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The construction and verification of a Self-Regulated Learning Process Model of the Electrical Technology Basic Competency

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ABSTRACT: The main purpose of this study was to construct a Self-regulated Learning Process Model of the Electrical Engineering Technology Basic Competency for students of a technological institute and to validate it with data from 188 undergraduates. The data were analysed with Structural Equation Modelling (SEM). Results showed that the theoretical model fits the observed data well, and the results supported the direct effects of students' personality, learning motivation and action control on self-regulated learning strategies; the indirect effects of students' personality on self-regulated learning strategies through learning motivation; and the indirect effects of learning motivation on self-regulated learning strategies through action control. According to the findings, the author suggests that further research that uses relevant personality variables as moderators of self-regulation training or interventions in an experimental design to determine whether individuals with certain traits are indeed more inclined to develop, or more motivated to use self-regulatory skills, so as to face the challenges of global competition.

INTRODUCTION

Technological and vocational education (TVE) has previously made significant contributions to the country by supplying a large workforce for Taiwan's economic development and training technical specialists of various levels required for different projects. Taiwan has become a developed country and a leading exporter of industrial products [1]. Facing global competition and industrial transformation, Taiwan's Ministry of Education has commenced implementing higher technological and vocational education (HTVE) reforms since 1996. The reforms resulted in promoting ten former institutes of technology (IT) and seventy junior colleges (JC) to create forty-one universities of science and technology (UST) and thirty-seven institutes of technology up to 2009.

The Council for Economic Planning and Development (CPED), Executive Yuan, has issued the *Taiwan Technology Manpower Supply and Demand Analysis from 2005 to 2015* report. It points out that in regard to studies in the field of electrics (including electrical, electronics, telecommunications, information engineering, information management), an increasing number of junior colleges have restructured themselves into technological colleges, leading to a substantial growth in the number of university institutions with a resulting growth in the student body. The original junior colleges were equipped with their own electrical, information management and other related fields of study, which has added to the number of bachelor level electrical engineering and information science students [2].

The active promotion of the Taiwanese Two Trillion, Twin Star (T3S) industry (the four industries of semiconductor, display sectors, digital content and biotechnology), has driven the need for labour in the field of electrical engineering and information science to a much higher level. One could reasonably expect the growth in newly graduated electrical engineering students to fill this need, but the voices whispering about the lack of intermediate and high level technology professionals can still be heard from time to time. The reason appears to be that changes in the value chain of the industry have created a need for technology professionals to perform highly specialised duties.

Unfortunately, new graduates from technological institutes do not have the skills to meet these new industry requirements. Some undergraduates of technological institutes in Taiwan have shown low learning motivation and efficiency that caused the decrease in learning outcomes. The reason may be due to the lack of individual learning management. In the context of these aforementioned problems and requirements, how to enhance students' learning skills to maintain education quality becomes an important issue.

For educational psychologists, self-regulated learning is an extremely new concept. Self-regulated learning is when a learner consciously controls his or her initiatives and objectives regarding learning behaviour, motivation and cognition [3]. Recently, self-regulated learning has received significant attention from researchers, policy makers, educators and teachers as an important objective in today's school education. By providing students with these self-regulating techniques, teachers can not only guide students in self-learning within the classroom, but can also help students conduct self-education outside the classroom, thereby increasing their knowledge [4]. Numerous scholars have discovered that while university students have more control over course selection, time management, and actual study plans and implementation than primary or secondary students do, they also experience difficulties managing this study freedom. Therefore, they have requested that universities emphasise and teach self-regulated learning [4][5].

However, recent research has revealed that the self-regulated learning process involves multi-dimensional regulating behaviour. Not only do students have to regulate their cognitive and metacognitive strategies, at the same time, they must regulate their motivation and behaviour as well [6]. In other words, learners who only have the ability to self-regulate cannot learn effectively as they also need motivation to use their ability to self-regulate a s elf-regulating information processing strategy, a metacognitive strategy and more effective action. While the factors and perspectives that are included in the self-regulated learning process vary between different learners, the three most accepted factors in the process are learning motivation, action control and learning strategy [7][8].

Another point of focus is that self-regulated learning strategies (hereafter referred to as SRL strategies) are considered the link between possible and existing individual differences in learning characteristics. Bidjerano and Dai discovered a correlation between personality traits and SRL strategies, the openness to experience directly affected learning results, while conscientiousness and agreeableness indirectly affected learning results, through efforts to regulate cognitive strategy [9]. For this reason, researchers must consider learners' personality traits in the self-regulated learning process.

The objective of this study is to investigate multi-dimensional factors in the learning process of students at technological institutes. Then, using Taiwan's electronics industry, the industry with the most pressing human resource needs, basic technology competency training a learning model was constructed that included personality traits, learning motivation, action control and SRL strategies.

Next, in addition to verifying the model and observing the suitability of the factors, the relationship between the important factors in the model and the influence of their interaction on students' use of SRL strategies were examined, thereby providing a reference for future developments of self-regulated learning materials and lesson plans for students in technology institutes. Finally, the results were verified through experimental teaching to improve the quality of technology education in Taiwan.

LITERATURE REVIEW

Based on the research motivation and objectives of this study, the following section examines the relationship between personality traits and learning motivation, action control and SRL strategies, before explaining the relationship between learning motivation, action control and SRL strategies.

Big Five Personality Traits and Learning Motivation

Of the various personality models, the big five personality-traits model is the preferred model by educational psychologists. Learning motivation is the inner psychological process that creates particular learning activities, sustains these learning activities and encourages these learning activities to achieve the teacher's objective [10].

Numerous factors affect learning motivation, which can generally be divided into extrinsic and intrinsic factors. According to attribution theory, the level of learning motivation is significantly influenced by personality and experiences. For example, learning courses alluding to psychomotor - especially practical skill courses - consistently attract students' interest, stimulating their learning motivation. However, numerous teachers realise that a high degree of student interest and learning motivation does not mean that students' learning results will be equally high. In other words, students being extremely interested in and happy to study courses that teach some practical skill is not equivalent to students being able to master that skill easily.

Most students display a high level of learning motivation during the early stages of learning a skill. Later, students will feel frustrated and interrupt their learning or will ultimately be unable to learn the skill due to a lack of perseverance. This phenomenon shows that when learning a skill, a learner's own traits and attitude are crucial to the results [11].

Winter et al indicated that the interaction between motivation and personality traits influence an individual's behaviour [12]. Liu showed that personality traits and learning motivation were significantly correlated in some dimensions [13]. Numerous desirable personality traits were positively correlated to learning motivation and were significantly correlated to learning motivation implications.

The two dimensions of task values and self-efficacy and expectation of success were positively correlated with numerous learning motivation implications. Negative emotional neuroticism was negatively correlated with extroversion, agreeableness, conscientiousness, self-efficacy and expectation of success, and test anxiety. Another negative correlation exists between extrinsic goal orientation and test anxiety. Students who study from extrinsically set values are overly concerned with their own test performance, creating test anxiety.

In summary, while some personality traits are significantly correlated with dimensions of learning motivation, an additional and important personality trait variable in the learning process, action control, lacks examination and needs further verification.

Big Five Personality Traits and Self-Regulated Learning Strategies

Strategies are a type of systematic, planned decision related to goal orientation using an intrinsic psychological process to solve problems. Learning strategies are used by learners to increase their understanding of the studied content and to improve their performance of activities, skills and procedures [14]. Various learning methods are used to maintain good learning motivation, planning, supervision and regulated learning to engage in information processing and to facilitate substantial progress in intrinsic cognition structures.

Learning strategies are the core of self-regulated learning. Learning motivation does not guarantee learning and must be used along with the appropriate learning strategy. Zimmerman showed that SRL strategies comprise 14 types, including self-evaluation [15-17]. Pintrich and DeGroot; Pintrich et al indicated that strategic uses of self-regulated learning include cognition, metacognition and resource management. Cognitive strategies include review, elaboration, organisation and critical thinking. Metacognitive strategies are planning strategies, monitoring strategies and regulation learning strategies. Resource management strategies include time and environment control, effort control, peer learning and seeking help [18][19].

For the relationship between personality traits and SRL strategies, Blickle identified that within research regarding personality, learning strategies and learning achievement, learners with *openness to experience* and *conscientiousness* were significantly related to the use of SRL strategies. Learners with *openness to experience* were significantly related to the cognitive strategy of rehearsal, while learners with *conscientiousness* were significantly related to planning strategies in metacognitive strategies [20]. However, researchers contend that choosing SRL strategies is not based solely on differences in personality, but that the interactions of other factors are important. Therefore, individuals with identical personalities will not necessarily choose identical SRL strategies.

Learning Motivation, Action Control and SRL Strategies

To understand the learning process in a given field or circumstance for students in different stages, numerous studies have proposed verification learning models [21-23]. These models generally reveal that learning motivation directly affects action control and, through action control, indirectly affects SRL strategies. However, whether learning motivation will directly affect SRL strategies depends on the given field or circumstance.

Furthermore, to integrate learning motivation, action control and SRL strategies, and discover their relationship under normal learning, Cherng and Lin studied middle school students, proposing an action control intermediary model composed of three factors, learning motivation, action control and SRL strategies [24]. The model's hypothesis, that learning motivation had a direct effect on action control and SRL strategies, and that action control had a direct effect on SRL strategies was verified by statistical tests, showing that under normal learning, learning motivation should directly affect action control and SRL strategies and indirectly affect learning strategies through action control.

Overall, relevant literature has used differences in students' personalities as a foundation to examine the effect from an overall perspective of different personality traits on the learning process. Based on these works, this study constructed a learning process model for electrical engineering technology basic competency of students in technological institutes. This model included four components, personality traits, learning motivation, action control and learning strategies, and hypothesised that personality had a direct effect on learning motivation and SRL strategies, that learning motivation had a direct effect on action control and SRL strategies, and that action control had a direct effect on SRL strategies. The model was verified using statistical tests.

METHODS

Participants

The participants in this study were 200 students selected from the electrical engineering and technology departments of three science and technology universities in central Taiwan. After eliminating incomplete participant data, the effective sample comprised 188 students, of which 182 were male, six were female, 88 were university sophomores, and 100 were university juniors.

Theoretical Model

Focusing on learning in specialised subjects, this study proposed the Self-regulated Learning Process Theoretical Model of the Electrical Technology Basic Competency for students in technology institutes to explain empirical data. The model included four potential variables, personality traits, learning motivation, action control and learning strategies, of which personality traits was the potential independent variable, while the other three were the potential dependent variables. This study, then, hypothesised about the relationship between the four potential variables and determined that personality would directly affect learning motivation and SRL strategies; learning motivation would directly affect action control and SRL strategies; and action control would directly affect SRL strategies.

Measures

The study used a questionnaire survey to collect the needed research data. The content was based on the above research structure and the questionnaire contained the following five sections:

- Background Information: To understand the distribution of characteristics among the participants and to consider the background factors that might influence the participants' learning results, this study gathered information on participants' gender, school membership, grade level, method of admission and parents' profession.
- Mini-Marker Scale: This study measured the personality traits of students in electrical engineering and technology departments at technological institutes based on Costa and McCrae's five-factor model [25], and applied Saucier's mini-marker as the personality trait measuring instrument [26]. Personality traits were given a score on a scale between 1 and 9, where 1 meant the subject completely lacked the characteristic and 9 meant the subject completely exhibited the characteristic. For negative items, the scores were reversed. Through factor analysis, this section's GFI was 0.965, AGFI was 0.896, SRMR was 0.071, and all other indicators were ideal.
- Learning Motivation Scale: This study's learning motivation scale used an amended version of the Motivated Strategies for Learning Questionnaire (MSLQ) created by Pintich et al to measure the learning motivation in students of electrical engineering and technology departments in technological institutes [18][19]. The MSLQ is divided into three parts: the motivation scale, the cognitive scale; and the resource management scale. This study used the motivation questionnaire section as the instrument to measure students' learning motivation. This scale used a s even-point Likert scale, where 1 meant the participant completely lacked this item and 7 meant the participant completely possessed it. For negative items, the scores were reversed. Through factor analysis, this section's GFI was 0.976, AGFI was 0.944, SRMR was 0.035, and all other indicators were ideal.
- Action Control Scale: This study's action control scale was adapted from the classifications by some studies, and included attention control, emotion control, will control, environmental control, and others control [23][27-30]. This scale utilised a seven-point Likert scale, where 1 meant the participant completely lacked this item and 7 meant the participant completely possessed it. For negative items, the scores were reversed. Through factor analysis, this section's GFI was 0.940, AGFI was 0.819, SRMR was 0.033, and all other indicators were ideal.
- Learning Strategy Scale: This study applied the technology institute students-applicable learning strategy scale developed by Liang [31], which included the learner's cognitive strategy, metacognitive strategy and resource management strategy during the learning process. Cognitive strategy is the strategy used by learners to apply and deal with learning materials during the learning process, and includes strategies such as drill strategies, elaboration strategies, organisation strategies and critical thinking strategies. Metacognitive strategy is defined as consciousness, knowledge and control over cognition, with an emphasis on self-regulation and control, but also including planning, monitoring and effort regulation. Resource management strategy is a learner's management and supervision of the environment, time, people and other usable resources when engaging in a learning activity. This scale also used a seven-point Likert scale, where 1 meant the participant completely lacked this item and 7 meant the participant completely possessed it. For negative items, the scores were reversed. Through factor analysis, this section's GFI was 1.00, AGFI was 1.00, and all other indicators were ideal.

Data Analysis

This study conducted data analysis using AMOS 18.0 and PRELES 2.50 computer statistical ensemble software. After collecting and recording the data, PRELES 2.50 was used to test the multiple variable normal distribution hypothesis before AMOS 18.0 estimated the model parameters, using $\alpha = 0.05$ as the standard for statistical significance. According to the research of Hair et al investigating offending estimates can be used to rate the overall model fit and the fit of the internal structural [32].

Procedure

This study verified the research hypotheses primarily through Linear Structural Relation (LISREL). This procedure was divided into two stages of model development and analysis [32]. In the first stage, the measurement model allowed for separate analysis and, then, conducted confirmatory factor analysis for each variable to test the convergent validity of each dimension. In the second stage, the structural equation model was developed and analysed to verify the hypotheses. During verification, the study confirmed the fit of the theoretical model and, then, verified each individual hypothesis through individual path coefficient.

RESULTS

Descriptive statistics (mean and SD) and bivariate correlations are shown in Table 1 (see the end of article). As can be seen in Table 1, Extroversion had small correlations with Attention control ($r = 0.167$, $p<0.05$), Motivation control ($r =$

0.227, p<0.01), Emotion control (r = 0.174, p<0.05), Cognition strategy (r = 0.252, p<0.01), Metacognition strategy (r = 0.269, p<0.01), and Resource Management strategy (r = 0.212, p<0.01). Agreeableness had small correlations with Intrinsic motivation (r = 0.199, p<0.01), Control belief (r = 0.175, p<0.05), Attention control (r = 0.196, p<0.01), Motivation control (r = 0.153, p<0.05), Emotion control (r = 0.163, p<0.05), and Others control (r = 0.182, p<0.05). Conscientiousness had small correlations with Intrinsic motivation (r = 0.279, p<0.01), Extrinsic motivation (r = 0.215, p<0.01), Task value (r = 0.254, p<0.01), Control belief (r = 0.228, p<0.01), Motivation control (r = 0.290, p<0.01), Emotion control (r = 0.189, p<0.05), Others control (r = 0.200, p<0.05), Resource Management strategy (r = 0.222, p<0.01.). Conscientiousness also had medium correlations with Self-efficiency (r = 317, p,0.01), Attention control (r = 0.320, p<0.01), Cognition strategy (r = 0.371, p<0.01), and Metacognition strategy (r = 0.365, p<0.01).

Openness to experience had small correlations with Intrinsic motivation (r = 0.271, p<0.01), Extrinsic motivation (r = 0.193, p<0.01), Task value (r = 0.221, p<0.01), Control belief (r = 0.212, p<0.01), Motivation control (r = 0.218, p<0.01), Emotion control (r = 0.243, p<0.01), Others control (r = 0.236, p<0.01.), Resource Management strategy (r = 0.211, p<0.01). It also had medium correlations with Self-efficiency (r = 365, p,0.01), Attention control (r = 0.305, p<0.01), Cognition strategy (r = 0.302, p<0.01), and Metacognition strategy (r = 0.341, p<0.01). Neuroticism only had small correlations with Test anxiety (r = -0.194, p<0.01).

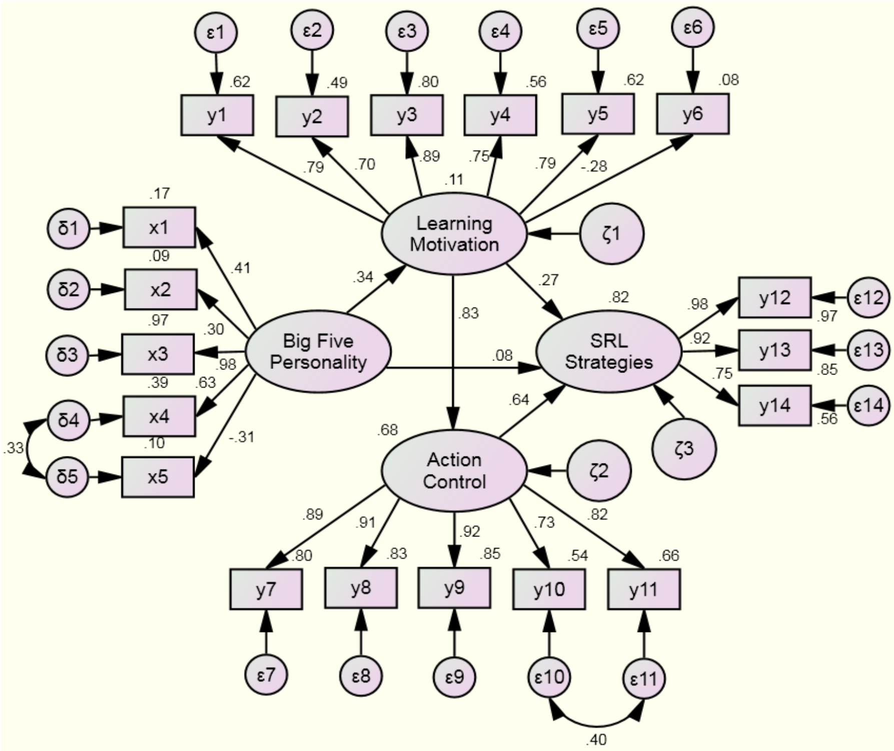

Figure 1: Model of a Self-regulated Learning Process Model of the Electrical Technology Basic Competency (Standardised solution; N = 188).

To establish whether the theoretical model in Figure 1 is tenable, this study used AMOS 18.0 statistical software to evaluate the fit. The software's assumed parameter estimation method is maximum likelihood (ML), therefore, the hypotheses regarding the number of samples and the multi-variant normal distribution were rigorously demanding and the observed indicators in the measurement model should conform to the one-dimension standard. For this reason, the following theoretical models were developed and constructed.

Measurement Model One Dimension Testing

To test the one dimension hypothesis, the study first conducted factor analysis on the correlation matrix between observed indicators in the same concept. The size of the characteristic's value was then used to explain accumulated variation and to determine whether a significant factor existed. If only one significant factor existed, then, the one dimension hypothesis held; if no significant factors existed, it was determined that the one dimension hypothesis was disproved. The measurement model one dimension testing for this study indicated that personality traits, learning motivation, action control and SRL strategies all included a factor value significantly greater than 1, meaning that the observed indicators for each variable conformed to the one dimension standard.

Single Variable and Multivariable Normal Distribution Testing

Regarding the multivariable normal distribution hypothesis, the researcher first tested the scale data for single variable and multivariable normal distribution to confirm whether it violated the ML method basic hypothesis on multivariable normal distribution. After testing, it was discovered that of the 19 observed variables, only 9 variables were significant when tested for single variable distribution, meaning that the observed variables were abnormally distributed. Furthermore, the multivariable normal distribution test also achieved significance, meaning that the multivariables were also abnormally distributed.

When a scale does not appear to have multivariable normal distribution, using the ML method to estimate the model parameters will produce inaccurate standards, and the chi-square fit will also be incorrect. Therefore, this study switched its observed variable score to standard score and reanalysed the structural equation model. The average score, standard deviation and normal distribution test for each observed variable adjusted for standardisation conformed to single variable normal distribution. For multivariable normal distribution, the χ^2 value for the multivariable normal test decreased from a pre-shift 505.1 to 272.78, conforming to the multivariable normal distribution hypothesis.

Model Fit Rating

- Model Basic Fit Test: Before rating the model, the range of acceptable estimated parameters must first be firmly established to avoid inappropriate explanations. Three rules exist for basic fit rating: 1) measurement error for indicators must achieve a level of significance and cannot be negative; 2) standardised coefficients (the load capacity for internal hidden observable indicators) cannot exceed 1 or be close to 1, as λ (factor loading) ideally needs to be between 0.5 and 0.95; and 3) all estimated coefficients cannot have excessive standard errors [33]. The ratings revealed that error deviations were all positive without any offending estimates. Next, although conscientiousness and cognitive strategy slightly exceeded 0.95, because the corresponding estimate was positive, they still achieved significance ($p<0.001$) and, therefore, did not directly impede model recognised demands. According to Table 1, the correlative interaction for a majority of the 14 observed indicators in the model achieved the 0.05 level of significance. Besides the low correlation between neuroticism, test anxiety and other variables, all other variables were at least correlated at a middle level. In summation, this model did not create offending estimates.
- Model Modification: Next, the modification index provided by AMOS 18.0 was used to test model modification. First, in the same measurement model, the measurement errors between action control's *environment control* and *other control* had the highest MI estimate (26.52), while the measurement errors between personality traits *openness to experience* and *neuroticism* had the second highest MI estimate (12.72). However, due to the fact that these two indicators measure the same potential concept, and due to the crisscrossing connection between the topics, the potential connection between these two measurement errors is easy to understand, and the source of these mutual errors is reasonable. Therefore, the researcher changed the above two groups of observable variables and fixed parameters to free parameters, allowing the model to better fit the observed data. This modified conception model is called the *theoretical medication model*.

The Overall Model Fitness for the Learning Process

The overall fitness can be evaluated from absolute fitness, incremental fitness and parsimonious fitness. First, if the normed chi-square value for the fitness of the theoretical model and the observed data reaches the 0.05 level of significance ($\chi^2(14) = 335.71$, $p<0.05$), the null hypothesis regarding the equivalence of the covariant matrix for the theoretical model and the observed data must be refused. However, some studies contend that the model fitness test normed chi-square values will fluctuate with the sample size and, therefore studies should not be overly dependent on normed chi-squares when rating a model's fitness. Instead, multiple indicators need to be considered for an overall determination [33][34]. For this reason, parameters in this study consider other fit measures. The following three aspects were used to rate the model's fitness:

- Absolute Fit Measures: For absolute fit measures GFI = 0.847, slightly lower than the accepted 0.90; RMSEA = 0.084, which is between 0.1 and 0.05, meaning the model is acceptable.
- Incremental Fit Measures: For incremental fit measures NFI = 0.88, near the acceptable value of 0.90; CFI = 0.927, greater than 0.90; IFI = 0.928, also greater than 0.90. These measurements indicate that the model is acceptable.
- Parsimonious Fit Measures: Parsimonious fit measures normed chi-squares = 2.315, which is between 2 and 3, conforming to the indicator standards; PNFI = 0.746, higher than the acceptable value of 0.500, PGFI = 0.646, greater than the acceptable value of 0.5, so the model is acceptable.

Overall, the above fitness measurement analysis indicates that the theoretical modification model conforms to empirical data. The complete standardised paths of coefficient for the modification model are displayed in Figure 1.

Direct, Indirect and Total Effects

Before confirming the fitness of the theoretical modification model with observed statistics, the effect between potential variables were calculated, including direct effect, indirect effect and total effect [16]. This study used the effect between variables to expound on the relationships between each primary variable. Direct, indirect and total effects allow one to understand the potential independent variable's direct effect on the dependent variables and the indirect impact through other potential dependent variables. Total effect is the sum of direct and indirect effects. The above test helped to explain the structural linear relationship between variables, outlined below:

- Direct Effects: Direct effect is the path coefficient between two potential variables. Table 2 shows that personality's direct effect on learning motivation is 0.338, learning motivation's direct effect on action control is 0.826, learning motivation's direct effect on learning strategies is 0.269, and action control's direct effect on learning strategy is 0.641. These paths are all significant (p<0.001) and personality's direct effect on learning strategies (0.085) also achieved significance (p<0.05).
- Indirect Effects: Table 3 shows the indirect effects between potential variables. Personality traits' indirect effect on action control was 0.279, its indirect effect on SRL strategy was 0.270, and learning motivation's indirect effect on SRL strategy was 0.529. These paths all achieved significance (p<0.001).
- Total Effects: Total effect is the sum of direct and indirect effects. Table 4 shows that the total effects of personality traits on learning motivation, action control and SRL strategy were 0.336, 0.279 and 0.354, respectively; the total effect of learning motivation on action control and SRL strategies was 0.826 and 0.799, respectively; and the total effect of action control on SRL strategy was 0.641. These paths were all significant (p<0.001).

Table 2: Direct effects between latent variables.

Latent Variables	1	2	3	4
1. Big five personality	0.000	0.000	0.000	0.000
2. Learning motivation	0.338***	0.000	0.000	0.000
3. Action control	0.000	0.826***	0.000	0.000
4. SRL strategies	0.085*	0.269***	0.641***	0.000

*p<0.05, **p<0.01, ***p<0.001

Table 3: Indirect effects between latent variables.

Latent Variables	1	2	3	4
1. Big five personality	0.000	0.000	0.000	0.000
2. Learning motivation	0.000	0.000	0.000	0.000
3. Action control	0.279***	0.000	0.000	0.000
4. SRL strategies	0.270***	0.529***	0.000	0.000

*p<0.05, **p<0.01, ***p<0.001

Table 4: Total effects between latent variables.

Latent Variables	1	2	3	4
1. Big five personality	0.000	0.000	0.000	0.000
2. Learning motivation	0.338***	0.000	0.000	0.000
3. Action control	0.279***	0.826***	0.000	0.000
4. SRL strategies	0.354***	0.799***	0.641***	0.000

*p<0.05, **p<0.01, ***p<0.001

DISCUSSION AND CONCLUSIONS

The majority of problems for technology institute students' learning specialised technology basic competency stems from issues that arise during the self-learning process. If the factors which affect the students' learning process can be improved, the difficulty in learning specialised competency will decrease proportionally. This study systematically integrated attribution theory and action control theory in a theoretical model to construct a learning process theoretical model for the electrical technology basic competency in students enrolled in technological institutes. Based on the investigations by relevant literature confirming the learning process for technological basic competency and after using SEM to analyse the collected data, the research results were obtained using the model. The results of the study are as follows.

First, regarding the effect of potential variables, the results showed that action control had the strongest direct effect on SRL strategies, followed by learning motivation and personality traits. However, the indirect and total effects between learning motivation and SRL strategies were the greatest.

Concerning the causality between personality traits and SRL strategies, the research results indicated that the direct effect of personality on learning motivation or SRL strategies both achieved the 0.05 level of significance. Personality indirectly influenced SRL strategies primarily through learning motivation and action control, and this effect was significantly greater than the direct effect of personality traits on SRL strategies. These results support the relationship between personality and the above variables [9][12][35].

Next, for the causality between learning motivation and SRL strategies, the results revealed that the direct effect of learning motivation on action control or SRL strategies achieved the 0.05 level of significance. Learning motivation, through action control, also indirectly affected SRL strategies to a significantly greater degree than the direct effect.

The study also attempted to test the relationship between personality traits and action control, discovering that the direct effect of individual characteristics on action control was insignificant. To develop a correlation with action control, personality traits must go through the intermediary of learning motivation. This result supports prior research results on action control [21][36], that action control is an important intermediary between learning motivation and SRL strategies that can expand the impact of learning motivation on SRL strategies. In other words, if students can develop a willingness to learn and convert these intentions into action, it will facilitate more complete intention strategies and behaviour.

According to these results and discussion, this study echoes attribution theory, contending that learners' own personality traits will influence the next stage of learning intentions. The positive response from students' personality will interact with students' personality traits to affect the strength, direction and outcome of their behaviour. This repetitive process influences the learning process for technology basic competency. Furthermore, action control theory also supports this research, believing that a student's positive response will create intent on the following desire. However, to confirm the sustainability and completion of this action, learners must concentrate on the use of SRL strategies through significant effort and protection.

Finally, the learning process model established by this study can be used to establish the variables and factors that affect the skill-learning achievements of students in technology institutes, and increase understanding of students' learning problems and difficulties. Therefore, the factors that affect the learning process can provide a reference consideration when developing and improving courses and teaching. For example, integrating self-regulated learning into coursework could improve students' self-regulated learning abilities, enhancing their technological basic competency achievements.

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Table 1: Inter-correlations among big five personality traits, learning motivation, action control and SRL strategies.

	M	SD	x1	x2	x3	x4	x5	y1	y2	y3	y4	y5	y6	y7	y8	y9	y10	y11	y12	y13	y14
x1	5.38	1.25	1																		
x2	6.01	0.85	0.040	1																	
x3	5.80	1.11	0.402**	0.297**	1																
x4	5.29	1.18	0.286**	0.083	0.616**	1															
x5	4.50	1.07	-0.113	-0.175*	-0.309**	0.048	1														
y1	4.85	0.90	0.118	0.199**	0.279**	0.271**	-0.003	1													
y2	4.89	0.97	-0.057	0.091	0.215**	0.193**	0.111	0.525**	1												
y3	4.79	1.00	0.077	0.133	0.254**	0.221**	-0.006	0.696**	0.665**	1											
y4	5.20	0.94	0.068	0.175*	0.228**	0.212**	0.020	0.593**	0.517**	0.698**	1										
y5	4.45	0.98	0.138	0.007	0.317**	0.365**	0.062	0.566**	0.515**	0.723**	0.573**	1									
y6	3.80	0.88	0.094	0.070	0.034	-0.062	-0.194**	-0.270**	-0.297**	-0.209**	-0.140	-.0240**	1								
y7	4.67	0.83	0.167*	0.196**	0.320**	0.305**	-0.039	0.575**	0.449**	0.585**	0.521**	0.627**	-0.242**	1							
y8	4.68	0.92	0.227**	0.153*	0.290**	0.218**	-0.102	0.661**	0.578**	0.684**	0.516**	0.617**	-0.327**	0.807**	1						
y9	4.78	0.86	0.174*	0.163*	0.329**	0.243**	-0.071	0.661**	0.541**	0.682**	0.591**	0.583**	-0.205**	0.842**	0.833**	1					
y10	4.51	0.85	0.150*	0.147*	0.189**	0.129	0.076	0.442**	0.408**	0.463**	0.383**	0.474**	-0.275**	0.672**	0.687**	0.658**	1				
y11	4.71	0.81	0.124	0.182*	0.200**	0.236**	0.075	0.594**	0.412**	0.546**	0.487**	0.517**	-0.264**	0.733**	0.733**	0.753**	0.754**	1			
y12	4.60	0.79	0.252**	0.140	0.371**	0.302**	-0.034	0.721**	0.537**	0.691**	0.609**	0.684**	-0.188**	0.759**	0.812**	0.805**	0.627**	0.716**	1		
y13	4.51	0.88	0.269**	0.102	0.365**	0.341**	-0.009	0.631**	0.471**	0.602**	0.546**	0.658**	-0.240**	0.716**	0.745**	0.727**	0.640**	0.690**	0.907**	1	
y14	4.33	0.61	0.212**	0.110	0.222**	0.211**	0.050	0.493**	0.381**	0.447**	0.390**	0.461**	-0.210**	0.697**	0.644**	0.679**	0.625**	0.714**	0.730**	0.698**	1

$^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$

*Note:*x1 = Extroversion; x2 = Agreeableness; x3 = Conscientiousness; x4 = Openness to experience; x5 = Neuroticism; y1 = Intrinsic motivation; y2 = Extrinsic motivation; y3 = Task value; y4 = Control belief; y5 = Self-efficacy; y6 = Test anxiety; y7 = Attention control; y8 = Motivation control; y9 = Emotion control; y10 = Environment control; y11 = Others control; y12 = Cognition strategy; y13 = Metacognition strategy; y14 = Resource Management strategy