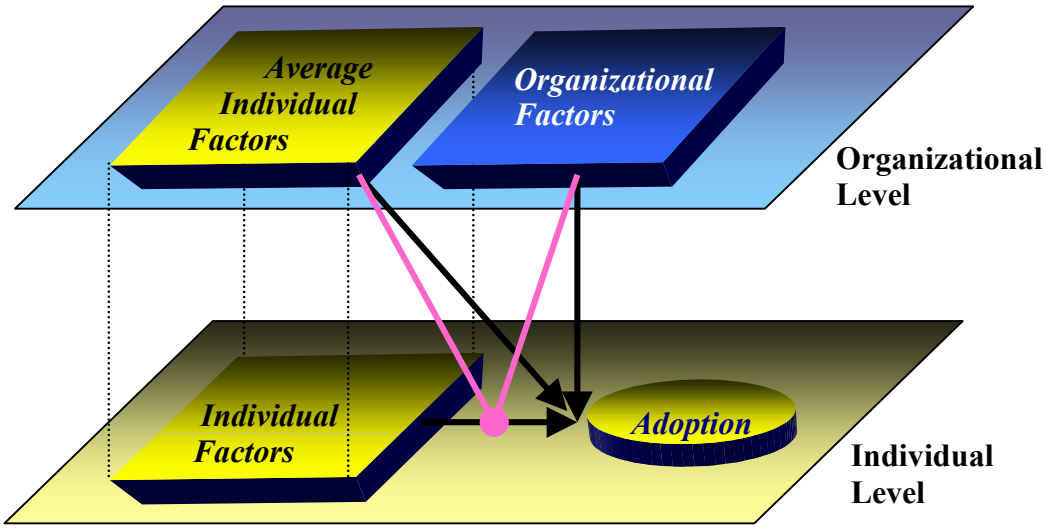

Figure 1. Two-level Model of Adoption

Table 1 lists the individual level (or level-1 or micro-level) variables as well as the organizational level (or level-2 or macro-level) variables that are examined. Darmawan (2000, 2001) elaborates the scales used to measure these variables. Where reference is made to variables used in the HLM analyses reported in this study, variable names are given in uppercase. Variables that are measured at level-1 and aggregated to the group level are assigned the suffix "_21". The aggregated variables are used to represent the organizational and district climates that may affect the outcome variable.

Table 1. List of Variables

Individual Level	Organizational Level	Description
Organizational Factors		
	OSIZE	Organizational size
	TYPE	Organizational type
	OCOM	Organizational complexity
	CENTRAL	Level of centralisation
Individual Factors		
SEX	SEX_21	Gender of Employee
AGE	AGE_21	Age of employee
EDUC	EDUC_21	Level of Education
COMCH	COMCH_21	Communication channel
ANXTY	ANXTY_21	Computer related anxiety
ATTID	ATTID_21	Attitude toward change
RELAD	RELAD_21	Relative advantage
COMPA	COMPA_21	Compatibility
COMPL	COMPL_21	Complexity
OBSER	OBSER_21	Observability
INITI	INITI_21	Initiation
ADOPT	ADOPT_21	Adoption

DATA USED FOR THE STUDY

The data in this paper come from the study focusing on the adoption and implementation of information technology in local government of Bali-Indonesia. The total number of agencies that participated in this study was 153 agencies across all regions of Bali. Those 153 agencies employ a total of 10,034 employees. Of these, 1,427, or approximately 14 per cent, used information technology in their daily duties. They may be considered end-users. Of these end-

users, 975 employees participated in this study. The goal of this study is to examine various potential factors that might affect information technology adoption and implementation processes in the context of Bali's local government. These respondents are grouped into two categories, the initiators and the non-initiators. The initiators are those who are involved in the decision making process in adopting the technology, while the non-initiators are those who are not involved in the decision making process. For this particular analysis, the two-level HLM model of adoption, only initiators' responses are used. This sub-sample includes 465 respondents in 117 organizations.

TWO-LEVEL ADOPTION MODEL FOR INITIATORS

It should be noted that in this chapter, the term level-1, individual level, within group level, between employees, and micro-level are employed interchangeably. Likewise, the term level-2, organizational level, between group level, between organizations, and macro-level are used synonymously.

The selection of variables for the two-level HLM analysis is based on the results of the PLSPATH (Sellin, 1989), AMOS (Arbuckle & Wothke, 1999), and MPLUS (Muthen and Muthen, 1998) analyses (Darmawan, 2001). The limitations of PLSPATH and AMOS as a single level techniques are acknowledged, therefore the two-level MPLUS results are included in the model and exploratory analyses are also employed to find any other possible variables to be included in the model. However, while MPLUS provides for multilevel analysis at two levels it does not model cross-level interaction effects and does not readily provide estimates of residuals. Consequently, the HLM 5 (Raudenbush et al., 2000) and MLwiN 1.1 (Rasbash et al., 2000) analyses are employed to overcome those deficiencies that currently exist in MPLUS. Nevertheless, neither HLM nor MLwiN provide for the estimation of latent variables and in the HLM and MLwiN the latent variables have to be formed outside of these programs using principal components analyses.

Null Model

The analysis of the two level HLM model is undertaken by first running the fully unconditional model to obtain the estimates of the amount of variance available to be explained in the model using HLM 5 (Raudenbush et al., 2000). An estimate in a fully unconditional model is obtained from a model without entering into the equation any individual level or organizational level variables. This model is equivalent to one-way ANOVA with random effects (Bryk & Raudenbush, 1992).

A fully unconditional model specified in the first run of the two levels HLM analysis is given in the following equation:

Level-1 Model: $Y_{ij} = \beta_{0j} + r_{ij}$ [1]

where:

- Y_{ij} is the IT adoption level according to employee *i* in the organization *j,*
- β_{0j} is the intercept for organization *j* (the mean adoption score for the *j*th organization),
- r_{ij} is a random error.

In the above equation, the level of IT adoption according to employee *i* in the organization *j* is considered to be equivalent to the organization mean plus a random error. In other words, the fully unconditional model assumes no differences in the IT adoption level perception between employees within organization at level-1. It is assumed that each level-1 error, $r_{ij,}$ is normally

distributed with a mean of zero and a constant level-1 variance, σ^2 (Bryk & Raudenbush, 1992).

Level-2 Model: $\beta_{0j} = \gamma_{00} + u_{0j}$ [2]

where:

β_{0j} is the intercept for organization *j,*

γ_{00} is the adoption score across organizations (the grand mean outcome in the population),

u_{0j} is the unique random effect associated with organization *j*.

In the level-2 equation, the IT adoption score of organization *j* is considered to be equivalent to the mean across all organizations plus a random error. In other words, the fully unconditional model assumes no differences in the IT adoption score between organizations at level-2. It is assumed that the random effect associated with organization *j*, u_{0j}, is normally distributed with the mean of zero and variance τ_{00}.

Substituting level-2 equation into level-1 equation yields the combined model

$$Y_{ij} = \gamma_{00} + u_{0j} + r_{ij} \quad [3]$$

According to Bryk and Raudenbush (1992), the variance of the outcome is

$$VAR(Y_{ij}) = VAR(u_{0j} + r_{ij}) = \tau_{00} + \sigma^2 \quad [4]$$

Estimating the null model is an important preliminary step in a hierarchical analysis. It produces a point estimate and confidence interval for the grand mean, γ_{00}. Furthermore, it also provides information about the variability of the outcome variable at each level. The σ^2 parameter represents the within-group (level-1) variability, and τ_{00} captures the between-group (level-2) variability (Bryk & Raudenbush, 1992). The HLM results for the null model are presented in Table 2.

Table 2. Fully Unconditional Model - Adoption for Initiators

Final estimation of fixed effects					
Fixed Effect	Coefficient	Standard Error	T-ratio	DF	Approx. P-value
For INTRCPT1, B0					
INTRCPT2, G00	-0.032	0.08	-0.391	116	0.695
Final estimation of variance components					
Random Effect	Reliability	Standard Deviation	Variance Component	DF	Chi-square	P-value
INTRCPT1, U0	0.822	0.8	0.64	116	848.74	0
level-1, R		0.62	0.39			
Statistics for current covariance components model					
Deviance		1102.1			
Number of estimated parameters		2			

Final Level-1 Model

The hierarchical model that is examined is based on those results of PLSPATH, AMOS and MPLUS analyses (Darmawan. 2001). The limitations of PLSPATH and AMOS as a single-level technique are acknowledged and the possibility of the misspecification of a hierarchical model based on those results cannot be ignored. However, little relevant research is available to serve as a sound theoretical and empirical basis for the specification of a hierarchical

model. Because of the complexity of the model, PLSPATH, AMOS, and MPLUS results are considered to be an appropriate basis for selecting potential predictors at both level-1 and level-2 in the HLM analyses.

In order to specify the level-1 model, variables that are found to influence the level of adoption directly at the individual level PLSPATH and AMOS analyses as well as the within model in MPLUS results are entered into the equation one by one according to the magnitude of path coefficients starting from the strongest path, but without the organizational level predictors. Bryk and Raudenbush (1992) suggest that this step is necessary to examine how much of the variance is explained by individual level predictors. Results are then examined and those coefficients that are found not to be significant are removed from the model and the next potential variable is entered into the equation. The input is altered accordingly and the data are reanalysed. These steps are repeated step by step until a final level-1 model with only significant effects is obtained. In each run, an exploratory analysis is also performed to check the possibility of each level-2 variable to be included in the model.

From this step, it is found that only one variable at the individual level, the employees' perception of IT complexity (COMPL), has a significant effect on adoption. To investigate the nature of the relationship between employees' perception of IT complexity (COMPL) and the perceived level of adoption (ADOPT), a series of exploratory analysis is undertaken using MLwiN 1.1 software (Rasbash et al., 2000).

By only entering employees' perception of IT complexity (COMPL) into the equations, MLwiN results are shown in Figure 2 and the regression line for each organization is shown in Figure 3.

$$\mathbf{adop}_{ij} \sim \mathrm{N}(XB, \Omega)$$
$$\mathbf{adop}_{ij} = \beta_{0ij}\mathbf{cons} + \beta_{1j}\mathbf{compl}_{ij}$$
$$\beta_{0ij} = -0.042(0.081) + u_{0j} + e_{0ij}$$
$$\beta_{1j} = 0.112(0.045) + u_{1j}$$
$$\begin{bmatrix} u_{0j} \\ u_{1j} \end{bmatrix} \sim \mathrm{N}(0,\ \Omega_u) \ :\ \Omega_u = \begin{bmatrix} 0.631(0.099) & \\ -0.042(0.037) & 0.047(0.023) \end{bmatrix}$$
$$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim \mathrm{N}(0,\ \Omega_e) \ :\ \Omega_e = \begin{bmatrix} 0.325(0.027) \end{bmatrix}$$
$$-2 * loglikelihood(IGLS) = 1061.385(465 \text{ of } 465 \text{ cases in use})$$

Figure 2. MLwiN Results for Final Level-1 Model

It can be seen in MLwiN results in Figure 2 that in the final level-1 model, which only includes level-1 predictor, the mean of COMPL slope is 0.112 (0.045). However, the individual organization slopes vary about this mean with a variance of 0.047 (0.023). The intercepts of the individual organization lines also differ. Their estimated mean is -0.042 (0.081) and their estimated variance is 0.631 (0.099). In addition, there is a negative covariance between intercept and slope estimated as -0.042 (0.037). This negative covariance suggests that a higher intercept is associated with a lower slope. In other words, organizations with lower level of adoptions tend to some extent to have steeper slopes or lower impact of complexity on adoption. The variability of complexity slopes is presented in Figure 3. The individual adoption scores vary around their organizations' lines by quantities e_{0ij}, the level-1 residual, whose variance is estimated as 0.325 (0.027).

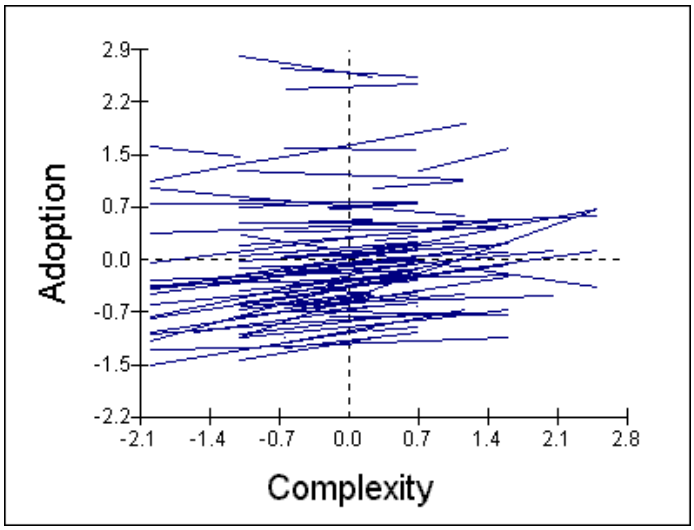

Figure 3. Regression lines for Each Organization

In order to investigate further the nature of data regarding the two variables, residual analyses are undertaken with the slope being fixed. Since 117 organizations are involved in this study, there are 117 level-2 residuals plotted in caterpillar plot, one for each organization in the data set, as presented in the first panel of Figure 4. It can be seen in the caterpillar plot that a group of around 10 organizations at each end of the plot where the confidence intervals for their residuals do not overlap zero. Remembering that these residuals represent organizations' departures from the overall average line predicted by the fixed parameter, this means that the majority of the organizations do not differ significantly from the average line at the 5 per cent level. The second and the third panels of Figure 4 present the scatter plot of adoption versus complexity and individual organizations' lines with complexity slopes being fixed respectively. In the third panel, it can also be seen the average line, the line with the largest residual, and line with the lowest residuals. These results suggest that there is a possibility of random error at the organizational level.

In order to investigate this possibility, another prediction is calculated. This time the slope is allowed to vary. The scatter plot of intercept against slope is presented in the first panel of Figure 5. The second panel of Figure 5 shows the scatter plot of adoption versus complexity. The average line and the lines with the largest and the lowest residuals are plotted in the third panel of Figure 5 along with their confidence interval.

By undertaking these exploratory analyses with MLwiN 1.1, it is confirmed that there are some possible interaction effects of variables at level-2 with the slope of complexity (COMPL). However, there is no easy way to explore the possible variable that may affect the intercept or interact with the slope in MLwiN. Particularly, when the interaction effect involves a continuous level-2 variable. MLwiN only allows categorical variables at level-2 to interact with level-1 predictors. In order to be able to explore the possible variables that may affect the intercept or interact with the slope and to allow any continuous variables at level-2 to interact with level-1 predictors, the exploratory analysis using HLM 5 is undertaken and the results are discussed in the following section.

Full Model

The next step is to run a full model that is by entering the individual level and organizational level variables into the analysis. HLM 5 is used to examine this model by using its exploratory analysis sub-routine to check for possible interaction effects. The organizational level

variables are entered one by one according to their t-values shown in the exploratory analysis results. These steps are repeated step by step until a final model with only significant effects at both levels is obtained.

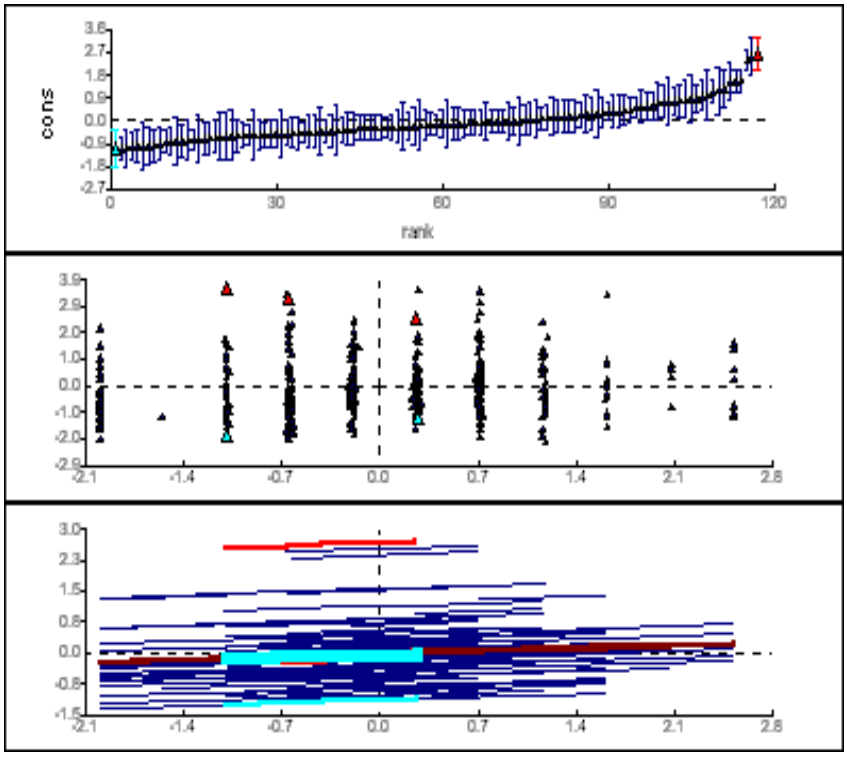

Figure 4. Exploratory Graphs with slope being fixed

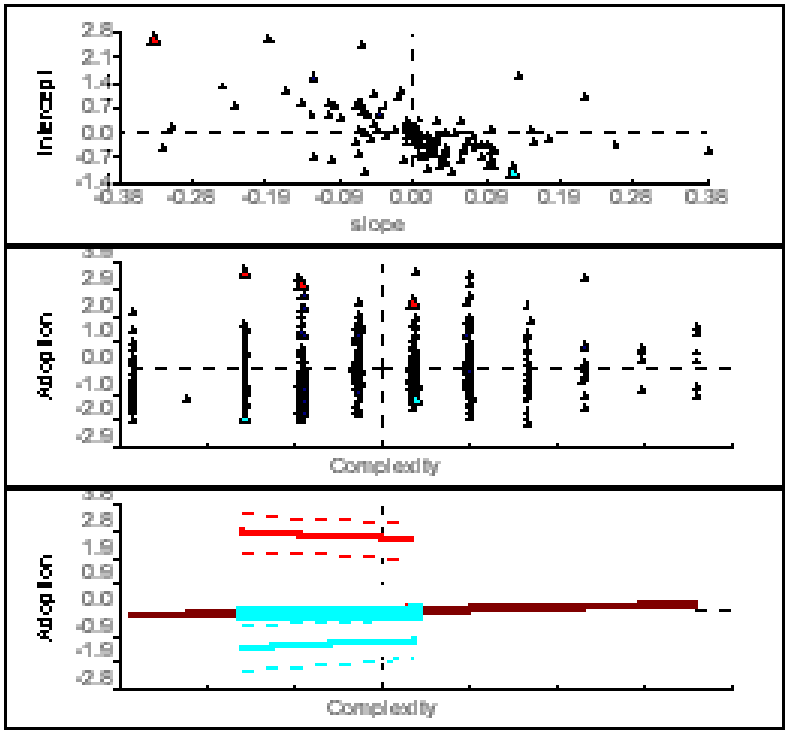

Figure 5. Exploratory Graphs with random errors at level-2

The final model is specified by the following equations:

Level-1 Model

$$Y_{ij} = \beta_{0j} + \beta_{1j} *(COMPL) + r_{ij} \quad [5]$$

Level-2 Model

$$\beta_{0j} = \gamma_{00} + \gamma_{01} *(TYPE) + \gamma_{02} *(OCOM) + \gamma_{03} *(COMCH\_21) + \gamma_{04}*(INITI\_21) + u_{0j} \quad [6a]$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11} *(ANXTY\_21) + \gamma_{12} *(ADOPT\_21)+ u_{1j} \quad [6b]$$

By substituting level-2 equations (Equations 6a and 6b) into level-1 equation (Equation 5), the final model equation is

$$\begin{aligned} Y_{ij} = {} & \gamma_{00} + \gamma_{10} *(COMPL) + \gamma_{01} *(TYPE) + \gamma_{02} *(OCOM) + \gamma_{03} *(COMCH\_21) \\ & + \gamma_{04} *(INITI\_21) + \gamma_{11} *(ANXTY\_21)*(COMPL) + \gamma_{12} *(ADOPT\_21) *(COMPL) \\ & + u_{0j} + u_{1j} *(COMPL) + r_{ij} \end{aligned} \quad [7]$$

This equation illustrates that the adoption level may be viewed as a function of the overall intercept (γ_{00}), five main effects, two cross-level interaction effects, with a random error ($u_{0j} + u_{1j} *(COMPL) + r_{ij}$). The five main effects are the direct effects from IT complexity (COMPL, γ_{10}), organizational type (TYPE, γ_{01}), organizational complexity (OCOM, γ_{02}), average communication channel (COMCH_21, γ_{03}), and average initiation level (INITI_21, γ_{04}). The two cross-level interaction effects involve ANXTY_21 with COMPL (γ_{11}) and ADOPT_21 with COMPL (γ_{12}).

These so-called 'interaction effects' are at the core of the additional information that HLM produces as a result of the concept of 'slope as outcome' analysis (Bryk & Raudenbush, 1992). Table 3 shows that one level-1 variable has an effect on performance, namely COMPL, the perceived complexity of the technology. In addition, four level-2 variables influence the average adoption in each organization, namely organizational type (TYPE), organizational complexity (OCOM), average communication channel (COMCH_21), and average initiation (INITI_21). The first two variables, TYPE and OCOM, are variables at level-2 or the characteristics of the organization, whereas the last two, COMCH_21 and INITI_21, are variables aggregated from the individual level. Moreover, two level-2 variables influence the slope of perceived complexity of the technology, namely the average perceived anxiety (ANXTY_21) and the average perceived adoption level (ADOPT_21). All variables are aggregated from the individual level. These relationships are shown in Figure 6.

In general, a cross-level interaction effect relates three variables to one-another, namely, the outcome variables, its level-1 predictor, and a level-2 variable that is considered to influence the effect of the level-1 predictor on the outcome variable. In order to illustrate the interaction effect and the detail, which could be obtained from HLM output, parts of the equations for the final model involving ANXTY_21 and COMPL are presented below with the remaining terms set to zero since neither ANXTY_21 or COMPL are involved and there is no loss in generality.

$$Y_{ij} = \beta_{0j} + \gamma_{10} *(COMPL) + \gamma_{11} *(ANXTY\_21)*(COMPL) + r_{ij} \quad [8]$$

where (see Table 4)

β_{0j} = γ_{00} (as the average adoption across organization)
= 0.00 (since it is not significantly different from zero, $p > 0.05$)
(This is a consequence of the use of standardized criterion variable)

γ_{10} = 0.10 and γ_{11} = -0.12

Hence :

$$Y_{ij} = 0.10 \ *(COMPL) - 0.12 \ *(ANXTY\_21)*(COMPL) + r_{ij} \quad [9]$$

Table 3. Final Model - Adoption for Initiators

Final estimation of fixed effects					
Fixed Effect	Coefficient	Standard Error	T-ratio	DF	Approx. P-value
For INTRCPT1, B0					
INTRCPT2, G00	0.01	0.07	0.12	112	0.902
TYPE, G01	0.20	0.08	2.56	112	0.011
OCOM, G02	0.15	0.04	3.31	112	0.001
COMCH_21, G03	0.27	0.09	3.00	112	0.003
INIT_21, G04	0.24	0.07	3.37	112	0.001
For COMPL slope, B1					
INTRCPT2, G10	0.10	0.05	1.99	114	0.047
ANXTY_21, G11	-0.10	0.06	-2.05	114	0.040
ADOPT_21, G12	-0.50	0.05	-10.76	114	0.000

Final estimation of variance components:						
Random Effect	Reliability	Standard Deviation	Variance Component	DF	Chi-square	P-value
INTRCPT1, U0	0.72	0.67	0.45	87	511.30	0.000
COMPL slope, U1	0.42	0.40	0.16	89	212.66	0.000
level-1, R		0.59	0.34			

Statistics for current covariance components model	
Deviance	1053.9
Number of estimated parameters	4

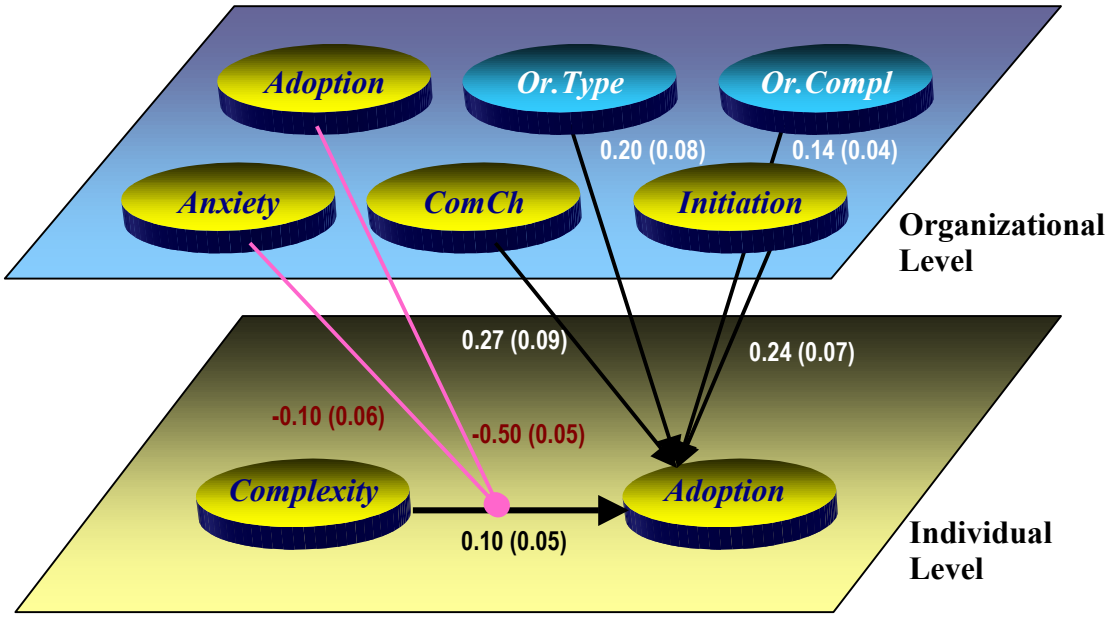

Figure 6. Two Level Model of Adoption for Initiators

In order to provide a graphical presentation of this expression, coordinates can then be calculated by substitution in equations for organizations (Equation 9) that are:

1. one standard deviation above the average on COMPL and ANXTY_21 (i),

2. one standard deviation above the average on COMPL and one standard deviation below the average on ANXTY_21 (ii),
3. one standard deviation below the average on COMPL and one standard deviation above the average on ANXTY_21 (iii),
4. one standard deviation below the average on COMPL and one standard deviation below the average on ANXTY_21 (iv),
5. average on COMPL and one standard deviation above the average on ANXTY_21 (v),
6. average on COMPL and one standard deviation below the average on ANXTY_21 (vi).

Consequently, the coordinates are:

i. high anxiety and high IT complexity (COMPL = 1; ANXTY_21 = 1)
Y (ADOPT) = 0.10 * (1) – 0.12 * (1) * (1) = -0.02

ii. high anxiety and low IT complexity (COMPL = -1; ANXTY_21 = 1)
Y (ADOPT) = 0.10 * (-1) – 0.12 * (1) * (-1) = 0.02

iii. low anxiety and high IT complexity (COMPL = 1; ANXTY_21 = -1)
Y (ADOPT) = 0.10 * (1) – 0.12 * (-1) * (1) = 0.22

iv. low anxiety and low IT complexity (COMPL = -1; ANXTY_21 = -1)
Y (ADOPT) = 0.10 * (-1) – 0.12 * (-1) * (-1) = -0.22

v. average anxiety and high IT complexity (COMPL = 1; ANXTY_21 = 0)
Y (ADOPT) = 0.10 * (1) – 0.12 * (0) * (1) = 0.10

vi. average anxiety and low IT complexity (COMPL = -1; ANXTY_21 = 0)
Y (ADOPT) = 0.10 * (-1) – 0.12 * (0) * (-1) = -0.10

These coordinates are used to generate Figure 7. It can be seen that all regression lines have their intercept at 0.00, which was the value of Y_{ij} when COMPL and ANXTY_21 were equal to zero, and hence the average intercept across all organizations. A similar technique is employed to generate Figure 8 that shows the interaction of complexity (COMPL) and organizational level of adoption (ADOPT_21) to influence the adoption by individuals as the criterion variable.

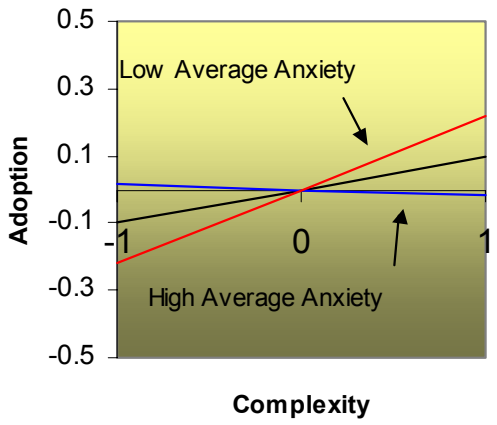

Figure 7. Effect of Average Anxiety on Complexity Slope

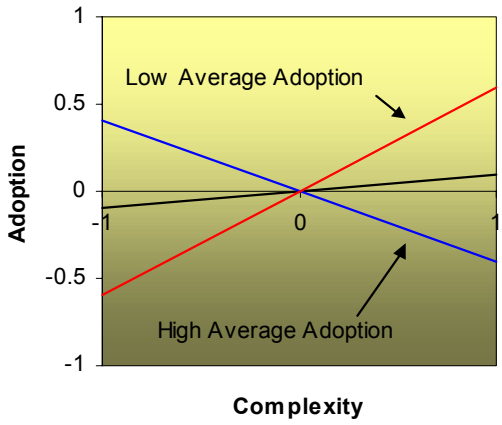

Figure 8. Effect of Average Adoption on Complexity Slope

The results reveal an interesting pattern. In general, initiators who appreciate the complexity of the technology (COMPL) tend to have higher levels of adoption (ADOPT). However, the effects of complexity on adoption for initiators in an organization are also influenced by the average levels of anxiety (ANXTY_21) and adoption (ADOPT_21) in that organization. Hence, the slope of complexity on adoption varies from organization to organization, and it depends on the average anxiety and average perception of the level of adoption in that organization. In this study, it seems that initiators in an organization where on average the initiators have a low level of anxiety tend to have a higher level of adoption. They are more motivated than those who see the technology as a source of anxiety and who therefore reject it. The former group of initiators, initiators in organizations that have low levels of average anxiety, see the technology as a challenge and consequently try to adopt it. This interaction effect is presented in Figure 7.

A high level of adoption in an organization, on the one hand, does not indicate that initiators in that organization are motivated and willing to adopt the technology despite its complexity. On the other hand, organizations that have low levels of adoption seem to be more motivated to increase that level in spite of the complexity of the technology. This result gives credence to the earlier conclusion, that complexity may spur on initiators rather than demoralise them. These interaction effects are presented in Figure 8.

Furthermore, it seems that organizational type and organizational complexity (the spread of IT skills and IT expertise in an organization) are positively correlated with adoption. Moreover, the results also suggest that the level of adoption is affected by the way it has been communicated. In addition, adoption was closely influenced by initiation as expected. That is, initiators are willing to adopt technology if they perceive it as necessary for their work. The reverse is also true.

In addition to the effects, it is also of interest to examine the variance components at both between employee (level-1) and between organization (level-2) levels. Table 4 presents this information for the fully unconditional model and the final model. In the first step, a null model is estimated. This model has no predictor at level-1 or level-2 and provides information with respect to the partitioning of variance at the two levels. Bryk and Raudenbush (1992, p.30) refer to this model as a fully unconditional model. From these values, estimates of the variance at each level were calculated according to the equations given by Bryk and Raudenbush (1992, p.63) and recorded in the second panel of Table 4. The results in Table 4 indicate that 37 per cent of the variance in the level of adoption is found between employees while 63 per cent can be attributed to differences between organizations.

Table 4. Estimation of Variance Components - Adoption for Initiators

Model	Estimation of Variance components between employees (n = 459)	between organizations (n = 117)
fully unconditional model	0.39	0.67
final model	0.34	0.45
Variance at each level		
between employees	0.39 / (0.67 + 0.39) = 37%	
between organizations	0.67 / (0.67 + 0.39) = 63%	
Proportion of variance explained by final model		
between employee	(0.39 - 0.34) / 0.39 = 0.13 = 13%	
between organization	(0.67 - 0.45) / 0.67 = 0.33 = 33%	
Proportion of total available variance explained by final model		
(0.13 x 0.37) + (0.33 x 0.63) = 0.26 = 26%		

In the second step, estimates of variance components are computed for the final model, which has predictors at both levels. Calculations recorded in panel 3 of Table 4 provide estimates of the overall explanatory power for this model at level-1 (13%) and level-2 (33%). Overall, 26 per cent of total available variance has been explained by the final model at both levels. It can also be seen from Table 3 and Table 4 that the deviance is also reduced by 49 with an additional two degrees of freedom. Since the ratio of the decrease of deviance by the increase of degrees of freedom is greater than 1, the final model is considered to be better.

CONCLUSION

It is found in this study that the level of adoption can be viewed as a function of five main effects, two cross-level interaction effects, with a complex random error term. The five main effects are the direct effects from IT complexity (COMPL), organizational type (TYPE), organizational complexity (OCOM), average communication channel (COMCH_21), and average initiation level (INITI_21). The two cross-level interaction effects involve ANXTY_21 with COMPL (γ_{11}) and ADOPT_21 with COMPL (γ_{12}).

The results reveal an interesting pattern. In general, initiators who appreciate the complexity of the technology (COMPL) tend to have higher levels of adoption (ADOPT). However, the effects of complexity on adoption for initiators in an organization are also influenced by the average levels of anxiety (ANXTY_21) and adoption (ADOPT_21) in that organization. Furthermore, it seems that organizational type and organizational complexity (the spread of IT skills and IT expertise in an organization) are positively correlated with adoption. Moreover, the results also suggest that the level of adoption is affected by the way it has been communicated.

In addition to the effects, it is also of interest to examine the variance components at both between employees (level-1) and between organizations (level-2) levels. The results indicate that 37 per cent of the variance in the level of adoption is found between employees while 63 per cent can be attributed to differences between organizations. The overall explanatory power for this model at level-1 is 13 per cent and at level-2 is 33 per cent. Overall, 26 per cent of total available variance has been explained by the final model at both levels.

The findings of this study contribute to both the theoretical and empirical knowledge on organizational adoption of IT innovations for those governmental agencies in developing countries by adding to the case studies available the local characteristics of Bali, Indonesia. In addition, this study also provides a contribution in identifying the facilitators and inhibitors for IT adoption in local government agencies of Bali. By recognizing these factors, the Bali's government agencies are expected to be able to formulate better strategies in adopting IT in order to increase their service quality and productivity. It also provides the Indonesian government with a better understanding of local conditions in Bali for formulating their IT policy.

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