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Developing of the Measurement Model of Self-Directed Learning Characteristics

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Abstract

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Problem statement: Self-directed learning is a factor essential for learners. But, factors both differ and overlap. The structures of various factors are not consistent. Research Questions: The model of self-directed learning characteristics of technical college students was developed valid or not? Purpose of the Study: This research aims to develop a model of self-directed learning characteristics of technical college students by factor analysis and multidimensional item response analysis, and to validate the self-directed learning model. Research Methods: Samples were two groups. The first sample was used to analysis the model factors (230 students) and the second sample, used to validate the model (1,563 students). The instruments were 44 items (four choices). Data were analyzed through the methods of means, standard deviation, confirmatory factor analysis, and multidimensional item response analysis. Findings: First, results of analyzing item of the model are as follows. Factor analysis: items were suitable for the self-directed learning model (93.18%). Multidimensional item response analysis: all questions were suitable for the model (100.00%). The selected model had eight factors (32 items). Second, the model had validity. Conclusions: The model developed from the Guglielmino's theory and the self-directed learning model was consistent with empirical data. The standard of the self-directed learning model was interpreted on four levels: awareness, interest, attempts at learning, and actual practice.

Keywords: Self-directed learning; validation.

1. Introduction

At present, advanced sciences and technologies, and the easy access to information, are inevitably affecting how people live their lives and make decisions, causing social, economic and cultural changes. It is, therefore, important to stay abreast of information. One of the key factors of human development is education. The National Education Plan, Revised Edition (2009-2016) mentioned educational development with the following qualitative aims: 1) making Thai people moral, efficient, happy, knowledgeable, professional, ethical, eager to learn and for knowledge; and 2) turning Thai

society into a society of integrity, wisdom and education by creating knowledge, innovation and technologies leading to a sustainable learning society (Office of the Education Council, 2010). Education is key to human resource development and the foundation of the country's growth.

However, the results of Thailand's education reform did not turn out as expected, as seen in a report by the International Institute of Management Development (IMD) that ranks competitiveness of different countries on the global scale. Thailand's education in 2006 was ranked no. 46 out of 55 countries while, in 2008, it was ranked no. 43 out of 55 countries (Office of the Higher Education Commission, 2008). Results from the evaluation of education quality of 17,562 schools nationwide (49.1% of all schools), six years after the education reform and enactment of the National Education Act, B.E. 2542, showed that only 26.5% of the learners had self-directed learning skills, loved learning and continuous personal development and were of quality (Ratmanee, 2011). These results showed that education quality had not improved as anticipated and learners were not actively seeking knowledge and developing themselves.

Education has to adjust to changes in the scientific, technological, social, economic and cultural domains. Self-directed learning is a characteristic essential for learners in the modern world where everything changes so rapidly. This is consistent with the National Education Act, Section 1 (General: Objectives and Principles, Article 7), stating that the learning process must encourage learners to continuously rely on themselves, be creative, eager for knowledge and learn independently (Office of the Education Council, 2002). This is also consistent with the concept of Isarawat (1999) who said that self-directed learning could be created and developed. Whenever a learner learns by themselves, and comes to love searching for knowledge, that learner will keep learning until he/she becomes a lifelong learner. This leads to the social practice of learning (Hung et al, 2009), which is the goal of modern academics. Self-directed learning is a trait important for education and in everyday life.

Theorists disagree on the number of key traits involved in self-directed learning. According to Knowles (1975) there are nine traits, according to Guglielmino (1977) there are eight traits, Skager (1978) claims there are seven traits, Isarawat (2000) suggests there are only three, and the Educational Research Division (2000) suggests eight traits. Accordingly, these traits both differ and overlap. The structures of the various factors are not consistent. Translation criteria are also not always clear or suitable for the Thai context. This is similar to the theory of Sapyaprapa (1997), who states that a good measuring model has to be based on culture, values and characteristics of each particular country, with validity measurement, population and standard criteria created for people in each country.

Considering the structure of factors, there are many concepts of self-directed learning. They are not consistent. Scores are not interpreted based on standard criteria suitable for Thai society. Previous studies inside and outside Thailand have focused on factors affecting self-directed learning by students, followed by self-directed learning characteristics. Most of these studies addressed basic education. Therefore, a self-directed learning model must be developed.

This research was conducted with students from technical colleges affiliated with the Office of Vocational Education Commission of Thailand. They were selected for study because they were becoming adults and could play their roles in society appropriately, adjust themselves, accept changes, have mental and emotional freedom, prepare to select their careers, and demonstrate intelligence and an

understanding of sophisticated concepts (Kotrakun, 2005). Moreover, they were eager to learn and enter into the higher education system. They were competitive and ready to deal with problems and enter into the labour market. The Office of the Education Council (2008) found that there were not enough researches and vocational advances. Therefore, this study will focus on development of learners in an effective and efficient way. This research also helped learners develop a self-directed learning system using self-assessment.

2. Purpose of the study

This research aims to develop a valid and reliable model to measure and determine self-directed learning by technical college students. Specific objectives are as follows: To analysis the self-directed learning model of technical college students by factor analysis and multidimensional item response analysis, and to validate the self-directed learning model for technical college students.

3. Research methods

3.1. Population and sample

The population sampled was technical college students, affiliated with the Office of Vocational Education Commission of Thailand.

There were two sample groups. The first sample group was used to analysis the model factors of technical college students affiliated with the Office of Vocational Education Commission of Thailand acquired from two-stage random sampling. The first step was simple random sampling, by which students were classified by region. The provinces with technical colleges were random units. The second step was simple random sampling of students in technical colleges acquired from the first step. Then 230 students were sampling units. The number of sample groups were enough according to the principles of analysis of Hair et al. (2006), who suggested determining the size of the sample groups using the ratio of the number of variables to the number of samples, 1:20. This research had eight variables. Therefore, there should be 160 sample units according to the principles of analysis set out in the multidimensional Rasch model. There were 200 students in the sample group (Wright, & Stone, 1979 cited in Yen, & Fitzpatrick, 2006).

The second sample group, used to validate the model and standards setting, included technical college students from the academic year 2011-2012. The sample was acquired from a simple random sampling. First, the researcher determined the size of the sample group based on the sampling principle of Hair et al. (2006), who use 20 sample units per variable. In this research, the items on the evaluation forms were used as observed variables. There were 40 items on each form. Thus, the sample group should have at least 800 students. The sample groups were classified by region, determined by the National Research Council of Thailand as the Central Region (including the East), the North, the Northeast and the South.

Second, the sample groups were acquired from a three-stage random sampling. The first step was a simple random sampling with sampling units. The second step was a simple random sampling with technical colleges as the sampling units. The third step was a simple random sampling with technical college students as the sampling units. In total, there were 1,563 students in the sample group.

3.2. Instrument

The instruments were 44 items with four choices developed from two principles: the factor principle and the self-directed learning principle. The latter was developed from the work of Guglielmino (1977), which was adapted to suit the Thai context. This principle includes eight factors: 1) openness to learning opportunities, 2) self-conception as an effective learner, 3) initiative and independence in learning, 4) informed acceptance of responsibility for one's own learning, 5) love of learning, 6) creativity, 7) a positive orientation to the future, and 8) the ability to use basic study skills and problem-solving skills. The self-directed learning principle was synthesized from Rogers's concept of new knowledge introduction (Rogers, 1983) and Cross's concept of self-directed learning (cross, 1981): Awareness (1 score), interest (2 scores), attempts at learning (3 scores) and practice (4 scores).

The evidence of reliability and validity of the multi-method used in this model was tested for internal consistency and stability, while the construct validity was tested by correlation analysis, confirmatory factor analysis, and comparative analysis. The sample group for this study was 119 technical college students. This first re-test found a reliability, in terms of internal consistency, of .67, the second re-test scored .74 and stability was calculated at .60. The construct validity of the test was related to a medium-to-high level. The self-directed learning model was consistent with experimental data, and did not change with time.

3.3. Procedure

The research procedure was as follows. First, relevant documents were collected. Additional studies on self-directed learning were conducted. Secondly, research instruments were developed according to factors and the learning sequence. Third, the self-directed learning factors were developed and confirmatory factor analysis based on the Classical Test Theory (CTT), and multidimensional item response analysis based on the Item Response Theory (IRT), were performed. Fourth, validate of the self-directed learning model. Confirmatory analysis was conducted using the LISREL.

4. Findings

4.1. Model analysis to model development

4.1.1. General information of respondents

Respondents were technical college students: 63 from the North (27.39%), 58 from the Northeast, (25.22%), 55 from the Central Region (including the East) (23.91%) and 54 from the South (23.48%). The proportion of males and females was slightly different: 129 females (56.09%), 98 males (42.61%) and three not indicating their gender (1.30%). Regarding education, 183 students were pursuing high vocational certificates (79.57%), 45 students were pursuing vocational diplomas (19.57%), while two students didn't indicate their education status (0.86%); their collective GPA was 2.89 (s=.47).

Analysis of the basic statistics concerning self-directed learning showed the means to be between 2.31 and 3.16. Standard deviation was .90 to 1.21. Most responses were negative skewness and platykurtic. The correlation coefficients of 118 pairs of items were from -.243 to .323, which were related with a statistical significance of .05. The measure of sampling adequacy (MSA) was between

.34 and .71. More than half of the items yielded predictions without discrepancy from the other 26 items (59.00%), considered from the value of .50 and up (Hair et al, 2006). The result from Bartlett's Test of Sphericity was 1365.590 (df=946, p=.000). This meant that the independent variables in the data analysis were related enough for an analysis of factors and multidimensions. The Kaiser–Meyer–Olkin (KMO) used to evaluate appropriateness of the data was .526, which was more than that of Hair et al (2006), who suggested upwards of .50. It can therefore be said that the data were appropriate for analysis of factors and multidimensions.

4.1.2. Analysis of the self-directed learning model using confirmatory factor analysis

In the pre-adjusted model structure, factor loading was found to be between -.20 and .58. Factor loading of 28 of the items had statistical significance of .05. This showed that most items were significant or related to the factors when other variables were removed. The squared multiple correlations (R^2) of the items were between .00 and .33. This showed that variation of the items in each factors that could be explained by factors were at the low to high level: 0.00-33.00%. When the self-directed learning structure and experimental data were examined, the chi-square test statistic was found to be 1037.30 (df=874, p=.00011) with statistical significance. The goodness-of-fit index (GFI) was .83, while the adjusted goodness-of-fit index (AGFI) was .81. The root mean squared residual (RMR) was .065, and the root mean squared error of approximation (RMSEA) was .029. The Index of the model showed congruence of the self-directed learning structure and empirical data.

In the post-adjusted model structure, factor loading was found to be between -.14 and .61. Factor loading of 28 of the items had statistical significance of .05. This showed that most items were significant or related to the factors when other variables were removed. The squared multiple correlations (R2) of the items were between .00 and .37. This showed that variation of the items in each factors that could be explained by factors were at the low to high level: 0.00-37.00%. When the self-directed learning structure and experimental data were examined, the chi-square test statistics was found to be 933.94 (df=865, p=.051) without statistical significance. The goodness-of-fit index (GFI) was .84, and the adjusted goodness-of-fit index (AGFI) was .82. The root mean squared residual (RMR) was .062, while the root mean squared error of approximation (RMSEA) was .019. The Index of the model showed congruence between the self-directed learning structure and empirical data.

Statistical significance and practical significance showed each factor with the following details. First, openness to learning opportunities (OLO) passed the statistical significance criteria: one item passed the practical significance criteria and one did not. Second, self-conception as an effective learner (SEC) passed the statistical significance criteria: four items passed the practical significance criteria and one did not. Third, initiative and independence in learning (IIL) passed the statistical significance criteria: three items passed the practical significance criteria and two did not. Fourth, informed acceptance of responsibility for one's own learning (REL) passed the statistical and practical significance criteria: six items passed the statistical significance and three items passed the practical significance. Fifth, love of learning (LOL) passed the statistical significance criteria: four items passed the statistical significance criteria and one did not. Sixth, creativity (CRE) passed the statistical and practical significance criteria: three items passed the statistical significance criteria and two items

passed the practical significance criteria. Seventh, positive orientation to the future (POO) passed the statistical and practical significance criteria: four items passed the statistical significance criteria and one item passed the practical significance criteria. Eighth, ability to use basic study skills and problem-solving skills (ABS) passed the statistical and practical significance criteria: four items passed the statistical significance criteria and one item passed the practical significance criteria.

4.1.3. Analysis of the self-directed learning model using multidimensional item response analysis

Analysis of the multidimensional items, according to the multidimensional item response theory (MIRT) and the multidimensional form of the partial credit model using ConQuest 2.0, showed congruence between the self-directed learning model structure with item fit. The OUTFIT MNSQ for all the items was between .93 and 1.11, while the INFIT MNSQ statistics for all the items were between .94 and 1.10. All of the 44 items had OUTFIT MNSQ and INFIT MNSQ at the rating scale: .60 to 1.40 (Wright et al., 1994). This showed that the self-directed learning measuring structure was suitable for the items. According to the responses to the multidimensional tests, the structure had deviance statistics (G^2)=26655.297, parameters=168, Akaike information criterion (AIC)=26991.297. Each factor was found to have appropriate items for all items.

4.1.4. Analysis of items leading to model development

The principles were as follows. First, the items were deemed to be consistent/passing the criteria in all analytical dimensions, on the basis of the Classical Test Theory (CTT), which was a confirmatory factor analysis, and the Item Response Theory (IRT), which was a multidimensional item response analysis. Secondly, four items in each factor were selected in order to explain the significance of each factor with the same weight complied with the model development principle Hair et al. (2006) suggest that each factor structure should have at least three indicators. Thirdly, if any factor had more than four items, items with better qualification should be identified using analysis of factors, with both statistical and practical significance being considered. If their qualifications were still the same, better factor weight should be considered. Analysis of multidimensional items should be based on values at an appropriate range. Fourth, if any factor had fewer than four items, items with acceptable qualification in practice should be identified using analysis of factors. An analysis of multidimensional items as a result of analysis found 44 items, analysis based on eight factors with 32 items as seen in Table 1.

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Table 1. Analysis of the model using factor analysis and multidimensional item response analysis.

Factor	Item	CFA	MIRA	Selection Results	Factor	Item	CFA	MIRA	Selection Results
OLO	item1	✓	✓	Hold	LOL	item25	✓	✓	Hold
	item2	✓	✓	Hold		item26	✓	✓	Hold
	item3	✓	✓	Hold		item27	✓	✓	Hold
	item4	×	✓	Reject		item28	×	✓	Reject
	item5	✓	✓	Hold		item29	✓	✓	Hold
SEC	item6	✓	✓	Hold	CRE	item30	✓	✓	Hold
	item7	×	✓	Reject		item31	✓	✓	Hold
	item8	✓	✓	Hold		item32	✓	✓	Reject
	item9	✓	✓	Hold		item33	✓	✓	Hold
	item10	✓	✓	Hold		item34	✓	✓	Hold
IIL	item11	✓	✓	Hold	POO	item35	✓	✓	Hold
	item12	✓	✓	Reject		item36	✓	✓	Hold
	item13	✓	✓	Hold		item37	✓	✓	Hold
	item14	✓	✓	Hold		item38	✓	✓	Hold
	item15	✓	✓	Hold		item39	✓	✓	Reject
REL	item16	✓	✓	Reject	ABS	item40	✓	✓	Hold
	item17	✓	✓	Reject		item41	✓	✓	Reject
	item18	✓	✓	Hold		item42	✓	✓	Hold
	item19	✓	✓	Reject		item43	✓	✓	Hold
	item20	✓	✓	Reject		item44	✓	✓	Hold
	item21	✓	✓	Hold					
	item22	✓	✓	Reject					
	item23	✓	✓	Hold					
	item24	✓	✓	Hold					

It can be seen that factor analysis and multidimensional item response analysis were congruent with the agreement rate (Chianchana, 2012). This congruence was .93, meaning that both types of analysis yielded highly congruent results.

4.2. Validation of the model

The researchers used the model acquired from development to conduct validation of the self-directed learning model of technical college students, using confirmatory factor analysis and the LISREL.

4.2.1. General data of respondents

The respondents were technical college students: 428 from the North (27.45%), 380 from the Central Region (including the East) (24.31%), 379 from the Northeast, (24.25%) and 375 from the South (23.99%). The proportion of males and females was 1,157 males (74.02%) to 386 females (24.70%), with 20 not indicating their gender (1.28%). Regarding education, more than half of the students were pursuing vocational diplomas - 879 students (56.24%) and 684 students (43.76%) were pursuing high vocational certificates. Their collective GPA was 2.84 (s=.48).

4.2.2. Examining the structural of self-directed Learning from confirmatory factor analysis

The chi-square test statistic was 418.96 (df=376, p=.062) with no statistical significance. Other statistics were considered as follows: the goodness-of-fit index (GFI) was .98, the adjusted goodness-of-fit index (AGFI) was .98, the root mean squared residual (RMR) was .023, and the root mean squared error of approximation (RMSEA) was .008. The Index of the model showed congruence between the self-directed learning structure and empirical data, i.e. the self-directed learning model of technical college students had construct validity as developed and seen in Table 2.

Table 2. Validity of self-directed learning model of technical college students.

Factor	item	b	SE	t	R^2
OLO	O1	.04	.04	1.12	.00
	O2	.19*	.04	5.04	.04
	O3	.45*	.07	6.57	.21
	O4	.07*	.04	1.98	.01
SEC	S1	.63*	.15	4.20	.40
	S2	.12*	.04	3.30	.02
	S3	.00	.06	.07	.00
	S4	.16*	.07	2.32	.03
IIL	I1	.15*	.03	4.43	.02
	I2	.22*	.04	5.06	.05
	I3	.15*	.03	4.56	.02
	I4	.17*	.04	4.60	.03
REL	R1	.27*	.03	7.84	.07
	R2	.35*	.03	10.25	.12
	R3	.47*	.04	12.65	.22
	R4	.15*	.03	4.46	.02
LOL	L1	.37*	.07	5.26	.14
	L2	.26*	.05	4.81	.07
	L3	.09*	.04	2.06	.01
	L4	.20*	.08	2.64	.04

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Factor	item	b	SE	t	R^2
CRE	C1	.19*	.05	3.47	.04
	C2	.07*	.03	2.21	.01
	C3	.07*	.03	1.99	.00
	C4	.21*	.06	3.53	.04
POO	P1	.17*	.03	4.85	.03
	P2	.21*	.04	5.82	.05
	P3	.27*	.04	6.61	.07
	P4	.21*	.04	5.57	.04
ABS	A1	.22*	.04	6.20	.05
	A2	.05*	.04	1.55	.00
	A3	.46*	.00	11.45	.21
	A4	.39*	.04	10.40	.15
Chi square = 418.96(df =376, p = .062), GFI = .98, AGFI = .98, RMR = .023, RMSEA=.008					

5. Conclusions

The model developed from the theory of Guglielmino and the self-directed learning model that the researcher developed (44 items) had items suitable for 41 items of the self-directed learning model (93.18%). The model was consistent with empirical data (Chi-square = 933.94 (df = 865, p = .051), GFI = .84, AGFI = .82, RMR = .062, RMSEA = .019). When responses were analyzed, all multidimensional items were found suitable for the self-directed learning model (100.00%). The model had G^2 = 26655.297, np = 168, AIC = 26991.297 (The two analyzing methods were highly congruent, with a value of .93.) The self-directed learning model that was developed had eight factors: 1) openness to learning opportunities, 2) self-conception as an effective learner, 3) initiative and independence in learning, 4) informed acceptance of responsibility for one's own learning, 5) love of learning, 6) creativity, 7) a positive orientation to the future, and 8) the ability to use basic study skills and problem-solving skills (32 items).

The self-directed learning model of technical college students had validity that was developed. The chi-square test statistic was 418.96 (df=376, p=.062) with no statistical significance. The goodness-of-fit index (GFI) was .98. The adjusted goodness-of-fit index (AGFI) was .98. The root mean squared residual (RMR) was .023, and the root mean squared error of approximation (RMSEA) was .008.

6. Discussion

The first topic for discussion is the self-directed learning model. This study found that, in the self-directed learning model analyzed by analysis factors, when considered item-by-item, three items (6.82%) did not pass the statistical significance and/or the practical significance. It is considered that this model was perfectly appropriate (93.18%) and consistent with overall statistics of the model, which can be considered from statistics of congruence with the experimental data. All statistics were acceptable and reflected congruence between the model and experimental data.

The self-directed learning model analyzed by the multidimensional factors found appropriateness of every item and item fit. Wright et al. (1994) suggest statistics of congruence based on estimation with

values from .60 to 1.40. This means that all items were congruent with the self-directed learning model under the theory of responses to multidimensional tests (Chianchana, 2009), i.e. students with high self-directed learning capabilities had a higher chance of answering these items than students with low self-directed learning capabilities.

It can be seen that there were congruence between factor analysis and multidimensional analysis with the value of .93. This showed that factor analysis and multidimensional analysis were congruent at a very high level, which was consistent with the reliability consideration of Nunnally & Bernstein (1994), who suggested considering an evaluation with high impact at .90. This was with Chianchana (2012), who suggested that the confidence was .60-.79. The result was quite good and .90 up meaning very good.

The self-directed learning model of technical college students was developed from eight factors, namely openness to learning opportunities, self-conception as an effective learner, initiative and independence in learning, informed acceptance of responsibility for one's own learning, love of learning, creativity, a positive orientation to the future, and the ability to use basic study skills and problem-solving skills via factor analysis. Analysis of responses to multidimensional tests (multidimensional item response theory) showed validity according the developed structure with chi-square test statistics of 418.96 (df=376, p=.062) with no statistical significance. Goodness-of-fit index (GFI) was .98. Adjusted goodness-of-fit index (AGFI) was .98. Root mean squared residual (RMR) was .023. Root mean squared error of approximation (RMSEA) was .008. All indexes complied with a consideration of Bollen in 1989 Kelloway in 1998 and Diamantopoulos, & Siguaw in 2000, who showed the model developed, with congruence with empirical data (Bollen, 1989; Kelloway, 1998; Diamantopoulos, & Siguaw, 2000).

Regarding implementation, the self-directed learning model should be implemented among technical college students, in terms of examination and interpretation, in order to develop a reliable self-directed learning model suitable for their age groups and schools. The self-directed learning model was consistent with experimental data. Future studies should aim to develop a self-directed learning system by way of self-assessment.

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