Development of a causal model of self-regulated learning by students at Loei Rajabhat University

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Research Article

Keywords: Self-regulated learning, causal model, self-efficacy, achievement motive, learning by imitation

Posted Date: June 26th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-3044239/v1

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Abstract

Background

Self-regulation learning are behaviors based on the concepts of self-regulation and learning in social cognitive theory. Self-regulation is the process of controlling one's own thoughts, behaviors, and emotions to acquire new skills through one's own motivation and action. Examining the congruence between a causal model of self-regulated learning and empirical data, as well as investigating the direct and indirect effects, were the aims of this study.

Methods

In the model for 660 students at Loei Rajabhat University, the data were analyzed using structural equation modeling, which is implemented in the LISREL software package.

Results

The research results show that the causal model of self-regulated learning was congruent with the empirical data. Self-efficacy, achievement motive, and learning by imitation had direct effects on self-regulated learning at a statistical significance of 0.01, while achievement motive and learning by imitation had indirect effects on self-regulated learning via the self-efficacy variable with a statistical significance of 0.01. The variables of learning by imitation and achievement motive were able to explain the variance of the variables of self-regulated learning and self-efficacy at percentages of 73.60% and 72.10%, respectively.

Conclusions

This research suggests that teachers should organize teaching and learning activities that promote achievement motivation and develop self-efficacy, and they should be good role models for students. All parties, including administrators, should implement policies that promote and develop activities to create incentives for achievement. Self-efficacy and learning by imitation are necessary for students to practice self-regulated learning in the future.

1. Background

In the Twelfth National Economic and Social Development Plan B.E. 2560–2564 (2017–2021) [1], Strategy 1 on the potential promotion and development of human capital sets the goal of all Thai people of all ages possessing skills, knowledge, and ability as a basis for national development through lifelong learning. This is because education is a mechanism for developing people's quality of life so that they can live happily in society in accordance with the prevailing and rapidly advancing economic, environmental, social, and technological conditions. Moreover, most behavioral psychologists view the act of learning as being different from learning according to social cognitive theory, which focuses on the internal behavior of a person. For instance, the learning theory of Bandura [2] assumes that people learn through observation, modeling, and reinforcement; this theory is rooted in social perception theory, focusing on social factors in human behavioral development.

The theory of self-regulated learning (SRL) focuses on the involvement of an individual learner in three processes: (i) cognition is the learner's mental process of perceiving, processing, and storing new data, involving aspects such as interest, memory, and problem-solving; (ii) metacognition is the learner's perception and control of their own strengths and weaknesses, ability to plan and monitor their own learning, and ability to reflect on their own learning experience, involving aspects such as planning, examination, and evaluation; (iii) motivation is an internal and external factor affecting the
learner's involvement, effort expenditure, and persistence to learn, involving aspects such as goal-setting, self-efficacy, and self-determination [3]. SRL is not a static process but is instead constantly changing and dynamic, and can be improved by training or instruction [4]. SRL is behavior that is based on the concepts of self-regulation and learning in social cognitive theory. Self-regulation is the process of using various strategies to regulate thoughts, behaviors, and emotions in order to learn different skills via one's own motivation and action [5]. Self-regulation has three causes: person, environment, and behavior, all of which have interdependent effects which change with each factor [6]. The process of self-regulation involves three steps. (i) Self-observation helps a person to perceive their own actions; this is important because successful self-regulation partly results from clear, regular, and accurate observation. Therefore, self-regulation enables a person to accurately diagnose conditions in order to express or adjust their behaviors. (ii) Self-judgment uses information from self-observation by comparing it with certain criteria before making a judgment to change one's own behavior. Self-judgment affects behavioral change when the outcome is valuable enough and concerns one's own ability and action. (iii) Self-reaction is a process that depends on each person's decision benchmark and obtained outcome: for example, if a person achieves a specified standard, then they will reward themselves; in contrast, if they do something below a specified standard, then they usually react by punishing themselves. In addition, self-reaction can be either observable (e.g., working harder) or unobservable (e.g., a sense of pride). Therefore, SRL is an important behavior for learners in the 21st century because it can regulate and guide learners to continue studying outside of class in order to develop their knowledge, understanding, and skills; in an age with quick access to information without time and place limitations, learners can study using technological media [7]. Learners without SRL usually face both academic and behavioral problems at school [8].

It is essential to study the background or causes of self-regulation, so this study focuses on SRL by reviewing previous research that included variables that affect self-regulation. Many researchers have studied the relationship between different variables and SRL. For example, some scholars have studied the relationship between achievement motive (MOT) and SRL, finding that achievement motive had a significant effect on SRL [4, 9–12]. Meanwhile, other researchers studied self-efficacy (SEE) and SRL, finding that self-efficacy had a significant effect on SRL [11, 13–16]. Scholars have also studied learning by imitation and SRL, finding that learning by imitation (LIM) had a significant effect on SRL [17–21]. Thus, these studies demonstrate that students who have a high level of achievement motive, self-efficacy, and learning by imitation will have a high level of self-regulation in their learning.

Against the above background, the present authors were interested in developing a causal model of SRL by students at Loei Rajabhat University (LRU) in order to obtain data to guide the development of student potential. It is hoped that teachers and administrators will use the model as a guideline for developing students’ SRL, leading to students’ development in their future occupations, as well as benefiting society and the country more broadly. The research objectives were as follows: (i) to examine the congruence between the model and empirical data; (ii) To investigate the direct and indirect impacts of achievement incentive, self-efficacy, and learning by imitation on self-regulated learning according to the model. We make the following assumptions:

H1: SEE will positively affect the SRL.

H2: MOT will positively affect the SRL SEE, and SEE plays a mediating role.

H3: LIM will positively affect the SRL SEE, and SEE plays a mediating role.

2. Methods
2.1. Population and sample

This survey research was a descriptive investigation of a causal model of SRL by LRU students. The study population comprised 12,279 undergraduate students from five faculties at LRU in the 2022 academic year, and the sample size was estimated using the LISREL software package. Schumacker and Lomax [22] suggested the rule of thumb of using a sample
size of 10–20 per estimated parameter; in the present study, the estimation involved 29 parameters, so the authors determined the sample size using the ratio of 20 participants per parameter and obtained a sample size of no fewer than 580 participants. Proportional stratified random sampling was then used to select undergraduate students at LRU in the 2022 academic year. The number of participants in each stratum was calculated proportionally based on the sample size and the population in each strata, with an additional 20% of participants selected from each faculty to mitigate against missing data due to non-respondents and to obtain adequate coverage for the data analysis. Consequently, the final sample comprised 660 undergraduate students: 219 were male (33.20%) and 441 were female (66.80%). Within the sample, 173 respondents were from the Faculty of Education (26.20%), 142 were from the Faculty of Science and Technology (21.50%), 151 were from the Faculty of Humanities and Social Sciences (22.90%), 171 were from the Faculty of Management Science (25.90%), and 23 were from the Faculty of Industrial Technology (3.50%).

2.2. Study variables

The endogenous latent variable was SRL as measured by three observed variables in [20] and [8]. These are summarized as components as follows: (i) self-observation (SEO), (ii) self-judgment (SEJ), and (iii) self-reaction (SER). The mediator latent variable was self-efficacy (SEE) as measured by three observed variables in [23] and [24]. These are summarized as components as follows: (i) choice behavior (CHO), (ii) effort expenditure and persistence (EEP), and (iii) thought and emotion reaction (TER). The exogenous latent variables were achievement motive (MOT), which was measured by three observed variables in [23] and [24]. These are summarized as components as follows: (i) energetic (ENE), (ii) individual responsibility (IND), and (iii) ambition (AMB) and learning by imitation (LIM) were measured by two observed variables in [19] and [20]. These are summarized as components as follows: (i) peer imitation (PIM) and (ii) teacher imitation (TIM).

2.3. Research framework

Based on the SRL literature, the variables used in the present study were synthesized from previous studies, and all the synthesized variables were summarized into a framework based on Bandura's social cognitive learning to develop the present causal model of SRL by LRU students. In the causal model, SEE, MOT, and LIM have direct effects on SRL, and MOT and LIM have indirect effects on SRL by transmission through SEE. The research framework is shown schematically in Fig. 1.

2.4. Instrument for data collection

The instrument for data collection was a three-part questionnaire about the SRL of students at LRU: Part 1 covered basic data on the respondents in terms of gender, educational level, and faculty, Part 2 covered SRL, and Part 3 covered the variables affecting SRL, i.e., SEE, MOT, and LIM. The questionnaire used a five-level rating scale (1 = minimum, 5 = maximum), and after it was developed, the questionnaire was tested for content validity by five experts. The results showed that all items had an item-level content validity index (CVI) higher than 0.78, and the scale-level CVI was 0.91, higher than the specified criterion of no less than 0.90 [25]. The questionnaire contained 58 items in total: three on basic respondent data, such as gender, education level, and faculty, 15 on SRL in three aspects, 15 on SEE in three aspects, 15 on MOT in three aspects, and 10 on LIM in three aspects. After validation, the questionnaire was revised and improved before being tested on another group of 100 students similar to the sample, i.e., 20 students from each faculty. The results were used to examine the quality of the instrument by calculating the corrected item-total correlation (CITC) with Pearson's correlation coefficient; the criterion for selection was a discrimination power of 0.20–1.00. The reliability was then calculated to find the Cronbach’s alpha coefficient; according to George and Mallery [26], the reliability should be moderate (0.70) or higher. The questionnaire was classified according to each variable as follows.

The SRL is based on the models of Susuk [20] and Chianchana et al. [8]. Part of the questionnaire included 15 items with a discrimination power of 0.623–0.789 and a reliability of 0.946. It contained three factors, each of which comprised five items: (i) SEO (e.g., A student concentrates on their work during class. A student develops learning goals) with a discrimination power of 0.617–0.717 and a reliability of 0.864; (ii) SEJ (e.g., A student is free to choose how to study. A student can determine how to study) with a discrimination power of 0.617–0.717 and a reliability of 0.864; (iii) SER (e.g., A student is free to choose how to study. A student can determine how to study) with a discrimination power of 0.617–0.717 and a reliability of 0.864; (iv) MOT (e.g., A student is energetic. A student is determined to do well in their studies) with a discrimination power of 0.617–0.717 and a reliability of 0.864; (v) LIM (e.g., A student imitates peers. A student imitates teachers) with a discrimination power of 0.617–0.717 and a reliability of 0.864.
student reviews their own work) with a discrimination power of 0.609–0.819 and a reliability of 0.874; (iii) SER (e.g., A student looks for ways to better themselves in order to get better grades. A student examines their own methods of learning) with a discrimination power of 0.790–0.844 and a reliability of 0.913.

The SEE is based on the models of Thammawong [23] and Lokthaisong [24]. Part of the questionnaire included 15 items with a discrimination power of 0.530–0.751 and a reliability of 0.925. It contained three factors, each of which comprised five items: (i) CHO (e.g., A student is free to select their own learning activities. A student thinks the chosen learning exercises are appropriate for his or her skill level) with a discrimination power of 0.580–0.809 and a reliability of 0.884; (ii) EEP (e.g., A student will never attempt learning again if they believe it to be too difficult and complex. A student is assured that success is achievable if they put in the necessary time and effort) with a discrimination power of 0.429–0.750 and a reliability of 0.799; (iii) TER (e.g., A student looks forward to classwork. A student has anxiety while studying in class) with a discrimination power of 0.523–0.773 and a reliability of 0.859.

The MOT is based on the models of Thammawong [23] and Lokthaisong [24]. Part of the questionnaire included 15 items with a discrimination power of 0.655–0.790 and a reliability of 0.949. It contained three factors, each of which comprised five items: (i) ENE (e.g., A student will perform optimally on their assignments. A student will always complete assignments to the best of their ability) with a discrimination power of 0.685–0.830 and a reliability of 0.908; (ii) IND (e.g., A student is motivated to put in the necessary effort to meet the objectives. A student doesn't need to ask for commands or directions to complete tasks; they can be completed independently by the learner) with a discrimination power of 0.850–0.891 and a reliability of 0.951; (iii) AMB (e.g., A student aspires to lead by example among his or her peers. A student works hard in class to outperform the other students) with a discrimination power of 0.566–0.933 and a reliability of 0.924.

The LIM is based on the model of Choeysuwan [19] and Susuk [20]. Part of the questionnaire included 10 items with a discrimination power of 0.528–0.787 and a reliability of 0.911. It contained two factors, each of which comprised five items: (i) PIM (e.g., A student observes peers who examine material in their spare time. A student will imitate their peers when they spend their spare time learning new things) with a discrimination power of 0.658–0.777 and a reliability of 0.883; (ii) TIM (e.g., A student plans assignments in accordance with teachers' instructions. A student follows their lecturers while they conduct online and library research) with a discrimination power of 0.732–0.887 and a reliability of 0.938.

2.5. Data analysis

The scale was examined on scores according to the criteria and was analyzed using the basic statistics of mean, standard error, standard deviation, minimum and maximum, and normal distribution considering skewness and kurtosis. Pearson's correlation coefficient was then used to test the congruence between the hypothesized model and empirical data, and the fitness index was used in the LISREL software package for the data analysis. The criterion values for the model fit coefficients were as follows: 0.05 < p ≤ 1.00; 0 < χ² / df ≤ 2; 0.95 ≤ GFI ≤ 1.00; 0.95 ≤ AGFI ≤ 1.00; 0 < RMSEA ≤ 0.05; 0 < SRMR ≤ 0.05; 0.95 ≤ NFI ≤ 1.00; 0.97 ≤ CFI ≤ 1.00; CN ≥ 200 [27]. In addition, the path coefficient was analyzed in the causal model to examine the direct effect (DE), indirect effect (IE), and total effect (TE) of different variables in the model in order to study the direct and indirect effects on SRL by LRU students.

3. Results

3.1. Descriptive statistical analysis of variables

The means (M) of the latent variables were between 3.484 and 3.795. The mean of self-efficacy was the highest (M = 3.795), followed by achievement motive, self-regulated learning, and learning by imitation (M = 3.746, 3.672, and 3.484, respectively). The standard deviation (S) ranged from 0.647 to 0.733. Learning by imitation variables were discovered to be significant when the coefficient of variation (CV) of the variables was taken into account. The data were distributed most widely (CV = 21.032), followed by the achievement motive variable (CV = 18.202) and the self-regulation learning variable.
(CV = 17.904), while the self-efficacy variable had the lowest distribution coefficient (CV = 17.058). Considering the skewness (Sk) of the variables, all variables were left skewed. Since there was a statistically significant negative value at the 0.01 level, it showed that most students had a higher opinion level of the variable than the average. In terms of kurtosis (Ku), it was found that all variables had positive kurtosis with statistical significance at the 0.05 and 0.01 levels. The distribution characteristics of the variables were curved higher than normal (leptokurtic), showing that the students had a high degree of agglutination behavior.

3.2. Correlation coefficients between variables observed in the model

Pearson's correlation coefficient analysis between all 52 pairs of observed variables found that none of the correlation coefficients was greater than 0.800. All variables were significantly correlated at the .01 level with correlation coefficients ranging from 0.276 to 0.747. These results are given in Table 1.

<table>
<thead>
<tr>
<th>variables</th>
<th>SRL</th>
<th>SEE</th>
<th>MOT</th>
<th>LIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEO</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEJ</td>
<td>.747**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SER</td>
<td>.610**</td>
<td>.639**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>CHO</td>
<td>.542**</td>
<td>.594**</td>
<td>.518**</td>
<td>1</td>
</tr>
<tr>
<td>EEP</td>
<td>.531**</td>
<td>.537**</td>
<td>.495**</td>
<td>.648**</td>
</tr>
<tr>
<td>TER</td>
<td>.524**</td>
<td>.543**</td>
<td>.488**</td>
<td>.665**</td>
</tr>
<tr>
<td>ENE</td>
<td>.607**</td>
<td>.637**</td>
<td>.530**</td>
<td>.615**</td>
</tr>
<tr>
<td>IND</td>
<td>.581**</td>
<td>.653**</td>
<td>.516**</td>
<td>.531**</td>
</tr>
<tr>
<td>AMB</td>
<td>.463**</td>
<td>.536**</td>
<td>.448**</td>
<td>.485**</td>
</tr>
<tr>
<td>PIM</td>
<td>.419**</td>
<td>.411**</td>
<td>.337**</td>
<td>.276**</td>
</tr>
<tr>
<td>TIM</td>
<td>.465**</td>
<td>.501**</td>
<td>.411**</td>
<td>.430**</td>
</tr>
<tr>
<td>S</td>
<td>0.737</td>
<td>0.753</td>
<td>0.748</td>
<td>0.751</td>
</tr>
</tbody>
</table>

Bartlett's test of sphericity $\chi^2 = 4519.193 \ (p = 0.000)$, KMO = 0.915

Notes: SRL—self-regulated learning; SEO—self-observation; SEJ—self-judgment; SER—self-reaction; SEE—self-efficacy; CHO—choice behavior; EEP—effort expenditure and persistence; TER—thought and emotion reaction; MOT—achievement motive; ENE—energetic; IND—individual responsibility; AMB—ambition; LIM—learning by imitation; PIM—peer imitation; TIM—teacher imitation. **p < 0.01, *p < 0.05.

3.3. Data analysis according to research objectives

Examination of the causal model of SRL by LRU students showed that the model was not congruent with the empirical data. ($\chi^2 = 107.615, df = 38, p = 0.000, GFI = 0.971, AGFI = 0.950, RMSEA = 0.053, SRMR = 0.024, NFI = 0.989, CFI = 0.993, CN = 359.801$). The model was then adjusted by the researcher to be compatible with the empirical facts, taking into account its applicability and theoretical feasibility. The researcher changed the values in the THETA-DELTA (TD) and THETA-DELTA-EPS (TH) matrices as follows: TD (3,2) TD (4,3) TH (2,5) TH (4,1) TH (4,3) TH (2,1) TH (3,4). This was done one by one according to the program's instructions until the model agreed with the empirical data and showed that the model was congruent with.
the empirical data ($\chi^2 = 38.404, df = 31, p = 0.169, GFI = 0.990, AGFI = 0.978, RMSEA = 0.019, SRMR = 0.015, NFI = 0.996, CFI = 0.999, CN = 882.315$). For the 11 observed variables, their reliability was in the range of 0.484–0.859, with the highest reliability in TIM ($R^2 = 0.859$) followed by ENE ($R^2 = 0.796$), and the lowest reliability in AMB ($R^2 = 0.484$). For the forecasting coefficient ($R^2$) in the structural equation of the latent variables, the values for SRL and SEE were 0.736 and 0.721, respectively, indicating that LIM and MOT could explain the variance of SRL and SEE at 73.60% and 72.10%, respectively, as shown in Fig. 2. The results for the sizes of the direct and indirect effects among the studied variables are described below.

### 3.3.1. Self-efficacy (SEE)

Regarding the direct effects on SEE, the study found that MOT and LIM had direct effects on SEE at a statistical significance of 0.01. MOT had a positive effect on SEE with an effect value of 0.769, higher than the direct effect of LIM with a positive effect of 0.129. This indicates that students with high MOT and LIM had high SEE as well.

### 3.3.2. Self-regulated learning (SRL)

Regarding the direct and indirect effects on SRL, it was found that SEE, MOT, and LIM had direct effects on SRL at a statistical significance of 0.01 with effect sizes of 0.316, 0.460, and 0.169, respectively, indicating that students with high SEE, MOT, and LIM had high SRL in terms of SEO, SEJ, and SER. Moreover, MOT also had an indirect effect on SRL at a statistical significance of 0.01 with an effect size of 0.243 by transmission through SEE, and LIM had an indirect effect on SRL at a statistical significance of 0.01 with an effect size of 0.041 by transmission through SEE. Comparing the direct and indirect effects on SRL, the direct effect of MOT (0.460) was higher than its indirect effect (0.243), and the direct effect of LIM (0.169) was higher than its indirect effect (0.041). These results are given in Table 2.
Table 2
Statistical results for causal model of SRL by students at LRU.

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>LIM</th>
<th>MOT</th>
<th>SEE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TE</td>
<td>IE</td>
<td>DE</td>
</tr>
<tr>
<td>SEE</td>
<td>0.129**</td>
<td>0.129**</td>
<td>0.769**</td>
</tr>
<tr>
<td></td>
<td>(0.043)</td>
<td>(0.043)</td>
<td>(0.044)</td>
</tr>
<tr>
<td>SRL</td>
<td>0.210**</td>
<td>0.041**</td>
<td>0.169**</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.017)</td>
<td>(0.038)</td>
</tr>
</tbody>
</table>

Statistical Values

\[ \chi^2 = 38.404, \text{df} = 31, p = 0.169, \text{GFI} = 0.990, \text{AGFI} = 0.978, \text{RMSEA} = 0.019, \text{SRMR} = 0.015, \text{NFI} = 0.996, \text{CFI} = 0.999, \text{CN} = 882.315 \]

<table>
<thead>
<tr>
<th>Variables</th>
<th>SEO</th>
<th>SEJ</th>
<th>SER</th>
<th>CHO</th>
<th>EEP</th>
<th>TER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>0.708</td>
<td>0.777</td>
<td>0.535</td>
<td>0.681</td>
<td>0.618</td>
<td>0.624</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables</th>
<th>ENE</th>
<th>IND</th>
<th>AMB</th>
<th>PIM</th>
<th>TIM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>0.796</td>
<td>0.680</td>
<td>0.484</td>
<td>0.588</td>
<td>0.859</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables in Structural Equation</th>
<th>SRL</th>
<th>SEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>0.736</td>
<td>0.721</td>
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</table>

<table>
<thead>
<tr>
<th>Matrix of Correlation Among Latent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latent Variables</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>SRL</td>
</tr>
<tr>
<td>SEE</td>
</tr>
<tr>
<td>MOT</td>
</tr>
<tr>
<td>LIM</td>
</tr>
</tbody>
</table>

Notes: TE—total effect; IE—indirect effect; DE—direct effect; bold numbers—effect in form of standardized scores; numbers in brackets—standard error; SRL—self-regulated learning; SEO—self-observation; SEJ—self-judgment; SER—self-reaction; SEE—self-efficacy; CHO—choice behavior; EEP—effort expenditure and persistence; TER—thought and emotion reaction; MOT—achievement motive; ENE—energetic; IND—individual responsibility; AMB—ambition; LIM—learning by imitation; PIM—peer imitation; TIM—teacher imitation. **p < 0.01, *p < 0.05.

4. Discussion

The study results are discussed separately according to the study objectives below; the following two issues are of relevance.

**Issue 1.** Without adjustment, the causal model of SRL by LRU students was not congruent with the empirical data. Therefore, the authors modified the model by adjusting the error terms of the observed variables to partly correlate with one another so that the adjusted model was congruent with the empirical data.
Issue 2. Apart from the congruence of the causal model of SRL by LRU students with the empirical data, some other interesting issues are discussed below.

1. The variable with the highest direct effect on SRL by LRU students was MOT (0.460) as measured by ENE, IND, and AMB, and the factor with the most weight of importance was ENE, followed by IND and then AMB. These findings indicate that to achieve good MOT, ENE is the main factor that stimulates students to study diligently, work, and pay full attention to assignments. Despite dealing with hard work demanding mental and physical effort, students attempt to accomplish tasks and obtain a sense of achievement. Compared to students with low MOT, those with high MOT pay better attention to studying and assignments, are more patient when faced with failures, prefer complex tasks, initiate different things from their own ideas, and are proud to deal with difficult work, leading to an effect on SRL by LRU students. These findings are consistent with previous studies that found that MOT had an effect on students’ SRL \[4, 9–12\]. Therefore, helping students to possess MOT helps them to perform SRL.

In addition, MOT had a positive direct effect on SEE (0.769), which reflects the fact that students’ MOT has an effect on their SEE. This accords with studies that found that MOT has an effect on SEE \[23–24, 28\].

Regarding indirect effects, it was found that MOT also had an indirect effect on SRL by LRU students through SEE. This finding reflects the fact that to enhance students’ SRL, MOT alone is not enough, and SEE is also needed.

2. The next variable with a direct effect on SRL by LRU students was SEE (0.316) as measured by CHO, EEP, and TER; the factor with the most weight of importance was CHO, followed by TER and then EEP. These findings indicate that if students have CHO, then they will decide to perform some behaviors and do some learning activities according to their ability in particular situations, demonstrating effort and persistence to learn successfully through the process of TER. Consequently, these students obtain good SEE with an effect on SRL by LRU students. These findings are consistent with studies that noted that SEE has an effect on students’ SRL \[9, 13–15, 29–31\]. Therefore, helping students to acquire SEE helps them to have SRL.

3. The last variable with a direct effect on SRL by LRU students was LIM (0.169) as measured by PIM and TIM; the factor with the most weight of importance was TIM followed by PIM. TIM involves imitating teachers’ good practice such as punctuality, work planning, persistence, additional research, and activity participation, while PIM involves imitating friends in terms of study, play, lesson review, time management for study, knowledge-seeking, and activity participation. Such imitation enables students to achieve LIM, resulting in SRL by LRU students. These findings are consistent with studies that noted that LIM has an effect on students’ SRL \[18–21, 32\]. Therefore, helping students to learn by good imitation helps them to have SRL.

Moreover, LIM also had a positive direct effect on SEE (0.129), which reflects the fact that if students learn by good imitation, then their SEE will be positively affected as well. This finding is consistent with studies that noted that LIM has an effect on SEE \[33, 34\].

In terms of indirect effects, it was found that LIM had an indirect effect on SRL by LRU students through SEE. This finding reflects the fact that to enhance students’ SRL, LIM alone is not enough, and SEE is also needed.

This study used a sample comprising only LRU students. Future studies should investigate developing the SRL of students at other universities to test whether the results of the present causal model of SRL are confirmed or confounded. Also, the present results should be examined further in future research by studying a learning activity package for developing students’ SRL in self-development and the development of knowledge and necessary skills, as well as students’ potential and learning achievement.

5. Conclusions
The causal model of SRL by LRU students was congruent with the empirical data and SEE, MOT, and LIM were found to have direct effects on SRL. Moreover, MOT had an indirect effect on SRL by transmission through SEE, and LIM had an indirect effect on SRL. The study results offer useful guidelines for how teachers and administrators can develop and promote students’ self-regulated learning. Teachers should organize learning activities and activities for developing desirable student characteristics both inside and outside classes in order to promote and develop students’ SRL. For example, activities should be arranged for students to practice goal-setting, determining desirable behaviors, methods for behavior modification, and self-monitoring. Administrators should implement policies for promoting the organization of activities and the development of SRL by using teaching methods to enhance students’ SEE and MOT. Administrators should also train teachers to be good role models for students and integrate various activities in courses, activities, or projects.

**Abbreviations**

*TE:* total effect

*IE:* indirect effect

*DE:* direct effect

*SRL:* self-regulated learning

*SEO:* self-observation

*SEJ:* self-judgment

*SER:* self-reaction

*SEE:* self-efficacy

*CHO:* choice behavior

*EEP:* effort expenditure and persistence

*TER:* thought and emotion reaction

*MOT:* achievement motive

*ENE:* energetic

*IND:* individual responsibility

*AMB:* ambition

*LIM:* learning by imitation

*PIM:* peer imitation

*TIM:* teacher imitation

*LRU:* Loei Rajabhat University

**Declarations**

*Ethics approval and consent to participate*
This study was approved by the Loei Rajabhat University Ethics Committee for Human Research based on the Declaration of Helsinki and the ICH Good Clinical Practice Guidelines (Approval No. HE 016/2563, certificated on August 28, 2020). Informed consent was obtained from all study participants. All methods were carried out in accordance with relevant guidelines and regulations.

Consent to publication

Not applicable.

Availability of data and materials

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy restrictions.

Competing interests

Authors state no conflict of interest.

Funding

This article is supported by the Loei Rajabhat University Personnel Research Support Fund, administered by the Faculty of Education in 2019 (076/2562).

Acknowledgements

Thank you, Loei Rajabhat University, for providing funding and grants in support of this research article's publication.

Authors’ contributions

Mr. Anuphum Kumyoung contributes to the design of the technical route and questionnaire, data analysis, article writing, questionnaire production and collection, literature review, data checking, article submission, translation, data checking, article submission, and response to the reviewers. The review of the translation of the article, examination of the content of the article, idea of the project, determination of contribution journals, and suggestions for revision. Miss. Patthraporn Kessung and Mr. Chao Inyai are responsible for data checking. Mr. Chaimongkhon Pinasa and Ms. Jutamas Srijumnong are responsible for questionnaire collection. All authors are responsible for the entire contents of this manuscript and agree to submit it.

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References


Figures
Figure 1

Conceptual framework of causal model of self-regulated learning (SRL) by students at Loei Rajabhat University.

Figure 2

SRL model parameters with causal effects of SEE, MOT, and LIM. Notes: *p < 0.05, **p < 0.01.

Supplementary Files

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- questionnaire.docx