VIETNAM JOURNAL OF EDUCATION, 2022
Volume 6, Issue 2, 150-160
https://doi.org/10.52296/vje.2022.165

ORIGINAL ARTICLE

Student Self-assessment in Regard to the Learning Outcome Achievement Level When Using the CDIO Approach at University of Information Technology - Vietnam National University, Ho Chi Minh City

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Article history
Received: March 9, 2022
Accepted: May 16, 2022
Published: June 15, 2022

Keywords
Self-assessment, learning outcome achievement, CDIO approach, University of Information Technology

ABSTRACT
In 2010, Vietnam National University Ho Chi Minh City implemented the application of the CDIO (Conceiving - Designing - Implementing - Operating) approach, which has improved the quality of training in science and engineering majors. Nearly all of the curricula of Vietnam National University Ho Chi Minh City's member schools are built completely or partially based on CDIO principles. The CDIO approach is well-suited to the practical context of Vietnamese technology training, which is adapted to the Vietnam National Qualification Framework and domestic as well as international quality accreditation criteria. CDIO-based programs focus on learners' competency upon the completion of a program. A quantitative study was conducted to analyze student self-assessment concerning achievements in their learning outcomes, and to determine the correlation between their performance and how well they fulfilled learning outcomes requirements. The data was collected from a random sample of 502 students at University of Information Technology - Vietnam National University Ho Chi Minh City. The results indicated that student self-assessments of learning outcomes are similar to their assigned grades, which means there was a positive correlation in the evaluation. In addition, results acquired from the Analysis of variance (ANOVA) revealed that there is a significant variation in the assessments of learning outcomes between majors from different faculties (5 items out of 17 items.) The findings are meaningful to lecturers, students and managers in improving learning, teaching and evaluation activities, which in turn help students improve their performance and prepare them for their future careers.

1. INTRODUCTION

Universities in Vietnam have confronted a shortage of high-quality personnel that can meet the demands of the labor market due to the large gap between theory and practice, and insufficient skills of designing, implementing and operating to create the best products in their jobs. Therefore, higher education is in urgent need of solutions to improve training quality and address the issues related to inadequate approaches, without too much time or too excessive costs. CDIO, abbreviated from four English words: Conceive - Design - Implement - Operate (Building ideas, designing ideas, implementing ideas and operations) (Wu, 2018), is a comprehensive solution for the whole training process, including building learning outcomes, designing curricula, implementing them and assessing their effectiveness for further improvements. The features of learning outcomes in an CDIO-based educational program are divided into 4 major groups: (1) knowledge and deductive methods, (2) personal skills

and attitudes, (3) communication skills (teamwork, communication) and (4) forming awareness, design, implementation and operation in the context of business and society (Junaid et al., 2018). Vietnam National University Ho Chi Minh City (VNU-HCM) spent two years from 2008 to 2009 preparing for the CDIO implementation process, and officially conducted a pilot program at two engineering faculties belonging to two VNU-HCM's school members in 2010; then, based on the pilot results, extensively applied it to other programs in VNU-HCM. The university considers the CDIO approach a standard framework to develop curricula as Choo et al. (2015) affirms that CDIO plays a key role in meeting the US's Accreditation Board for Engineering and Technology's (ABET) criteria.

At the end of 2012, Crawley introduced the CDIO approach to the lecturers, managers and other stakeholders in engineering education which resulted in a major educational innovation at Queen's University of Australia. Subjects and ideas from the CDIO approach were incorporated into several of this school's curricula to some extent. Feedback from the lecturers, students and employers was frequently collected to improve the programs (Crawley et al., 2007). The CDIO approach focuses on the agreement of opinions from university and faculties' managers together with primary stakeholders because it is believed that by this way, the board of directors can figure out what to teach students so that they can meet the expected standards of the society. Thus, in designing curricula, learning outcomes under the CDIO approach always refer to stakeholders' feedback as compulsory evidence. However, currently, soliciting opinions is usually performed just to evaluate enterprise' satisfaction with the Alumni and to adjust the curricula. Although self-assessment is seen as an important practice that helps learners get actively involved in the learning process, it is still uncommon among Vietnamese higher educational institutions for the following reasons: 1 - Students feel that evaluation is the responsibility of lecturers; 2 - Teachers are yet willing to trust students' assessments and, 3 - Students lack sufficient self-assessment skills (Lee, 2011). This study aims to investigate the students' perceptions of whether they achieve the CDIO-based learning outcomes as well as the relationship between student self-assessments and learning results. To achieve these objectives, the study seeks to answer the three following questions:

1. Are there statistically significant differences ($\alpha = 0.05$) in mean values between student self-assessments and years of learning?

2. What is the correlation between student self-assessments and their performance?

3. Are there any significant differences between the students' individual characteristics and self-assessments regarding their learning outcomes when using the CDIO approach?

2. LITERATURE REVIEW

Once students understand the goals and criteria of a process, they must be given opportunities to self-assess their performance and make appropriate adjustments. In addition, teachers should utilize this as an opportunity to help them gain broader knowledge rather than just assign it as homework (Pintrich & Schunk 1996). Lecturers should give students rights that allow them to recognize their own strengths and weaknesses in learning because self-assessment is a very useful method for making effective use of feedback. (Sadler, 1989; Black & Wiliam, 1998). Moreover, students who are taught self-assessment skills often persist in completing difficult assignments, are more self-confident in their capabilities and more responsible for their jobs (Rolheiser & Ross, 2001).

Stiggins et al. (2007) point out that while self-assessment benefits all students, those with poorest performance benefit the most. Self-assessment plays an important role in developing students' self-awareness and creating increasing motivation because the participation of students depends on their beliefs about the ability to do well on a specific assignment and the good value of this job (Pintrich & Schunk, 2002; Schunk, 2004).

Bruce (2001), Schunk (1989), Zimmerman (2002), and Kitsantas et al. (2004) indicate that students' performance can be improved simply by allowing them to report their learning results. Students need to understand the purposes of knowing whether they achieve the goals that they have set. This is because they are more satisfied with their accomplishments when they can assess them and are provided with clear steps on how to attain their goals and bring about high levels of self-effectiveness.

Research on self-assessment as a tool for learning: Arter (1996), Dochy and McDowell (1997), O'Malley and Valdez (1996), Wendi (2001), Chamot and O'Malley (1994) state that self-evaluation is a tool for predicting challenges related to learning strategies and placing students at the center of their own learning.

Research on the roles of self-assessment claims that self-assessment is the combination of three elements in a process following a cycle, including: self-monitoring, self-judgement and implementation. The most fundamental objective of self-assessment is to give students a chance to provide feedback on both positive and negative aspects in their learning results (Saribeyli, 2018). Self-assessment can serve as a tool for encouraging students to take responsibility, stimulate them to work independently, and make the learning process their own. Because evaluation should not only be considered a duty and a task assigned by teachers, it needs to be shared and cooperated by lecturers and learners (Spiller, 2012). Besides, self-assessment involves both reflecting and evaluating results of the activities in the student learning process, so self-assessment gives them an opportunity to re-assess the learning activities, which helps develop positive attitudes and increase motivation for studying (Paris & Paris, 2001).

Research on the influence of student self-assessment: Sharma et al. (2016) contend that there is a significantly positive correlation between teachers' assessments and students' self-assessments. Self-evaluation increases students' interest and motivation in subjects, leading to improved learning and learning results, and the development of their critical skills. Similar to the point of Sharma et al. (2016), McMillan and Hearn (2008) investigate how students' self-evaluation is a crucial skill that enables students to boost their motivation and achievements. When learners set goals to improve their learning results, then identify the criteria, self-evaluate their progress, and put forward study strategies, they will see improvements in their learning results. In addition, self-assessment helps achieve two important goals: 1- improving the self-efficacy and confidence of students in learning, and 2 - achieving high scores in tests to raise the accountability. Ushioda (1996) confirms that by treating students fairly as academic peers in the learning and evaluation process, their self-esteem and ego are uplifted. As a result, learners develop a favorable perception of themselves thanks to their opinions being respected, which has a positive impact on their motivation.

Research on the relationship between teachers' assessments and student self-assessments: The study of Lee (2011) compare the evaluations made by lecturers and second year students majoring in interpretation and translation themselves. The findings showed that there were relatively significant differences between grades given by teachers and student self-assessments. Secondly, different from lecturers, students usually regarded note-taking, memorization, and psychological factors as important assessment criteria, implying that while students' self-assigned grades were similar to teachers' grades, they did not hold the same opinion in terms of assessment content. Finally, there were more comments during the process of student self-assessment than in teacher's assessment. This study also shows that student self-assessment had distinct characteristics that can be used to supplement evaluation by teachers. Furthermore, the study of Thawabieh (2017) also compares the results of evaluation performed by these two groups. A quasi-experimental study of 71 students at Tafila Technical University studying Introduction to Psychology was conducted with the goal of determining the accuracy of the student self-assessments and their link with the teachers'. In the first experiment, the results showed that there was a statistically significant difference between the assessments made by these two categories because students had more positive assessments than lecturers, which could be explained by the fact that students who had just entered university (freshmen) being overconfident in their abilities, failing to master self-assessment skills and understand the nature of university tests. The following experiment revealed that there was almost zero statistically significant difference between the evaluation results of these two groups after teachers provided feedback to learners on self-assessment criteria and objectivity in self-assessment. Finally, the author concluded that students could correctly self-assess if they were instructed how to do so properly.

Similarly, Tejeiro et al. (2012) conduct a study on the accuracy and validity of summative self-assessment of two groups of total 122 freshmen majoring in two pedagogical majors at the Universidad de Cadiz (Spain), and participating in two different courses over a six-month period. Upon the completion of these courses, both groups completed a self-assessment questionnaire that includes sections on capacity, learning results, and content based on their self-assessment. Although all students participating in this study were to assign themselves grades at the end of courses, only half of them were informed that their self-assigned grades would count for 5% of their final grade. Students' self-assessment data was compared to the given teacher's scores, and the ten students with the greatest difference were chosen for an interview. In both groups, the student self-assessment results are better than the teacher's scores, especially significantly higher in the group of students with poorer academic results and the group of which the self-assessment result was included in the final scores. Tejeiro et al. (2012) concluded that when not included in the final scores, student self-assessments tended to be very similar to those of teachers; however, when

self-assessment was counted towards final grades, there were two distinct increasing trends: overestimation and underestimation. The authors explained this difference by suggesting that students were motivated by the desire to get the best grades possible or were affected by the stress associated with self-evaluation. Furthermore, the results of the student self-assessment showed no gender differences.

Studies on difficulties when students self-assess their learning outcomes: Lindblom et al. (2006) explored the experiences of 15 law students on the self-assessment process. The scoring matrix was used to facilitate the assessment for both teachers and learners. The findings showed that the students sometimes struggled with self-assessment because they believed they couldn't be objective when evaluating their performance, and they also had difficulty giving criticism in peer-assessment. At the same time, the students agreed that it was harder to assess content-related aspects as compared to technical ones. According to Gurbanov's (2016) study of 31 lecturers and 100 students at Qafqaz University in Baku, Azerbaijan, both teachers and students believed that self- and peer-assessment reduced anxiety and rendered the evaluation less stressful to some extent. They also put forward a positive view that self-assessment improved accountability and promoted self-awareness and learning in both students and teachers. However, both parties agreed that the reliability, scoring method, and objectivity of student self- and peer assessment were not as reliable as those performed by teachers.

Authors such as Vu Thi Lan Anh and To My Vien (2018) clarify the processes and procedures to develop curricular which meet social demands and international standards. Besides, this paper also mentions the principles to implement evaluation of students' results with CDIO; Liu et al. (2009) indicate that the CDIO approach is an innovative educational framework for producing the next generation of engineers. The authors demonstrate some advantages of the CDIO approach in reforming at School of Information and Electronic Engineering of Zhejiang University of Science and Technology (ZUST). The school comprehensively revised the curriculum system, the assessment method, and the experiential learning environments. Personal, interpersonal and system building skills are codified in the CDIO-based Syllabus.

The studies mentioned above highlighted the roles and impacts of summative self-assessment as well as the link between self-assessment and students' learning motivation and their relationship with teachers in the evaluation process. Self-evaluation increases students' achievements and learning activities, or there is a substantial positive association between evaluations made by students themselves and by teachers (Lindblom-ylänne et al., 2006). Nevertheless, the study of student self-assessments on the learning outcome achievement level using the CDIO approach remains a gap that needs to be filled to contribute to the improvement of teaching and learning quality in higher education that uses CDIO-based curricula.

3. MATERIALS AND METHODS

A quantitative study was designed to identify students' perceptions of learning outcomes under the CDIO approach at VNU-HCM-UIT. The majority of the data collected for this study was examined with descriptive statistics and statistical correlation analysis (ANOVA) by SPSS 20.0.

A questionnaire was used to collect background information from students as well as their summative self-assessments with the use of the CDIO approach. The study involved 502 students, including 16.9 percent of freshmen, 26.9 percent of sophomores, 34.5 percent of juniors, and 21.7 percent of seniors, who were randomly chosen from VNU-HCM-UIT and were all in the same age range (17-20). This sample population's demographics were as follows: females (13.9 percent) and males (86.1 percent). Only 0.8 percent of those who responded to the survey are ranked very poor, 14.3 percent are ranked average, 62.2 percent are ranked good, and the rest are ranked excellent. Furthermore, the percentage of students who had jobs while studying at the university was 74.1 percent.

The survey in this study used a 5-point scale, with responses ranging from 1 to 5, with 1 being very poor and 5 being excellent.

Besides, according to VNU-HCM-UIT regulations, curriculum and learning outcomes must be clearly disclosed to learners and stakeholders. In addition, the significant task of the lecturer in the first lesson is to introduce a syllabus, which clearly shows the forms of assessing and evaluating that may be used to help students achieve the learning outcomes. Therefore, this article will not present more details on the dissemination of learning outcomes when using the CDIO approach.

4. RESULTS AND DISCUSSION

4.1. Results

4.1.1. Student's self-evaluation of their learning outcomes when using the CDIO approach

The following learning outcomes are part of the fundamental outcome standards of engineering curricula. This study used factor loading, total variance explained, and internal consistency analysis (Cronbach's) to assess the validity and reliability of the measuring methods for students' self-assessments when using the CDIO approach. Values of factor loading for the items of student self-assessment ranged from 0.637 to 0.739, higher than the threshold level of 0.6. Total variance explained was 66.30 percent, higher than the threshold level of 60 percent and meeting the requirement for social science research (Hair et al., 2009). With Cronbach's α coefficient of 0.937, exceeding the threshold level of 0.6 (Hair et al., 2009) and 0.7 (Nunnally & Bernstein, 1994), proved satisfactory reliability.

The descriptive statistics of the students' summative self-assessments in conformity with the CDIO approach are shown in Table 1.

Table 1. Statistical analysis for student self-assessment in regard to their learning outcomes when using the CDIO approach

Learning outcomes (LOs)	Mean (M)	Std. Deviation (SD)
1. Technical knowledge and reasoning		
1.1. Principal knowledge	4.04	.909
1.2. Engineering fundamental knowledge	4.08	.873
1.3. Major knowledge	4.07	.895
2. Personal and professional skills and attributes		
2.1. Analytical ability and problem solving (identification, definition, analysis and conclusion problems)	4.00	.886
2.2. Experiment and knowledge discovery (look for information, conduct survey, hypothesis testing, and defense)	3.94	.904
2.3. System thinking (holistic analysis, identifying emerging issues, identifying core driving factors, looking for solutions, etc.)	4.03	.902
2.4. Personal skills and attitudes (Initiative, willing to take risks, perseverance, flexibility, creative thinking, self-awareness, lifelong learning, resources and time management, etc.)	4.02	.934
2.5. Professional skills and attitudes (professional ethics, integrity, responsibility, update frequently information related to engineering field, professional behavior to person and organization, etc.)	3.99	.923
3. Interpersonal skills: teamwork and communication		
3.1. Teamwork (forming team, organizing team, developing team, leadership, technical and multidisciplinary team collaboration)	4.09	.914
3.2. Communication (communication strategy, presentation, written communication/ multimedia, developing social skills)	3.95	1.008
3.3. Communication in foreign languages (English communication, English proficiency)	3.83	1.040
4. Problem solving abilities: conceiving, designing, implementing and operating skills in enterprise and society context		

4.1. External context (roles, responsibility of engineers, the impact of Information Technology on society, engineering society codes of ethics, etc.)	3.95	.907
4.2. Enterprise context (respecting diversity in enterprise cultures, goals, strategies và business plan, adapting to different workplaces, etc.)	3.94	.885
4.3. Conceiving and engineering systems (setting system goals and requirements, defining function, system structures, ensuring goal-setting fulfillment)	4.05	.823
4.4. Designing (designing process, method, approaches, utilizing knowledge, major design, multidisciplinary/multi-objective design)	4.14	.844
4.5. Implementing (making a plan, hardware detail machined and assembled, controlling and implementing software systems, testing and managing process)	4.00	.857
4.6. Operating (designing and optimizing operating process, improving and developing, operating management, etc.)	3.95	.889
Total variance explained (%)	**66.30**	
Cronbach's α	**.937**	
Total M(SD)	**4,00**	**0,90**

Table 1 shows that almost all values were assigned with more than four points, indicating that students achieved generally good learning outcomes. Two of them namely technical knowledge and reasoning, were rated higher than other learning outcomes (all values are above 4-point). The findings also revealed that students found themselves able to acquire the principle, fundamental and specialized knowledge.

The training is designed to follow the CDIO standards to train engineers who can conceive, design, implement, and run complicated processes in modern, multi-disciplinary environments. This requires students to understand the theories and principles of engineering operations, as well as to assess, apply, and evaluate these theories. Therefore, students being able to assess whether they achieve the learning outcomes is a strong foundation for students to gain knowledge at higher levels.

Besides, there are some criteria with lower scores than the others, as follows: Experiment and knowledge discovery (M = 3.94, SD = 0.94); Professional skills and attitudes (M = 3.99, SD = 0.923); Communication in foreign languages (M = 3.95, SD = 1,008); External context (M = 3.83, SD = 1,040); Enterprise context (M = 3.94, SD = 0.885), and Operating (M = 3.95, SD = 0.889). Of these, External context and Enterprise context of learning outcomes with SD measures greater than one indicate that the data strongly fluctuated and those values were far lower from the mean value, meaning that there was no consistency in the self-assessments of the students that responded. In addition, the results were consistent when being compared to the annual reports by VUN-HCM-UIT because practically all of the reports revealed that some of the student learning outcomes (communication and behavior skills, foreign language skills, and practical skills) were generally limited.

Overall, it was found that students at VNU-HCM-UIT fulfilled the CDIO learning outcomes in all categories to varying extents (Total M = 4.00, SD = 0.90).

4.1.2. Comparison between students' achievements and their self-assessment in relation to learning outcomes when using the CDIO approach at the Vietnam National University - Ho Chi Minh City, University of Information Technology

When the relationship between students' grades and learning outcomes were taken into consideration, there were only significant differences for 2 out of 17 criteria, but there were no significant differences in other categories, such as principle knowledge, engineering fundamental knowledge, Analytical ability and problem solving, system thinking, personal skills and attitudes, teamwork, communication, and problem solving abilities: conceiving, designing, implementing and operating in enterprise and society context.

However, when students' majors and their self-evaluation in relation to their learning outcome achievement level were compared, the finding showed that there were significant differences in 5 out of 17 items.

Table 2. ANOVA for comparing students' self-assessments and assigned grades in relation to learning outcomes when using the CDIO approach

Factors		N	M(SD)						
			Major knowledge	Experiment and knowledge discovery	Analytical ability and problem solving	Personal skills and attitudes	Professional skills and attitudes	Enterprise context	Operating
Grade description	Poor (A)	4	2.75 (.500)	2.75 (1.708)	-	-	-	-	-
	Average (B)	72	4.11 (.958)	3.94 (.870)	-	-	-	-	-
	Good (C)	312	4.08 (.904)	3.88 (.915)	-	-	-	-	-
	Excellent (D)	114	4.06 (.812)	4.15 (.812)	-	-	-	-	-
Major	C&CN(A)	175	-	-	4.05 (.870)	4.00 (.891)	3.78 (1.057)	4.15 (.838)	3.96 (.886)
	InfoSec (B)	79	-	-	4.33 (.693)	4.44 (.747)	4.32 (.856)	3.99 (.840)	4.22 (.673)
	IT (C)	74	-	-	4.01 (.884)	4.07 (.782)	4.05 (.719)	3.80 (.721)	3.96 (.851)
	CS (D)	221	-	-	4.09 (.824)	4.21 (.880)	4.08 (.875)	3.98 (.879)	4.18 (.811)
	CE (E)	57	-	-	3.81 (.833)	3.98 (.834)	3.93 (.942)	3.79 (.921)	3.81 (.875)
Years of university learning	Freshman (1)	85		3.86 (.978)	3.92 (.848)				3.87 (.768)
	Sophomore (2)	135		3.84 (.874)	3.87 (.913)				3.88 (.864)
	Junior (3)	173		4.11 (.859)	4.17 (.859)				4.24 (.775)
	Senior (4)	109		3.85 (.921)	3.96 (.892)				3.89 (.966)
F			2.992*	5.003*/ 3.227**	3.496*/ 3.592**	4.662*	5.489*	3.285*	4.109*/ 6.736**
Post Hoc			A < B	D > C; 2 < 3	B > C 2 < 3	A, C, E < B	D > A	A > C	E < B, D; 1,2,4 < 3

Note. CN&C: Communication and computer network; InfoSec: Information security; IT: Information technology; CS: Computer science; CE: Computer engineering

**p< .05, p< .01*

The ANOVA data showed that there were significant differences in student self-assessment concerning the criteria Major knowledge (F = 2.992, p 0.05) and Experiment and knowledge discovery (F = 5.003, p 0.05), as shown in Table 2. Furthermore, post-hoc analysis revealed that students with "poorer results" (M = 2.75, SD = 0.50) had lower scores in the assessment of their own learning outcomes than average students (M = 4.11, SD = 0.958). The findings also revealed that students who were ranked excellent had a higher assessment of the experiment and knowledge discovery of learning outcomes than those who were ranked good. It is an indisputable fact that students who were ranked at high positions tended to self-evaluate themselves better than others.

On the other hand, the results of student self-assessment regarding learning outcome achievements in different majors also had significant differences as follows:

• Analytical ability and problem solving: InfoSec (M = 4.33, SD = 0.693), in comparison with IT (M = 4.01, SD = 0.884), p < .05*

• Personal skills and attitudes: InfoSec (M = 4.44, SD = 0.747), in comparison with C&CN (M = 4.00, SD = 0.891), IT (M = 4.07, SD = 0.782), CE (M = 3.98, SD = 0.834), p < .05*

• Professional skills and attitudes: CS (M = 4.08, SD = 0.875), in comparison with C&CN (M = 3.78, SD = 1.057), p < .05*

• Enterprise context: C&CN (M = 4.15, SD = 0.838), in comparison with IT (M = 3.80, SD = 0.721), p < .05*

• Operating: InfoSec (M = 4.22, SD = 0.673), in comparison with CS (M = 4.18, SD = 0.811), and CE (M = 3.81, SD = 0.875), p < .05*

Furthermore, Table 3 also shows a positive correlation between the student self-assessment of their learning outcome achievement and their years of learning. Juniors had higher scores of self-assessments than other grades (p<0.01). This result showed that students in more senior years achieved higher scores of learning outcomes (specifically, in this study, third year students achieved higher output achievements than first and second year students, even seniors) because the more senior the students were, the higher level of difficulty of specialization of the majors was designed with. However, the results also pointed out that final year students had lower self-assessment regarding their learning outcome achievement compared to the third year students.

Nevertheless, according to the findings, when students were divided into two groups (the first group for students who had a poor to average ranking and the second for the other rankings) and data was analyzed by Independent sample test (t-test), only the learning outcome of operating differed significantly between the two groups. Moreover, there was a very slight difference between two groups when it came to the learning outcome of experiment and knowledge discovery.

Table 3. T-test for Comparing Self-Assessment and students' assigned grade between two groups

LO	**t-test for Equality of Means**		
Operate	F		1.607
	t		2.363
	df		500
	Sig. (2-tailed)		.019
	M (SD)	Poor to Average	4.01(.849)
		Good to Excellent	3.00(1.418)

4.1.3. The relationship between background factors and learning outcomes achievement level when using the CDIO approach of Vietnam National University - Ho Chi Minh City, University of Information Technology students

The authors such as Maldilaras (2002), Kirmani and Siddiquah (2008), Hansen (2000), Hijazi and Naqvi (2006) demonstrate that personal characteristics, accommodation, gender, time to attend class, family finances, etc. have a significant influence on students' learning outcomes. In this study, Table 4 suggests four factors that influenced the students' self-assessment regarding learning outcomes in conformity with the CDIO approach of the VNUHCM-UIT students. These factors explained 13.4% of variance in terms of the student self-assessment of learning outcome

achievement level (Adj. R 2 = .134). Multicollinearity diagnosis yielded no value of variance inflation factor (VIF) in the regression models higher than 10 (in this research VIF = 1.008 to 1.015), indicating no risk of serious multicollinearity of the models (Hair et al. 2009). Durbin-Watson coefficient = 2,050 (ranging from 1.5 to 2.5), so there was no autocorrelation for first-order sequences (Qiao, 2011).

Table 4. Regression analysis of students' individual characteristics impact on learning outcomes under CDIO approach at the VNUHCM - UIT students

Factors	Unstandardized B	Standardized Coefficients Beta (β)	t	Sig.	VIF
(Constant)	2,830		16.556	.000	
Gender	.155	.085	2.040	.042	1.012
Accommodation	.013	.022	.581	.561	1.008
Time in class	.316	.363	8.664	.000	1.012
Employment status	.048	.033	.796	.426	1.015
Adjusted R Square					.134
R Square					**.140**
F (Anova)					**20.308**
Sig. (Anova)					**.000[b]**
Durbin-Watson					**2.050**

The first symbol is the unstandardized beta (B), this value represents the slope of the line between the predictor variable and the dependent variable. For every one-unit increase in Variable 1, the dependent variable increases by 1.57 units. In other words, B reflects the amount by which the dependent variable changes if we change the independent variable. Concerning the specific relationship between independent factors and learning outcomes, only two out of four items, gender (= .085, p.05) and class participation time (= .363, p.05), had an impact on achieving the learning outcomes. Accommodation factors and employment status had sig. value greater than .05 means no impact on learning outcomes.

4. Discussion

The study investigates VNU-HCM-UIT students' self-assessment regarding their level of achievement of learning outcomes when using the CDIO approach, as well as the factors influencing student self-assessment. According to the findings of this study, the followings are some critical points:

To begin, there was a positive correlation between student self-evaluation at VNU-HCM-UIT and their assigned learning results, and there was no conflict with teachers' evaluation. These findings contradicted previous research by Tejeiro et al. (2012), who discovered that students tend to either overestimate or underestimate in self-assessment (Thawabieh, 2017).

Secondly, there were significant differences between majors and years of learning in the students' self-assessment in relation to learning outcome achievement level when using the CDIO approach. These results also revealed that the learning outcomes in the curriculum were represented through the series of subjects and designed with increasing difficulty, so the deeper students were into their majors, the higher learning outcomes would be. The study also proved that although there were differences in student self-assessments regarding their learning outcome achievement levels all share the same thought that various subjects had different learning outcomes according to the CDIO approach. Simultaneously, compared to those from the other years, third-year students gave the highest points during this process.

Finally, the study's findings were partly consistent with the previous research by Bratti and Staffolani (2013), which suggested that students' demographic characteristics such as gender and time spent in class play the primary and only role in the achievement of learning outcomes and have a direct relationship to it. Therefore, lecturers and managers should consider these factors in their teaching and assessment activities in order to improve training quality.

5. CONCLUSION

Student self-assessment is the act of monitoring students' processes and products in order to take effective actions with the purpose of deepening learning and improving performance. The study also demonstrates that student self-assessment in regard to the achievement level of learning outcomes can be implemented at any stage of a course, such as at the end of a lesson, a subject, or summative assessment.

What is unclear are the guidelines, criteria, and how to apply the CDIO approach's self-assessment, all of which require additional research.

Another limitation of the study is that the population sample is, to some extent, unbalanced in terms of gender, years of learning, and student learning results in order to fully review all aspects of the CDIO-based self-assessment. As a result, future research should collect data that meet the aforementioned requirements for more complete empirical evidence on self-assessment regarding learning outcomes of engineering students in Vietnam.

Another limitation found during the research process is that student self-assessments on the learning outcomes are subjective, so appropriate tools and instructions for students to perform this accurately at the end of a study period, such as a semester, are needed.

Conflict of Interest: No potential conflict of interest relevant to this article was reported.

REFERENCES

Arter, J. (1996). *Using Assessment as a Tool for Learning*. In Blum, R. & Arter, J. (Eds.), Student Performance Assessment in an Era of Restructuring (p. 1-6). Alexandria, VA: ASCD.

Black, P., & Wiliam, D. (1998). Assessment and Classroom Learning. *Assessment in Education, 5*(1), 7-74. https://doi.org/10.1080/0969595980050102

Bratti, M., & Staffolani, S. (2013). Student Time Allocation and Educational Production Functions. *Annals of Economics and Statistics*, *111/112*, 103-140. https://doi.org/10.2307/23646328

Bruce, L. B. (2001). Student Self-Assessment: Making Standards Come Alive. *Classroom Leadership*, *1(5)*, 1-6.

Chamot, A. U., & O'Malley, J. M. (1994). *The CALLA Handbook: Implementing the Cognitive Language Learning Approach*. Reading, MA: Addison Wesley.

Choo. K. W, Tan. D., Chong. J. & Wee. K. S. (2015). *CDIO and ABET accreditation - The Nanyang Polytechnic Experience*. Proceedings of the 11th International CDIO Conference, Chengdu, June 11-15, 2015.

Crawley, E., Malmqvist, J., Östlund, S., & Brodeur, D. (2007). *Rethinking Engineering Education: The CDIO Approach*. Springer US.

Dochy, F. J. R. S., & McDowell, L. (1997). Assessment as a Tool for Learning. *Studies in Educational Evaluation*, *23*(4), 279-298. https://doi.org/10.1016/S0191-491X(97)86211-6

Gurbanov, E. (2016). The Challenge of Grading in Self and Peer-Assessment (Undergraduate Students' and University Teachers' Perspectives). *Journal of Education in Black Sea Region*, *1*(2), 82-91.

Hair, J. F., Tatham, R. L., Anderson, R. E., Black, W. (2009). *Multivariate data analysis (6 ed.)*. Upper Saddle River, NJ: Prentice Hall.

Hansen, J. B. (2000). *Student Performance and Student Growth as measure of success: A evaluator's perspective*. Presented at annual meeting of the American Educational Research Association, New Orleans, Louisiana.

Hijazi, S. T., & Naqvi, S. M. M. R. (2006). Factors affecting students' performance: A Case of Private Colleges. *Bangladesh e-Journal of Sociology*, *3*(1), 1-10.

Junaid, S., Gorman, P., & Leslie, L. J. (2018). *Deliberate Practice Makes Perfect! Developing Logbook Keeping as a Professional Skill through CDIO*. In 5th Annual Symposium of the United Kingdom & Ireland Engineering Education Research Network (pp. 80-85). Aston University.

Kirmani, N. S., & Siddiquah, A. (2008). *Identification and Analysis of Factors Affecting Students Achievement in Higher Education.* International Conference on assessing quality in higher education, Lahore - Pakistan.

Kitsantas, A., Reiser, R., & Doster, J. (2004). Developing Self-Regulated Learners: Goal Setting, Self-evaluation, and Organizational Signals during Acquisition of Procedural Skills. *Journal of Experimental Education*, *72*(4), 269-287. https://doi.org/10.3200/JEXE.72.4.269-287

Lee, Y. (2011). *Comparing Self-assessment and Teachers Assessment in Interpreter Training*. Retrieved June, 12, 2021, from http://cms.ewha.ac.kr/user/erits/download/review_1/04_Yun-hyang%20Lee.pdf

Lindblom-ylänne, S., Pihlajamäki, H., & Kotkas, T. (2006). Self, peer- and teacher-assessment of student essays. *Active Learning in Higher Education*, *7*(1), 51-62. https://doi.org/10.1177/1469787406061148

Liu, Y., Yang, C., & Yang, X. (2019). *Teaching Reform and Innovation Based on CDIO*. 2009 Second International Conference on Education Technology and Training, 301-304. https://doi.org/10.1109/ETT.2009.91

McMillan, J., & Hearn, J. (2008). Student Self-Assessment: The Key to Stronger Student Motivation and Higher Achievement. *Educational Horizons*, *87*(1), 40-49.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.

O'Malley, J. M. & Valedez Pierce, L. (1996). *Authentic Assessment for English Language Learners: Practical Approaches for Teachers*. New York: Addison-Wesley Publishing Company.

Paris, S. G., & Paris, A. H. (2001). Classroom Applications of Research on Self-regulated Learning. *Educational Psychologist*, *36*(2), 89-101. https://doi.org/10.1207/S15326985EP3602_4

Pintrich, P. R., & Schunk, D. H. (1996). *Motivation in Education: Theory, Research, and Applications.* Englewood Cliffs, N.J: Merrill/Prentice Hall.

Qiao, Y. (2011). *Interstate Fiscal Disparities in America (2th ed.)*. New York and London: Routledge.

Rolheiser, C., & Ross, J. (2001). *Student Self-Evaluation: What Research Says and What Practice Shows*. Retrieved July 14, 2021, from http://eloewen.pbworks.com/w/file/fetch/118309278/Student%20Self%20Evaluation%20What%20Research%20Says%20and%20What%20Practice%20Shows.pdf

Sadler, D. R. (1989). Formative Assessment and the Design of Instructional Systems. *Instructional Science*, *18*(2), 119-144. https://doi.org/10.1007/BF00117714

Saribeyli, F. (2018). Theoretical and practical aspects of student self-assessment. *The Education and Science Journal*, *20*(6), 183-194. https://doi.org/10.17853/1994-5639-2018-6-183-194

Schunk, D. (2004). *Learning theories: An educational perspective.* Upper Saddle River. New Jersey: Merrill Prentice Hall.

Schunk, Dale H., & Meece, Judith L. (2008). *Motivation in Education: Theory, Research, and Applications* (2nd ed.). Englewood Cliffs, N.J.: Merrill/Prentice Hall.

Sharma, R., Jain, A., Gupta, N., Garg, S., Batta, M., & Dhir, S. (2016). Impact of self- assessment by students on their learning. *International Journal and Basic Medical Research*, *6*(3), 226-229. https://doi.org/10.4103/2229-516X.186961

Spiller, D. (2012). *Assessment Matters: Self-Assessment and Peer Assessment*. Hamilton, New Zealand: Teaching Development, University of Waikato.

Stiggins, R., Arter, J., Chappuis, J., & Chappuis, S. (2007). *Classroom assessment for student learning*. Upper Saddle River, New Jersey: Pearson Education, Inc.

Tejeiro, R. A., Gomez-Vallecillo, J. L., Romero, A. F., Pelegrina, M., Wallace, A., & Emberley, E. (2012). Summative self-assessment in higher education: implications of its counting towards the final mark. *Electron. J. Res. Educ. Psychol*, *10*(2), 789-812.

Thawabieh, A. M. (2017). A comparison between student self-assessments and teachers' assessment. *Journal of Curriculum and Teaching*, *6*(1), 14-20. https://doi.org/10.5430/jct.v6n1p14

Ushioda, E. (1996). *Learner Autonomy 5: The Role of Motivation*. Dublin: Authentik.

Vu Thi Lan Anh & To My Vien (2018). Innovation of Curriculum Planning in Accordance with CDIO Standards at Ho Chi Minh City University of Transport. *European Journal of Engineering and Technology Research*, *3*(9), 29-33. https://doi.org/10.24018/ejeng.2018.3.9.887

Wu, G. (2018). Based on complex learning theory CDIO project master of management education model research. *Learn. Educ*, *6*(2), 1-20.

Zimmerman, B. (2002). Becoming a Self-Regulated Learner: An Overview. *Theory Into Practice*, *41*(2), 64-70. https://doi.org/10.1207/s15430421tip4102_2