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The Impact of Work-Integrated Learning and Learning Strategies on Engineering Students' Learning Outcomes in Thailand: A Multiple Mediation Model of Learning Experiences and Psychological Factors

BURATIN KHAMPIRAT
Institute of Social Technology, Suranaree University of Technology, Nakhon Ratchasima 30000, Thailand
e-mail: buratink@sut.ac.th

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ABSTRACT Learning outcomes (LOs) provide an essential foundation for evaluating the effectiveness of higher education institutions (HEIs). LOs have been accepted as criteria for accrediting academic programs; however, little is known about why students vary in their desired outcomes and how experiences in the workplace and learning strategies have different impacts on LOs. Based on social cognitive career theory (SCCT), this study investigated the relationships among work-integrated learning (WIL), learning strategies, institutional and goal commitments, engineering skill self-efficacy, engineering career outcome expectations, lifelong learning skills (LLLs), achievement goal orientation, and LOs. The participant pool consisted of 1,316 undergraduate engineering students from 11 HEIs in Thailand. Hypotheses regarding the causal relationships, including the direct and indirect effects, were examined by using structural equation modeling (SEM). Both the measurement and structural equation models showed a good fit to the data. The results of the SEM indicated that achievement goal orientation, LLLs, and engineering skill self-efficacy had significant positive direct effects on LOs. Learning strategies had a strong direct effect on LLLs and institutional and goal commitments. The practice of WIL in the workplace was an important factor in building engineering skill self-efficacy and LLLs. The mediation analysis indicated that learning experience (i.e., institutional and goal commitments) and psychological factors played important roles in the relationship between learning strategies and LOs. This study confirmed and expanded the SCCT research. Finally, theoretical and practical implications for LO development were identified based on the results.

INDEX TERMS Work integrated learning, learning outcomes, learning strategies, career outcome expectations, lifelong learning skills, engineering skill self-efficacy.

I. INTRODUCTION

Competition in the present digital era and wage inequality between skilled and unskilled workers [1] increase the pressure on higher education institutions (HEIs) because society and stakeholders demand that HEIs demonstrate their concrete efficiencies and effectiveness. In particular, the employment of new engineering graduates is linked to a growing demand for highly skilled engineers to promote economic competitiveness and sustainable social development [2]. However, job markets in several countries face difficulty finding qualified graduates to join the industry [3], [4].

Learning outcomes (LOs) are constructed to measure graduate quality and include important statements about the knowledge, skills, and attitudes [5] that students are expected to gain after the completion of a higher education degree [6].

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LOs are also considered to be an essential foundation for evaluating the effectiveness of HEI professional development through learning experience [7]; for example, LOs are frequently used as important criteria for engineering program accreditation [8]. Studies have indicated that current students often lack a clear understanding of their LOs [9]–[11].

Prior studies have provided strong evidence that work-integrated learning (WIL) experience is an important tool for improving LOs [12]. WIL is one of the forms of the experiential learning process that offers students opportunities for participating in real-world work and plays an important role in student development and the creation of a sustainable society through career development [13]. A study by Khampirat, *et al.* [14] indicated that WIL experience can enhance student work skills performance because a variety of tacit and explicit forms of knowledge and skills can be developed during work placement [15], [16]. This suggestion is in accordance with the finding that everyday formal and informal work practice in WIL programs can improve students' LLLs, which are an essential attribute in engineering educational policy and ABET accreditation standards [17].

Furthermore, many learning approaches and theoretical models exist to help understand students' behavior related to LOs [18]–[22]. Social cognitive career theory (SCCT) is a widely accepted model for explaining the relationship between individual career goals and performance.

However, even though much attention has been given to the exploration of how university support services improve the self-efficacy and LOs of students transitioning into a career [23], [24], there is little previous research on how LOs developed through WIL are mediated by LLLs, career outcome expectations, and self-efficacy given that WIL program participation has an indirect effect on LOs rather than a direct effect. There is some evidence to support the effects of learning strategies [25], career outcome expectations [26], and self-efficacy on LOs [27]; few studies have explored the career outcome expectations and self-efficacy that mediate the relationship between learning strategies and LOs (e.g., Kim, *et al.* [28]; Jensen [25]). Therefore, it is advantageous to understand how and why WIL participation, career outcome expectations, and self-efficacy influence LOs.

In Thailand, the major problems in all academic fields are the "skill shortage" and the "skill gap" [4]. Therefore, the National Economic and Social Development Plan (2017-2021) [29] and the 20-year National Strategy (2018-2037) [30] of Thailand stated that HEIs must focus on strengthening students' LLLs and improving the WIL system to prepare new graduates to be highly skilled human resources and have the requisite employability skills before entering the labor market. There has been limited research in Thailand to study the effect of WIL experience, such as engineering skill self-efficacy, career outcome expectations, and the LOs of engineering students, which contributes positively to proactive behaviors and psychological processes. Most researchers have focused on the direct relevance of WIL to students' employability [14], [31], [32]. Previous research has tended to neglect the role of variables that may mediate the relationship between WIL and LOs. Because LOs are complex, studies need to consider the contributions of both learning and psychological processes.

II. PROBLEM STATEMENT

HEIs around the world have developed students' LOs and skills through pedagogical processes and WIL practice. These aim to bridge the skills gap, develop LLLs, and prepare students for a sustainable career of the future [13], [14], [33]. However, improving LOs and skills to meet workplace needs remains a global educational challenge due to the requirements of the workplace in the rapid technological change [34], and especially the outbreak of the coronavirus 2019 (COVID-19), which prohibits students to develop their work experience through the internship process [35], [36].

Over the past two decades, Thailand has been successfully expanding educational opportunities [37]. However, the quality of the Thai education has been found ineffective in terms of LOs, skill gap, and skills deficiencies, especially in the engineering disciplines [4], [13], [33]. Studies indicated that students' LOs are determined by several factors, including both academic and non-academic aspects [38], and there are two major limitations in the previous studies. Firstly, although most studies have shown a close relationship between WIL and LOs, few studies have explored the impact of WIL, psychology and learning factors on engineering students' LOs. Secondly, there are still limited studies that have systematically examined how WIL influences LOs, especially among engineering students in developing countries. Most empirical studies on this topic have been conducted in developed countries [12], [39]. To address these research limitations and fill the gaps in previous research, this study aimed to offer new directions for shaping LOs by analyzing quantitative data through cross-sectional structural equation modeling (SEM). Therefore, the objectives of this study were as follows:

- To develop and validate a structural equation model of engineering students' LOs.
- To analyze the relationships among LOs, WIL, and learning experience (e.g., learning strategies, institutional and goal commitments) that are mediated by psychological factors (e.g., abilities achievement goal orientation, LLLs, career outcome expectations, and engineering skill self-efficacy) in a sample of undergraduate engineering students in Thai HEIs.

The perspectives of SCCT were applied in this study to explain the connections between the WIL, learning experiences, and psychological processes that are critical in forming proactive socialization behaviors for engineering student achievement.

In particular, the analysis in this study examined the direct and indirect effects of WIL experience, learning strategies and institutional and goal commitments on LOs. The findings could be of great benefit to policymakers, career services and instructors to apply the recommended approach derived from the results for enhancing the student development process to promote success in their learning goals. This study could also help students improve their abilities and skills to enhance their academic performance and prepare for their future careers.

III. LITERATURE REVIEW AND THEORETICAL FRAMEWORK DEVELOPMENT

A. SOCIAL COGNITIVE CAREER THEORY (SCCT): THE DIRECT AND INDIRECT RELATIONSHIPS OF EDUCATIONAL PROCESSES WITH CAREER DEVELOPMENT

This study used SCCT [26] to support the relationships between the variables in the conceptual framework. SCCT explains related processes in education and career development by proposing three interrelated aspects: (1) basic academic and career interest development, (2) the selection of academic and career choice options, and (3) educational performance and the obtained career [26]. SCCT was derived primarily from the general social cognitive theory of Bandura [40], an influential theory of the cognitive and motivational processes that lead to the desired outcomes [41]. SCCT emphasizes individual psychological factors (e.g., self-efficacy, expected outcomes, and goals), sociodemographic and contextual factors (e.g., gender, race/ethnicity, and support systems), and learning experiences, which have critical roles in educational and career development processes, as well as performance (i.e., interests, choice, and performance). Lent *et al.* [26] indicated that in SCCT, self-efficacy, outcome expectations, and the process of setting goals, serve as the essential basic elements of enhancing performance.

Several studies and large-scale meta-analyses have provided support for many hypotheses of SCCT on interest, choice, and performance models [42] and have concluded that self-efficacy and outcome expectations influence both academic and occupational performance. Hackett *et al.* [43] studied engineering students and found that academic self-efficacy, faculty encouragement and vocational interests had strong positive effects on academic achievement and that students with high levels of positive outcome expectations had high academic self-efficacy. That is, students who had high self-efficacy set higher goals than students with lower self-efficacy [44]. This finding is consistent with the findings of Venugopal *et al.* [45], indicating that self-efficacy has an essential role in reinforcing the LOs of engineering students. Therefore, SCCT is a reasonable framework with which to investigate the effects of WIL, learning processes, and psychological factors on LOs.

B. THE DIRECT AND INDIRECT RELATIONSHIPS OF WIL EXPERIENCE WITH LOs, ENGINEERING SKILL SELF-EFFICACY, CAREER OUTCOME EXPECTATIONS, AND LLLs

WIL can be described as a pedagogical practice with the ultimate aim of integrating theory with real work experience to facilitate students' work in the professional workplace [46]. Research has shown that participation in WIL is related to knowledge and skills development [47], career development learning [48], [49], improved employability skills [50], students' perceived work self-efficacy [51], and better academic achievement [39]. The findings of Drysdale and McBeath [52] revealed that students who did not participate in a WIL program had lower academic achievement, were more likely to use shallow learning strategies and were more motivated by extrinsic reasons than students who did participate in the WIL program. Drewery *et al.* [53] maintained that WIL plays an integral role in students' LLLs.

C. THE DIRECT AND INDIRECT RELATIONSHIPS OF LEARNING STRATEGIES WITH INSTITUTIONAL AND GOAL COMMITMENTS, LLLs, AND LOs

Learning strategies have been defined as the way in which a learner prefers to respond or interact with the learning environment [54], [55]. Previous research has shown that psychological factors and academic engagement are mediating factors in the relationship between learning strategies and academic performance [25], [28], [56]. Uzunboylu and Selcuk [57] and Mbagwu, *et al.* [58] found nonsignificant direct effects of learning strategies on LLLs [57], [58]. Moreover, empirical research by Braxton, *et al.* [59] demonstrated that learning strategies were not only related to social integration in HEIs but also helped build students' institutional and goal commitments and LOs. Similarly, Daniel [60] concluded that students who engaged in course collaborative activities and active-learning strategies showed significantly higher LO gains than those who did not.

D. THE DIRECT AND INDIRECT RELATIONSHIPS OF ENGINEERING CAREER OUTCOME EXPECTATIONS WITH ENGINEERING SKILL SELF-EFFICACY AND LOs

Outcome expectations refer to personal beliefs that performing particular behaviors will lead to the anticipated consequences of success [26], [61], and they are essential to a person's behavior, career interest, and career goals [62]. SCCT focuses on the direct path from self-efficacy to expected outcomes [63]. However, later studies have shown the opposite relation, indicating that there is a reciprocal relationship between self-efficacy and expectation outcomes (e.g., Corcoran [64]; Flores, *et al.* [65]). Related studies showed that career outcome expectations were positively correlated with the occupational engagement of undergraduate students in Korea [66], which was supported by expectancy-value theory [67]. Students' expectancies and goals for learning were found to be determinants of their self-efficacy and performance [67].

E. THE DIRECT EFFECTS OF ENGINEERING SKILL SELF-EFFICACY ON LOs

Self-efficacy refers to a person's belief in his or her own ability to achieve results and the desired outcomes [61]. Student performance is often directly related to self-efficacy [68], [69], and a number of studies used this relationship to predict academic outcomes [27], [70]. Vogel and Human-Vogel [71] claimed that self-efficacy is a significant predictor of academic outcomes for engineering students.

F. THE DIRECT EFFECTS OF INSTITUTIONAL AND GOAL COMMITMENTS ON ACHIEVEMENT GOAL ORIENTATION

Institutional and goal commitments reflect students' loyalty to the university and dedication to achieving educational objectives [72]. Regarding the area of student achievement in particular, achievement goal orientation might be affected by a sense of subjective well-being [73], [74] related to institutional and goal commitments. Research on organizational studies has demonstrated that organizational and goal commitments are essential for achievement goal orientation [75]–[77]. Hence, it is reasonable to expect that institutional and goal commitments affect achievement goal orientation in HEIs.

G. THE DIRECT EFFECTS OF LLLs ON LOs

Lifelong learning is considered to be a process of continuously improving knowledge, skills, and competencies in every area of one's life [57], [78]. LLLs refer to skills developed through the practice learning activities related to the attitudes, beliefs, values and behaviors of an individual [79]. Drewery, *et al.* [53] found a significant relationship between WIL students' LLL characteristics and performance at a research-intensive Canadian university. A content analysis conducted by Soares and Dias [80] also found a strong influence of LLLs on LOs. This is consistent with the findings of Ro and Song [81] in Korea, who confirmed the indirect effect of learning characteristics and LLLs on LOs through wisdom.

H. THE DIRECT AND INDIRECT RELATIONSHIPS OF ACHIEVEMENT GOAL ORIENTATION WITH CAREER OUTCOME EXPECTATIONS, LLLs, AND LOs

Achievement goal orientation refers to an individual's intelligence or ability to develop traits or mindsets that will lead him or her to engage in different behaviors or approaches [82], [83] and to seek more learning opportunities [84]. Achievement goal theory [85]–[87] posits that students' achievement goal orientations are linked to their achievement-related processes and outcomes. Achievement goal orientations can enhance student outcomes [88]–[90]. Empirical studies have shown that achievement goal orientations are driven by previous socialization and lead individuals to have higher expectations of themselves [91] and that they have different patterns of adaptive outcomes (in terms of cognition, affect, and behavior) [69], [86], [92].

Based on SCCT and previous studies, the following hypotheses were formulated in this study:

Hypotheses on direct effects:

H1: WIL experience has a direct effect on engineering skill self-efficacy.

H2: WIL experience has a direct effect on LLLs.

H3: Engineering skill self-efficacy has a direct effect on LOs.

H4: Engineering career outcome expectations have a direct effect on engineering skill self-efficacy.

H5: Learning strategies have a direct effect on LLLs.

H6: Learning strategies have a direct effect on institutional and goal commitments.

H7: Institutional and goal commitments have a direct effect on achievement goal orientation.

H8: Achievement goal orientation has a direct effect on engineering career outcome expectations.

H9: Achievement goal orientation has a direct effect on LOs.

H10: LLLs have a direct effect on engineering career outcome expectations.

H11: LLLs have a direct effect on LOs.

Hypotheses on indirect effects:

H12: WIL experience has an indirect effect on LOs through engineering skill self-efficacy, LLLs, and engineering career outcome expectations as mediators.

H13: Learning strategies have an indirect effect on LOs through learning experience (institutional and goal commitments), psychological factors (namely, achievement goal orientation, engineering career outcome expectations, and engineering skill self-efficacy), and LLLs as mediators.

H14: Institutional and goal commitments have indirect effects on LOs through psychological factors (namely, achievement goal orientation, engineering career outcome expectations, and engineering skill self-efficacy) and LLLs as mediators.

I. HYPOTHESIZED MODEL DEVELOPMENT

Based on the SCCT framework, the reviewed literature, and the hypotheses developed in the previous section, the hypothesized relationships in the theoretical framework of the study were developed as depicted in Fig. 1.

This study sought to develop an in-depth understanding of the impact of WIL experience, learning strategies, learning experience, and psychological factors on engineering students' LOs. The factors in the model included both endogenous and exogenous variables with multiple mediator variables related to learning experience and psychological factors. The model fit and the hypotheses were assessed using SEM to identify the proposed causal relationships among the variables in the model; the hypotheses focused both on the direct and indirect effects of the factors.

IV. METHODOLOGY

A. MEASUREMENT INSTRUMENTS

The instruments used to measure the study variables were as follows.

WIL experience: The dichotomous variable WIL experience was used to indicate whether a student had participated in a WIL program (no WIL experience = 0; WIL experience = 1).

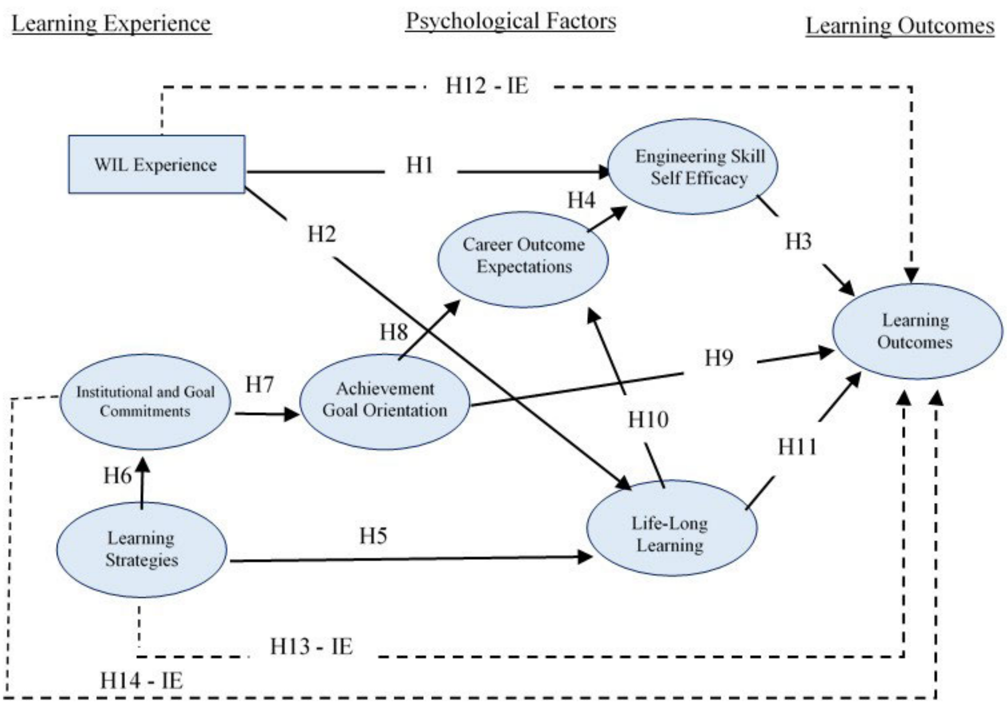

FIGURE 1. Hypothesized model of the direct and indirect relationships. The long-dashed lines indicate indirect effects (IEs).

Learning outcomes (LOs, 55 items): The scale was designed and developed by the author for assessing engineering students' LOs. It includes 4 dimensions: human skills, organizational skills, information skills, and knowledge and skills in engineering (Appendix A). The items were rated using a 5-point Likert scale (1-5). The Cronbach's reliability coefficient for the total scale in the current sample was .92.

Engineering skill self-efficacy (ENSE, 14 items): The ENSE scale was created by Mamaril [93] and Mamaril, *et al.* [94]. The students indicated their level of agreement from 1 (very bad) to 5 (very good). The ENSE scale comprises 14 items in 3 subscales: experimental skills self-efficacy (5 items), tinkering skills self-efficacy (5 items), and engineering design self-efficacy (4 items). A 5-point rating scale was used to rate each item (1-5). The internal consistency (Cronbach's α coefficient) in this sample was .92.

Engineering career outcome expectations (OEXP, 7 items): The OEXP scale focuses on two dimensions: career success expectations (3 items) and life success expectations (4 items). The scale was developed by Marra and Bogue [95], [96]. The participants were required to rate themselves on a 5-point rating scale, where 1 = low level of expectation and 5 = the highest level of expectation. The internal consistency reliability in this sample was .89.

Lifelong learning skills (LLLs, 12 items): The LLLs scale was created by Drewery, *et al.* [97]. The developed scale includes 12 items for measuring four characteristics of LLLs: (1) love of learning (4 items), (2) information seeking (3 items), (3) self-reflection (2 items), and (4) resilience (4 items). The responses were provided on a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). The internal consistency reliability in this sample was .93.

Achievement goal orientation (ACH, 15 items): The ACH scale was adapted from Harackiewicz, *et al.* [98], Midgley, *et al.* [99], and Mamaril, *et al.* [94] to measure three dimensions of ACH: mastery goals (6 items), performance approach goals (5 items), and performance avoidance goals (4 items). The scale used 5-point Likert-type scale from 1 (not at all true) to 5 (strongly agree). The internal consistency reliability in this sample was .88.

Institutional and goal commitments (IGO, 17 items): This scale comprises 17 items; it was adapted from Pascarella and Terenzini [100] to measure two dimensions: goal commitments (6 items) and institutional commitments (11 items). The students provided their opinions on institutional and goal commitments on a 5-point rating scale from 1 (unsatisfied) to 5 (very satisfied). The Cronbach's α coefficient in this sample was .89.

Learning strategies (LS, 14 items): The fourteen-item LS survey comprises two subscales: self-effort regulation (5 items) and collaborative learning (9 items). The scale was adapted and developed based on the scales of Pintrich, *et al.* [101], Ribera, *et al.* [102], and Terenzini, *et al.* [103]. The students indicated their level of agreement from 1 (strongly disagree) to 5 (strongly agree). The Cronbach's α coefficient in this sample was .79.

To validate these scales, confirmatory factor analysis (CFA) was conducted to examine the factor structures of sets of items with the Mplus 8.3 program.

B. DATA COLLECTION

The target population in the present work was undergraduate engineering students who were studying in their third or fourth year at a Thai university. The questionnaires were distributed to 1,500 students using multistage sampling for a descriptive cross-sectional survey design during December 2016 and March 2017. They were distributed by two researchers, three research assistants, and eight university staff members in regular classrooms and meeting rooms whenever the distribution was authorized and the rooms were accessible. The questionnaires were given to students from different regions and to approximately equal proportions of students who had participated in WIL (WIL experience) and who had not participated in WIL (no WIL experience). Students were informed that participation was voluntary. They could withdraw from the study at any time and could refuse to answer any question. All participants were assured that all information provided would be kept confidential and would be used for research purposes only. Any information that could identify the individuals would not be published or exposed anywhere. The research team also informed the participants that the survey was not a test and that there were no right or wrong answers. Memorandum books were provided to all of the students participating in the study as a token of appreciation and an incentive.

A total of 1,369 responses were returned, for a response rate of approximately 91.27%. Finally, after 53 questionnaires were excluded due to a high percentage of incomplete responses for a particular variable, data from 1,316 valid questionnaires were used for analysis.

C. DEMOGRAPHIC DATA

The basic demographic characteristics of the participants in this study are shown in Table 1. A total of 61.17% of the participants were male, 38.60% were female, and 0.23% did not report their gender. The average age was 21.97 years (SD = 1.4 years), ranging from 18 to 34 years. A total of 96.20% of the participants were 18-24 years old, and 3.27% were 25-34 years old. With regard to the year of study, most of the participants (87.77%) were in the third or fourth year. A total of 71.96% were studying at public universities, 19.00% were studying at private universities, 7.83% were studying at vocational universities, and 1.22% were studying at open universities. A total of 53.81% of the students had participated in WIL and had completed their work placement. The students' socioeconomic status (SES), which was measured based on family income and parents' educational background, ranged from the low to middle levels. The study participants were representative of the target population, as they were drawn from 11 universities in Thailand that (a) were geographically distributed in the four main regions of Thailand; (b) offered a wide range of courses in the major branches of engineering; (c) represented

TABLE 1. Demographic characteristics of the participants.

	Frequency	%
Total	1,316	100.00
Gender		
Female	508	38.60
Male	805	61.17
N/A	3	0.23
Age (M = 21.98 years, SD = 1.29 years)		
18-24	1,266	96.20
25-34	43	3.27
N/A	7	0.53
Year of Study		
1st	25	1.90
2nd	63	4.79
3rd	491	37.31
4th	664	50.46
5th	51	3.88
6th	14	1.06
7th	3	0.23
GPA (scale ranges from 0 to 4.0; M = 2.71, SD = 0.45)		
< 2.00	22	1.67
2.00 - 2.50	467	35.49
2.51 - 3.00	464	35.26
3.01 - 3.50	263	19.98
> 3.50	68	5.17
N/A	32	2.43
Type of University		
Private University	250	19.00
Public University	947	71.96
Vocational University	103	7.83
Open University	16	1.22
WIL experience		
Non-Participant in WIL program (no WIL experience)	590	44.83
Participated in a WIL program (WIL experience)	686	52.13
N/A	40	3.04
Family Income (per month) (Note: 32.03 THB = 1 USD)		
≤ 20,000 THB (≤ 624.41 USD)	411	31.23
20,001-40,000 THB (624.45-1,248.83 USD)	323	24.54
40,001-60,000 THB (1,248.86-1,873.24 USD)	176	13.37
60,001-80,000 THB (1,873.28-2,497.66 USD)	72	5.47
80,001-100,000 THB (2,497.69-3,122.07 USD)	81	6.16
> 100,000 THB (> 3,122.07 USD)	62	4.71
N/A	191	14.51
Fathers' Educational Level		
Did not study	17	1.29
Primary school	368	27.96
Junior high school	135	10.26
High school or vocational certificate	246	18.69
Diploma	118	8.97
Bachelor's degree	280	21.28
Master's degree	85	6.46
Doctorate degree	14	1.06
Do not know	43	3.27
N/A	10	0.76
Mothers' Educational Level		
Did not study	14	1.06
Primary school	406	30.85
Junior high school	145	11.02
High school or vocational certificate	222	16.87
Diploma	100	7.60
Bachelor's degree	266	20.21
Master's degree	54	4.10
Doctorate degree	10	0.76
Do not know	21	1.60
N/A	78	5.93

Note: N/A = not available or no answer.

TABLE 2. Descriptive statistics.

	CODE	*M*	*SD*	Skewness	Kurtosis
Learning Outcomes	LOs	3.72	0.39	-0.03	0.61
1) Human Skills	LO_1	3.89	0.45	-0.55	2.04
2) Organizational Skills	LO_2	3.71	0.44	0.05	0.36
3) Information Skills	LO_3	3.65	0.43	0.07	0.25
4) Knowledge and Skills in Engineering	LO_4	3.67	0.44	0.11	0.16
WIL Experience (0 = no WIL experience; 1 = WIL experience)	WIL experience	0.54	0.50	-0.15	-1.98
Learning Strategies	LS	3.54	0.41	0.38	0.19
1) Self-Effort Regulation	LS_1	3.23	0.53	0.65	0.26
2) Collaborative Learning	LS_2	3.85	0.52	-0.05	0.23
Institutional and Goal Commitments	IGO	3.89	0.56	-0.01	-0.67
1) Goal Commitments	IGO_1	3.86	0.85	-0.33	-1.25
2) Institutional Commitment	IGO_2	3.91	0.56	-0.22	-0.16
Lifelong Learning Skills	LLLs	3.86	0.50	-0.08	0.34
1) Love of Learning	LLL_1	3.90	0.56	-0.17	0.14
2) Information Seeking	LLL_2	3.81	0.56	-0.02	0.02
3) Self-Reflection	LLL_3	3.91	0.58	-0.08	-0.17
4) Resilience	LLL_4	3.81	0.54	0.01	0.16
Achievement Goal Orientation Scale	ACH	3.62	0.51	-0.20	0.71
1) Mastery Goals	ACH_1	3.92	0.58	-0.31	0.43
2) Performance Approach Goals	ACH_2	3.43	0.72	-0.46	0.58
3) Performance Avoidance Goals	ACH_3	3.41	0.72	-0.56	1.15
Engineering Skill Self-Efficacy	ENSE	3.49	0.55	-0.08	0.40
1) Experimental Skills Self-Efficacy	ENSE_1	3.52	0.57	-0.22	0.49
2) Tinkering Skills Self-Efficacy	ENSE_2	3.42	0.69	-0.25	0.31
3) Engineering Design Self-Efficacy	ENSE_3	3.53	0.64	-0.22	0.65
Engineering Career Outcome Expectations	OEXP	3.89	0.57	-0.34	0.70
1) Career Success Expectations	OEXP_1	3.95	0.60	-0.30	0.30
2) Life Success Expectations	OEXP_2	3.84	0.63	-0.40	0.86

different types of universities; (d) had students with diverse GPAs; and (e) had students of diverse socioeconomic levels.

D. DATA ANALYSIS

The data were managed and analyzed using SPSS version 18 and Mplus 8.3 [104]. Descriptive statistics (Table 2) were used to describe the participant characteristics and understand the features of the data. The correlations between variables were calculated using Pearson correlation analysis. Confirmatory factor analysis (CFA) was adopted to verify the factor structure of a set of observed variables and investigate the construct validity of the scale in terms of both convergent and discriminant validity. After the fit of the measurement model was evaluated, the construct reliability (CR) and average variance extracted (AVE) were calculated to evaluate the convergent validity and discriminant validity, respectively.

SEM was conducted to test the hypothesized theoretical model in predicting the direct and indirect effects of WIL experience, learning strategies, and other predictive variables on the dependent variables.

To evaluate the model fit indicated by CFA and SEM, a chi-square goodness-of-fit was used to determine the difference between the observed and estimated population covariance matrices [105]. Several model fit indices and their criteria were employed to assess the goodness of fit of the model with the given dataset, including the chi-square to degree of freedom ratio (χ^2/df, should be less than 5) [106], the comparative fit index (CFI, acceptable if ≥ 0.90), the Tucker-Lewis index (TLI, acceptable if ≥ 0.90), the standardized root mean square residual (SRMR, good fit if ≤ 0.08) [107], and the root mean square error of approximation (RMSEA, acceptable if < 0.06 to 0.08, with 90% confidence intervals) [108].

V. RESULTS

A. MEASUREMENT MODEL FIT

CFA was conducted to test the measurement model of the latent constructs in this study. All the fit indices in Table 3 indicate that the observed data had a good fit to the seven tested constructs, suggesting the reliability of the observed variables in relation to their factors.

B. CONVERGENT VALIDITY OF THE MEASURES

Convergent validity refers to the degree of relatedness between two measures of the same construct [109], and it can be assessed using the standardized factor loading ($\beta \geq |.5|$, $p < 0.05$), average variance extracted (AVE, should be .5 or greater), and composite reliability (sometimes called construct reliability, CR > 0.7) [110]. The findings in Table 4 show that the standardized factor loading values of the indicators ranged from 0.06 to 0.98, the AVE values were in the range of 0.38 to 0.75, and the CR values were above

TABLE 3. **Fit results of the measurement models.**

Measurement Models	χ^2	*df*	*p*	χ^2/df (< 5)	CFI (≥ 0.90)	TLI (≥ 0.90)	RMSEA (90% CI) (< 0.06 to 0.08)	SRMR (≤ 0.08)
LOs	174.79	68	0.00	2.57	0.99	0.98	0.04 (90% CI: 0.23 - 0.04)	0.02
LS	145.11	54	0.00	2.69	0.98	0.97	0.04 (90% CI: 0.03 - 0.05)	0.03
IGO	171.86	56	0.00	3.07	0.99	0.97	0.04 (90% CI: 0.03 - 0.05)	0.04
LLLs	9.37	2	0.00	4.69	0.99	0.99	0.05 (90% CI: 0.02 - 0.09)	0.01
ACH	177.35	46	0.00	3.86	0.98	0.97	0.05 (90% CI: 0.04 - 0.06)	0.04
ENSE	128.31	48	0.00	2.67	0.99	0.98	0.04 (90% CI: 0.03 - 0.04)	0.02
OEXP	8.24	5	0.14	1.65	0.99	0.99	0.02 (90% CI: 0.01 - 0.04)	0.01

TABLE 4. **Standardized factor loadings, reliability analysis, and discriminant validity for construct/variable in the SEM model.**

Constructs	No. of Items	Range of Standardized Factor Loading	Assessment of convergent validity		Cronbach's Alpha (> 0.70)
			Composite reliability (CR > 0.70)	Average Variance Extracted (AVE > 0.50)	
LOs	55	0.69 – 0.84	0.87	0.62	0.92
LS	14	-0.06 – 0.88	0.87	0.38	0.79
IGO	17	0.27 – 0.88	0.94	0.49	0.89
LLLs	12	0.79 – 0.92	0.92	0.75	0.93
ACH	15	0.44 – 0.98	0.81	0.60	0.88
ENSE	14	0.75 – 0.92	0.90	0.75	0.92
OEXP	7	0.70 – 0.80	0.89	0.55	0.89

TABLE 5. **Correlation coefficient matrix and discriminant validity for construct/variable in the SEM model.**

Constructs	Correlation coefficient (off-diagonal elements) and square roots of AVE (On-diagonal bold elements)							
	LO	WIL Student	LS	IGO	LLL	ACH	ENSE	OEXP
LOs	**(0.79)**							
WIL experience	.174**	-						
LS	.517**	.198**	**(0.62)**					
IGO	.377**	.161**	.636**	**(0.70)**				
LLLs	.659**	.129**	.548**	.487**	**(0.87)**			
ACH	.542**	-0.035	.286**	.285**	.495**	**(0.77)**		
ENSE	.611**	0.050	.238**	.183**	.523**	.554**	**(0.87)**	
OEXP	.557**	.058*	.478**	.480**	.502**	.540**	.428**	**(0.74)**

Note: On-diagonal bold elements in brackets are square roots of AVE. Off-diagonal elements are correlation coefficients.

0.7. Although the AVE values of learning strategies (0.38) and institutional and goal commitments (0.49) were less than the recommended threshold of 0.5, the CR was higher than 0.6, showing that the convergent validity of the construct was still adequate [111]. In summary, the convergent validity of all these concepts was acceptable.

C. DISCRIMINANT VALIDITY OF THE MEASURES

For multi-item scales, discriminant validity measures the degree to which different and unique measures of constructs are unrelated to other traits [110]. Fornell and Larcker [111] stated that if the square root of the AVE of each construct ($\sqrt{AVE}$) is greater than the correlations (r) with other latent constructs ($\sqrt{AVE} >$ r), this is good evidence that the scale has discriminant validity. The findings in Table 5 illustrate the discriminant validity of the seven constructs, as the lowest $\sqrt{AVE}$ was 0.62, which was larger than the largest correlation coefficients between constructs in the model [112].

D. RESULTS OF THE STRUCTURAL EQUATION MODELING

The hypothesized relationships in the proposed conceptual framework were tested by performing an SEM, as shown in Figure 2 and Table 6. The obtained goodness-of-fit statistical values were as follows: $\chi 2 = 513.01$, $df = 160$, $p < 0.001$, $\chi 2/df = 3.21$, RMSEA = 0.05 (90% CI: 04 to 0.05), CFI = 0.98, TLI = 0.96, SRMR = 0.04. All statistical values were consistent with the suggested criteria for model fit. Therefore, it was concluded that the proposed SEM model of LOs for Thai engineering students (Figure 2) had a reasonable fit to empirical data, and all the explanatory variables explained 64.70% ($R^2 = 0.647$) of the variance in the LOs.

Figure 2 and Table 5 also show the estimated standardized direct and indirect effects (β) with their significance levels for the hypotheses and the loadings of the indictors with their significance levels.

Regarding the direct relationships, Table 5 shows that all hypothesized direct effects were confirmed. WIL experience had significant direct effects on engineering skill self-efficacy (H1: $\beta = 0.13$, $p < 0.01$) and LLLs (H2: $\beta = 0.06$, $p < 0.05$).

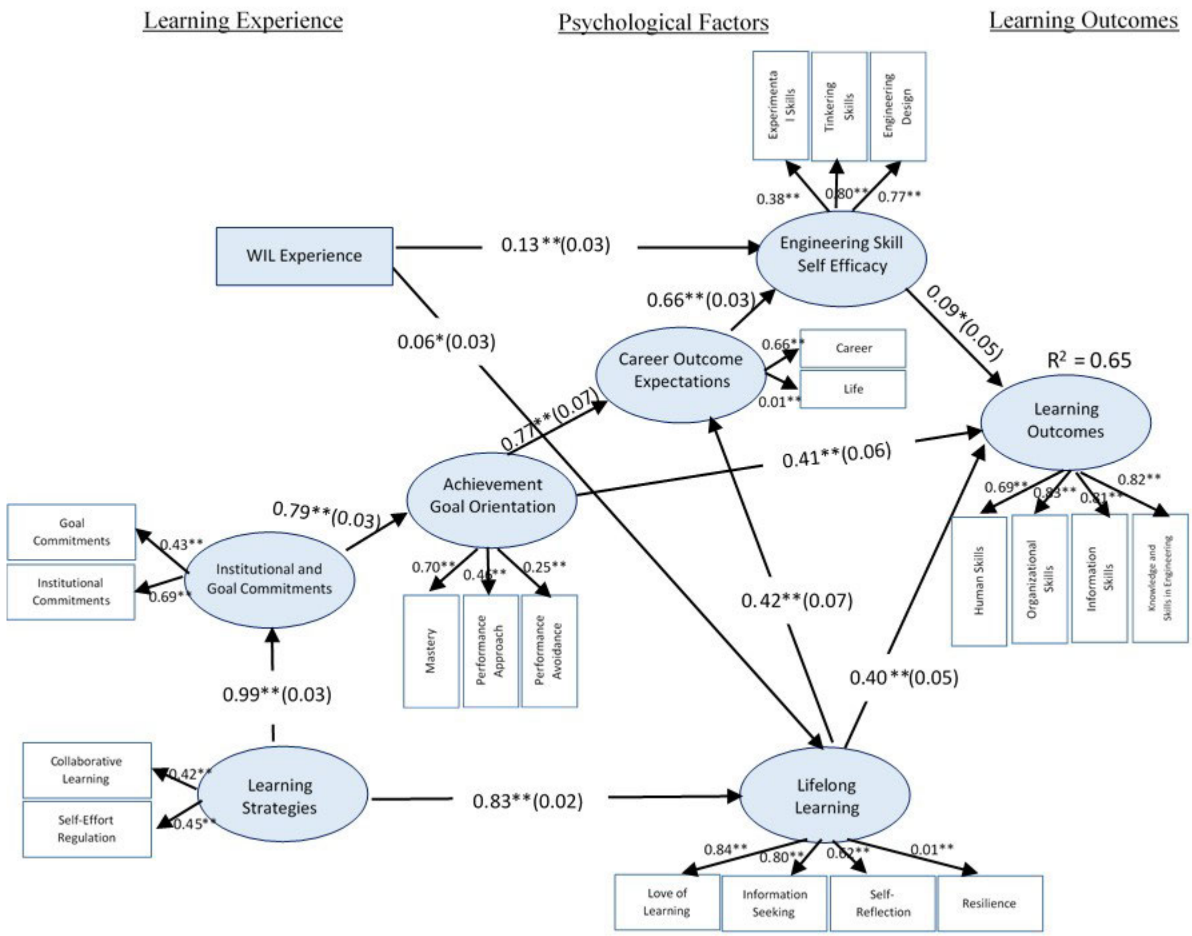

FIGURE 2. Results of the SEM of engineering student LOs (hypothesis testing). WIL experience was a dichotomous variable (1 = experience in a WIL program). The standardized path coefficients and standard errors (in parentheses) are provided. Note: Latent constructs are shown with an ellipse, and measured variables are represented by a rectangle. * *p* < .05; ** *p* < .01; *** *p* < .001.

TABLE 6. Hypothesis testing results of the structural model.

Hypotheses (effects from X to Y))		Standardized Estimate (β)	Z-value	P-value	Result
Direct Effect					
H1	WIL experience → ENSE	0.15***	4.83	0.000	Supported
H2	WIL experience → LLLs	0.06*	2.24	0.025	Supported
H3	ENSE → LOs	0.09*	2.02	0.043	Supported
H4	OEXP → ENSE	0.66***	25.37	0.000	Supported
H5	LS → LLLs	0.83***	36.01	0.000	Supported
H6	LS → IGO	0.99***	31.93	0.000	Supported
H7	IGO → ACH	0.79***	23.74	0.000	Supported
H8	ACH → OEXP	0.77***	11.28	0.000	Supported
H9	ACH → LOs	0.41***	7.22	0.000	Supported
H10	LLLs → OEXP	0.42***	5.85	0.000	Supported
H11	LLLs → LOs	0.40***	7.99	0.000	Supported
Indirect Effect					
H12	WIL experience → LOs	0.01	1.83	0.067	Not Supported
H13	LS → LOs	0.73***	14.61	0.000	Supported
H14	IGO → LOs	0.32***	5.964	0.000	Supported

Note: * *p* < .05; ** *p* < .01; *** *p* < .001

Engineering skill self-efficacy had a significant influence on LOs (H3: $\beta = 0.09$, $p < 0.05$). Engineering career outcome expectations had a significant influence on engineering skill self-efficacy (H4: $\beta = 0.66$, $p < 0.01$). Learning strategies had strong significant effects on LLLs (H5: $\beta = 0.83$, $p < 0.01$) and institutional and goal commitments

(H6: $\beta = 0.99$, $p < 0.01$). Institutional and goal commitments had a significant influence on achievement goal orientation (H7: $\beta = 0.79$, $p < 0.01$). Achievement goal orientation had significant influences on engineering career outcome expectations (H8: $\beta = 0.77$, $p < 0.01$) and LOs (H9: $\beta = 0.41$, $p < 0.01$). LLLs had significant influences on engineering career outcome expectations (H10: $\beta = 0.42$, $p < 0.01$) and LOs (H11: $\beta = 0.40$, $p < 0.01$). Based on these results, the smallest direct effect was found for the causal relationship between WIL experience and engineering skill self-efficacy, while the largest direct effect was found for the relationship between learning strategies and institutional and goal commitments.

Regarding the indirect relationships, hypothesis H12 was not supported; that is, there was no indirect effect of WIL experience on LOs (H12: $\beta = 0.01$, $p > 0.05$). Hypotheses H13 and H14 were supported. The largest indirect effect was found in the relationship between learning strategies and LOs, mediated by institutional and goal commitments, achievement goal orientation, engineering career outcome expectations, engineering skill self-efficacy, and LLLs (H13: $\beta = 0.73$, $p < 0.01$). The indirect effect of institutional and goal commitments on LOs (H14: $\beta = 0.32$, $p < 0.01$) was also found to be statistically significant and was mediated by institutional and goal commitments, achievement goal orientation, engineering career outcome expectations, and engineering skill self-efficacy. Accordingly, hypothesis H12 was rejected; that is, three psychological factors, including LLLs, engineering career outcome expectations, and engineering skill self-efficacy, did not mediate the relationship between WIL experience and LOs.

VI. DISCUSSION AND IMPLICATIONS

The difficult circumstances of today's social and economic conditions are very different than those of previous eras, thus making students more focused on their capabilities and future careers [113]. A number of previous studies have highlighted the importance of students' LOs for their development of long-term capabilities [10] associated with future skills and careers [114]. However, few studies have explored the relationship between WIL experiences and the development of LOs through learning experience and psychological factors, especially among engineering students. In accordance with the purposes of this study, this study makes several contributions to the literature. First, this study is the first investigation in Thailand or other developing countries to apply SEM to systematically examine the relevance of WIL experience and learning strategies for predicting the LOs of engineering students. Second, the results of this study help provide a better understanding of the benefits of WIL on skill self-efficacy and LLLs. Third, this paper provides evidence that LO development is associated with critical experiences and psychological factors, such as WIL experience, learning strategies, institutional and goal commitments, achievement goal orientation, LLLs, career outcome expectations, and skill self-efficacy. These results are discussed in more detail below.

A. DIRECT EFFECTS

First, regarding the direct effects, as expected, WIL experience predicted engineering skill self-efficacy (H1) and LLLs (H2). These results support previous findings related to SCCT indicating that students who have had WIL experience tend to have higher self-efficacy in professional skills and LLLs than those who do not. Such self-efficacy is relevant to an individual's belief in his or her capacity to perform professional roles and be lifelong learners. Participation in WIL provides an opportunity to work in the real world and to thereby integrate both hard and soft skills that can enhance engineering skill self-efficacy and LLLs among students. Consequently, the findings are in line with past research that has found that WIL experience can strengthen and enhance the development of professional self-efficacy [51], [115] and LLLs [12], [53] which can lead to improved adjustment, performance accomplishments, and desired skills. Although the path coefficients were small, these positive effects underscore the role of WIL experience in the development of skill self-efficacy and LLLs. It would therefore be an interesting target for future studies to investigate the relation of WIL to skill self-efficacy and LLLs.

Second, the results also showed that engineering skill self-efficacy had a direct effect on LOs (H3). This finding suggested that engineering skill self-efficacy can predict the quality of students' LOs and their achievement. A number of prior studies have revealed significant and substantial direct effects of engineering skills self- efficacy on academic expectations [116]–[119]. These findings support Bandura's theory [120] and suggest that self-efficacy is a crucial determinant for individuals, as it enhances motivation, which in turn leads to academic success [121]. Students with higher self-efficacy are more willing to choose to perform more challenging tasks [122] and show better academic performance than those with low self-efficacy [63].

Third, career outcome expectations had a direct effect on engineering skill self-efficacy (H4). This effect may occur because students with high outcome expectations are more likely to have consistent confidence in their work and their ability to perform tasks, and such high expectations help them strengthen their self-efficacy regarding their skills and performance. However, these results differ from those of some previous studies that proposed the influence of self-efficacy on outcome expectations (e.g., Pajares [123]; Lent, *et al.* [62]), which might be because career outcome expectations were hypothesized to be reciprocally related to skill self-efficacy. As Bandura [124] noted, the relationship between self-efficacy and the expectations of results can be confusing because these two variables may be represented by the same principal construct that is featured in general self-efficacy theory [62]. Therefore, the reciprocal relationship between career outcome expectations and skill self-efficacy should be studied for clarity in different contexts.

Fourth, learning strategies were strongly predictive of LLLs (H5) and institutional and goal commitments (H6). This finding demonstrates that students with higher levels of self-effort regulation and collaborative learning tend to develop better LLLs and institutional and goal commitments. This finding is in line with prior research showing the impact of strong learning strategies on LLLs among college students [125]. In addition, Demir and Doğanay [126] found a similar relationship between self-effort regulation and LLLs. Braxton, *et al.* [59] also found a relationship between learning strategies and institutional and goal commitments. A focus on learning strategies may result in better LLLs and institutional and goal commitments.

Fifth, this research showed that institutional and goal commitments had a direct effect on achievement goal orientation (H7). The results support research on organizational study [76], indicating a positive relationship between achievement goal orientation and institutional and goal commitments. In the context of Tinto's student integration theory [72], institutional and goal commitments were hypothesized to contribute to goals and actions, both directly and through achievement goal orientation. Students with stronger institutional and goal commitments were more likely to have a high positive achievement goal orientation attitude toward studying.

Sixth, the two hypotheses relating to the effect of achievement goal orientation on career outcome expectations (H8) and LOs (H9) were supported. The primary reason for these findings is that having a high achievement goal orientation will more effectively drive students toward positive LOs [82], [127]. These findings were similar to those of a number of previous studies showing the role of achievement goal orientation in terms of mastery and performance aspects (e.g., Tian, *et al.* [73], Wang, *et al.* [128], Daniels, *et al.* [129]). Because these two goal aspects are linked to deeper interest, higher academic achievement [130], and students' expectations [131], students who develop achievement goal orientations might be more motivated to work hard to achieve their goals [132] and have high levels of career aspirations [133].

Finally, this study examined whether LLLs increased career outcome expectations (H10) and LOs (H11). The results showed a strong impact of LLLs and provided support for H10 and H11. These findings are consistent with evidence from a previous observation by Rogers and King [134] demonstrating that LLLs could enhance students' outcome expectations. This might be explained by the fact that students' interest in developing greater LLLs leads to higher intention related to their career outcome expectations. Additionally, it has been well documented in the literature that LLLs contribute to LO quality [53], [81]. The processes of LLL development help students build better outcome expectations and LOs because they envision their success through the skills they possess.

B. INDIRECT EFFECTS

The findings indicated that learning strategies not only had the largest direct effect on institutional and goal commitments and LLLs but also had the largest indirect effect on LOs (H13). This could be because the quality of learning strategies, which is measured by self-effort regulation and collaborative learning, can enhance institutional and goal commitments, which result in student achievement goal orientations, and encourage students to strive to aim for success. Through the aforementioned learning strategies, habits related to the development of LLLs are created that lead to self-development and outcome expectations, which in turn lead to skill self-efficacy and success in LOs. As such, it is important to cultivate students' self-effort regulation and collaborative learning. Students should focus on learning strategies as a freshman at the very beginning of their university education to develop other skills that lead to increased quality LOs. This finding is consistent with those of Magulod [135] and Kim [136], who asserted that adequate preparation in the use of learning strategies, including making educational resources available, providing an active environment and learning activity guidelines, and selecting learning targets, is critical for the development of LOs.

Additionally, the findings showed that institutional and goal commitments had a positive indirect impact on the quality of LOs (H14). Students with a more positive attitude toward shared institutional and goal commitments seem to have better academic outcomes [72]. The findings from this study replicate the findings of previous studies that institutional and goal commitments and psychological variables are very important predictors of students' learning and that higher-quality of achievement goal orientation leads to greater expectations and LOs [137].

On the other hand, WIL experience had nonsignificant indirect effects on LOs (H12); thus, H12 was not supported. However, the results of this study showed a direct association between WIL experience and two factors, namely, engineering skill self-efficacy and LLLs. It is possible that the practice of WIL in the workplace is short-term (approximately 4 months), while the development of LOs is a continuous process of studying that requires a number of factors to support it. Therefore, WIL experience does not influence LOs. Rather, WIL experience is an important factor in building confidence in skills and promoting LLLs [14], [50]. This finding further emphasizes the necessity of investigating the associations between WIL experience, engineering skill self-efficacy, and LLLs.

C. THEORETICAL IMPLICATIONS

These findings contribute to the understanding of the relationship among WIL experience, learning strategies, psychological processes, and LOs. First, this study expands the research on the effectiveness of WIL programs. Many previous studies have focused on the direct effects of WIL on students' employability and self-efficacy. The link between

WIL experience and LOs through psychological mediator variables, such as self-efficacy, has not yet been investigated. Therefore, by focusing on the results for WIL, this study proposes the development of LOs through students' psychological processes to focus more on student outcomes.

Second, the findings of this research indicate that learning strategies have the most powerful indirect influence on LOs. A number of studies examined the direct relationship of learning strategies with LOs, institutional and goal commitments, and LLLs. However, these studies did not generate theoretical evidence to integrate SCCT and explore the effect of learning strategies on LOs through learning processes and psychological variables. Therefore, this research confirms and expands the SCCT research.

D. PRACTICAL IMPLICATIONS

This study has two practical implications. First, it was observed that achievement goal orientation and LLLs had a significant positive direct effect on LOs. Based on this study, students are encouraged to find ways to enhance their achievement goal orientations and improve their LLLs as a means of improving the quality of their LOs and preparing for their future careers. Second, learning strategies and institutional and goal commitments was found to play a vital role in determining the indirect path that students take to achieve their desired LOs. Learning strategies enhance LLLs and institutional and goal commitments, which lead to achievement goal orientation. Moreover, there was a positive mediating effect of psychological factors on the relationship between WIL and learning strategies with LOs. This finding suggests that the development of LOs should be based on training students by providing good, sound learning strategies and creating a wide range of WIL experiences so that students develop a commitment to their success, LLLs, and confidence in their career skills, which are predictors of LOs.

The results further suggest that education practitioners and administrators may draw insights from SCCT and this study to create development approaches and practices for the promotion of LOs; these approaches and practices can affect students' future career skills and increase the sustainability of their employability amidst uncertainty and the rapidly changing world economy and society. Student development practices such as engaging in self-directed and cooperative learning, achieving achievement goals, obtaining on-site internships to increase confidence in career skills self-efficacy, and developing LLLs may help to strengthen students' personal growth and LOs in terms of their human skills, organizational skills, information skills, and knowledge and skills in engineering, as well as their future career capabilities. In particular, students with WIL experience and higher achievement goal orientations have higher skill self-efficacy, which could lead to new ideas in teaching and new ways to guide engineering students to undertake achievement goal orientation and support students' learning in the workplace.

VII. LIMITATIONS AND FUTURE RESEARCH

There are still some limitations to this study, and some suggestions for future research should be noted. First, although there were many variables in the proposed model, other variables, such as digital usage, online education, learning environment, and academic aspirations, may also be causal or mediator variables in the relationships between WIL, learning strategies, and LOs. Therefore, future research should consider these variables.

Second, this study was cross-sectional, and the data were collected from engineering students in Thailand. Therefore, these findings should be further tested in terms of whether they can be applied to other regions/countries or other types of HEIs (e.g., community colleges or technical universities). In view of this, examining the SEM model in new samples, including multiple group structural equation analyses among specific groups of interest (e.g., invariance analysis between Thai students and students of other cultural backgrounds), is more important. In addition, students' perceptions of their self-efficacy, career outcome expectations, LLLs, and LOs can change over their lifetimes as a result of learning and experiences. Therefore, future studies could employ a longitudinal design (both prospective and retrospective) to analyze changes over time at the individual and school levels.

Third, self-reported questionnaire measures were used in this study. In survey research, when answering questions, respondents might not express their true attitudes or behaviors, which could lead to some errors in the results. Interviews may be a way of collecting more in-depth information to support data from the questionnaire.

Fourth, the sample size used in this study was sufficient for the SEM analysis. However, to increase the statistical power and reliable results, future studies should collect more data and increase the sample size as well as attempt to replicate these findings.

Finally, as current educational systems have been affected by the COVID-19 pandemic, universities worldwide have had to adopt online learning in place of face-to-face classes [138]. This becomes a valuable opportunity, because online learning makes the pedagogical processes more flexible [139], provides access to a very large amount of course materials and training programs [140], [141], and affects students' academic performance [142], further research should study the impact of online learning and online training on skill self-efficacy and LOs of engineering students.

VIII. CONCLUSION

This study investigated the interrelationships among various factors in engineering students' LO development based on a model from the SCCT framework. The statistical results revealed that LOs are strongly influenced by learning strategies, followed by achievement goal orientation, LLLs, institutional and goal commitments, skill self-efficacy, career outcome expectations, and WIL experience. The findings also showed that learning strategies have the largest indirect association with LOs. WIL experience can lead to significant

TABLE 7. Learning outcomes scale for engineering students.

Dimensions/items	
1. Human Skills	
1.1 Integrity and Ethical Responsibility	
1	Behave honestly and morally and are a good citizen
2	Have a calm and peaceful mind and happiness in life.
3	Are self-directed to continuously develop academically and professionally in accordance with reality and work goals.
4	Have common sense regarding your duties. Have responsibility in decision making. Your actions and performance are reliable.
1.2 Respect and Honor Others	
5	Have respect for human dignity, honor and acceptance of the role of others.
6	Show timeliness in listening and speaking
1.3 Social Skills	
7	Can perceive the complex emotions of the others and can respond quickly and appropriately.
8	Can improve and develop your habits continually and appropriately.
9	Can control your emotions and needs with proper expression based on status and roles.
1.4 Self Confidence and Understanding of Diversity	
10	Can create motivation and inspiration for yourself to be determined to reach a goal.
11	Are self-confident in dealing with challenges both at work and in your personal life.
12	Can handle feedback such as compliments, failures, and criticisms consciously and effectively.
13	In a variety of social and cultural contexts, you are able to adapt to responsible work professionally and quickly.
2. Organizational Skills	
2.1 Working Effectively and Efficiently	
14	Can effectively work in a timely manner in accordance with the standards of the job despite the barriers and pressures of the environment.
15	Can work and solve the working problems effectively in a diverse environment and with people from different social and cultural backgrounds.
16	Can work independently in tasks such as planning, practicing, and evaluating, including prioritizing and completing work without being directly controlled by a person or factor.
2.2 Membership and Leadership Skills	
17	Can motivate and persuade the others to rely on your own ideas rationally.
18	Can efficiently work with a diverse team of multiple professionals including both associates and engineering technical leaders
19	Can create a proud atmosphere for the team and participate in being responsible for the goal
2.3 Entrepreneurship	
20	Can prioritize tasks and manage them through completion
21	Can work or do any activity to effectively achieve the results or outputs
22	Have a deep understanding of the pattern, structure, corporate culture, and professional work of engineering
2.4 Knowledge of Business and Public Policy	
23	Have knowledge of general business, economics and public policy
3. Information Skills	
3.1 Communication Skills	
24	Can effectively communicate about engineering in Thai in writing, speaking, listening and presenting projects/work.
25	Can effectively communicate about engineering in English in writing, speaking, listening and presenting projects/work.
26	Can clearly communicate verbally with a good personality and good approach suitable for each group audience and seniority.
27	Can speak in public and adjust your way of speaking to suit the nature of the audience.
28	Can systematically and clearly present knowledge and information in a professional writing style.
29	Have knowledge and competence in using various necessary

TABLE 7. *(Continued.)* Learning outcomes scale for engineering students.

Dimensions/items	
	and modern information technology media for targeted communication such as project/report presentations, the expression of opinions, and the creation of motivation
3.2 Critical Thinking	
30	Can determine key issues to focus on problem solving based on the situation.
31	Have the skills and competence to think critically, analytically, and systematically to support problem solving and decision making at work.
32	Can evaluate alternatives for decision making in order to work effectively
33	Are careful in evaluating your own thoughts, which leads to the improvement and development of creative work.
34	Can assess your own knowledge and competence to continuously improve your work.
3.3 Learning Ability	
35	Have the enthusiasm and desire to research and learn to move forward to be an engineering professional in the field you are specializing in.
36	Can further your knowledge to enhance your skills in order to create more opportunities to be more professional
37	Are willing to learn, improve, and change your way of working as needed and demanded by the job or agency.
3.4 Initiative and Understanding of Current Issues in Engineering	
38	Can create new ideas leading to innovation and the quality of work in the profession.
39	Understand current issues and current problems in engineering at the national, regional, and global levels
4. Knowledge and Skills in Engineering	
4.1 Basic Knowledge in Science and Engineering	
40	Have sufficient knowledge and skills in numerical calculation and the use of mathematical, scientific and statistical techniques for the proper use and management of engineering information.
41	Can properly apply knowledge, theory and principles in engineering to solve problems and make decisions in the engineering profession.
4.2 Engineering Analysis and Design	
42	Can appropriately apply material science knowledge to solve engineering problems.
43	Can effectively apply engineering process, technics, and design to solve engineering problems.
44	Have knowledge and understanding of the impact of engineering solutions in the context of the world economy, environment and society.
45	Have the perseverance and patience to complete engineering work
46	Can design and conduct experiments to solve engineering problems as well as analyze and interpret the meaning of data to reach the correct conclusion.
4.3 Applying Professional Instruments and New Technology	
47	Can interact with cutting-edge software interfaces, such as human-machine interfaces, and human-robot interaction
48	Have the skills to apply digital technology, such as computers, PDAs, media players, and GPS, to communicate and create professional engineering networks.
49	Have skills in using advanced computer and information technology to produce, design and develop engineering work.
50	Have the skills, knowledge, and competence in using modern techniques and tools in engineering practice
51	Can design working systems, components, or engineering processes according to the needs and requirements of the job.
4.4 Work Quality and Problem Solving	
52	Are aware of the quality of the work required to meet the professional standards.
53	Can efficiently solve problems and handle conflicts when facing new situations
4.5 Adherence to the Code of Engineering Professional Ethics	
54	Are responsible and adhere to professional ethics to maintain strong working ethics throughout the duration of the job as an engineer.
55	Understand your roles and duties and are determined to develop yourself as a professional engineer according to the professional standards of engineering and control engineering.

changes in engineering skill self-efficacy and LLLs but does not affect LOs.

DISCLOSURE STATEMENT

The author declares no potential conflicts of interest with respect to the publication of this paper.

APPENDIX A

See Table 7.

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BURATIN KHAMPIRAT received the B.Ed., M.Ed., and Ph.D. degrees from Chulalongkorn University, Thailand.

She was a Visiting Professor with the Universidad Nacional de Educación a Distancia (UNED) in 2019. She is currently an Assistant Professor of educational research with the Suranaree University of Technology, Thailand. Her research interests include the assessment of efficiency and effectiveness in HEIs, employability, career and student development, and assessment of competencies using SEM and multilevel modeling. She received a number of national and international awards/honors, most notably the best refereed research paper award from WACE in 2017 and 2018. She is also a Co-Convenor of the European Educational Research Association (EERA) in Network 11-Educational Effectiveness and Quality Assurance.