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Development of a Training Process of Engineering Students' Collaborative Problem-Solving Competency through Organizing Experiential Learning Activities – A Case Study in Vietnam

Abstract

The collaborative problem solving (CPS) competency is one of the important competencies meeting requirements of any job position in the 21st century. Researches have concentrated on assessing and developing high school students' CPS competency rather than engineering students. Furthermore, researches also indicate that organizing experiential learning (EL) activities is one of the most effective ways to develop students' CPS competency. Therefore, research on developing CPS competency by organizing EL activities was conducted in Vietnam. The main purpose of the study is to find a process of training engineering students' CPS competency by organizing experiential learning activities.

Findings were based on two main fundamentals, including the theoretical foundation on the CPS competency and organizing experiential learning activities and the status of organizing EL activities and engineering students' participation in EL activities to develop their CPS competency at technical higher education institutions in Vietnam. A process of training engineering students' CPS competency is developed based on these fundamentals. The proposed process of training engineering students' CPS competency comprises four stages: (1) Designing EL activities, (2) Implementing EL activities, (3) Organizing reflective, abstract conceptualization and active experimentation and (4) Assessment of students' performance. Some minor suggestions to apply this process in the Vietnamese technical higher education institutions are also referred to.

Key words: *collaborative problem solving, competency, experiential learning.*

1 Introduction

The collaborative problem solving (CPS) was firstly mentioned by Stevens and Campion (1994), when the authors studied the requirements of knowledge, skills and attitude in working groups in the field of Human Resource Management. Since then, it has become one of the key competencies in the 21st century. Therefore, other authors and organizations have also drawn attention to the CPS competency such as Hesse (2015), Oliveri, Lawless & Molloy (2017), the Organization for Economic Co-operation and Development (OECD), and so on. Their and more researches have focused on finding CPS's definitions, frameworks, processes, and assessments. In 2015, this competency was officially selected in PISA test for 15-years-old students by OECD. Although the concepts and frameworks of the CPS competency have been developed, there is still demand for of developing the CPS competency in higher education.

Experiential learning (EL) is a teaching approach requiring students to participate in practical learning contexts to self-construct their own experience. Participation in EL helps students to develop professional and general competencies (Hollis & Eren 2016; Wu & Hyatt 2016; Jack 2011), such as leadership skill (Kolb 1982; Van Velsor & Gurvis 2007; Warnick, Schmidt & Bowden 2014), teamwork skill (Le Thi 2015; Eikenberry 2007), interpersonal skill (Burnard 1989; Van Velsor & Gurvis 2007). However, applying EL to develop engineering students' CPS competency has not been dealt with by researchers so far.

Therefore, this paper focuses on developing a process of training CPS competency of engineering students by organizing EL activities at technical higher education institutions in Vietnam.

2 The international discussion on the Collaborative Problem-Solving Competency and Experiential Learning

2.1 Collaborative Problem-Solving Competency

CPS competency is "the capacity of an individual to effectively engage in a process whereby two or more agents attempt to solve a problem by sharing the understanding and effort required to come to a solution and pooling their knowledge, skills and efforts to reach that solution" (OECD 2017, 9).

The framework of CPS competency differs among studies. Griffin and Care (2015) developed a CPS framework with two broad skill classes: Social skills and cognitive skills. There are three components in social skills (participation, perspective taking and social regulation) and two domains of cognitive skills (task regulation, and learning and knowledge building).

Meanwhile, OECD (2017) identified that collaboration and problem-solving the CPS competency. The collaboration includes three sub - components: (1) establishing and sharing, (2) taking appropriate action to solve the problem, (3) establishing and maintaining group organization. The Problem-solving has four sub-components: (1) exploring and understanding, (2) representing and formulating, (3) planning and executing, (4) monitoring and reflecting.

A broader approach was conducted by María Elena Oliveri et al. (2017) who proposed four main components (teamwork, communication, leadership and problem solving) and 17 subcomponents of CPS competency. Teamwork was divided into 6 sub-components: (1) team cohesion, (2) team empowerment, (3) team learning, (4) self-management, (5) adaptability/flexibility, (6) open-mindedness. Communication included active listening and exchanging information. Leadership had five sub-components: (1) organizing activities and resources, (2) performance monitoring, (3) reorganizing when facing with obstacles, (4) resolving conflicts, (5) transformational leadership. Problem solving consisted of five subcomponents: (1) identifying problems, (2) brainstorming, (3) planning, (4) interpreting and analyzing, (5) implementing and evaluating.

Although the framework of CPS competency is inconsistent among these studies, two main components are mentioned in all of these studies: Collaboration and teamwork and problem solving. The collaborative component reflects on the interaction of members that work together in groups. It includes factors relating to organizing groups, participating in groups, and managing members in groups, etc. Meanwhile, the problem solving component focuses on how a team member solves a problem. The problem solving component consists of subcomponents such as: analyzing, identifying and defining the problem, proposing solutions, deciding, planning and implementing, monitoring and evaluation.

Respecting the international discussion on CPS competency, this paper suggests the CPS framework includes 2 main components, 7 sub-components and 12 indicators as presented in table 1.

Table 1: **The proposed CPS competency framework**

No.	Components	Indicators
1	**Collaboration**	
1.1	Organize the group	Groups are established and roles are assigned
1.2	Participate in the group	Interact and share knowledge and skills
		Cooperate with other members
1.3	Manage the group	Resolve conflict in the group
		Understand each individual and members
		Be responsible and initiative
2	**Problem solving**	
2.1	Identify and define the problem	Analyze, identify and define the problem
2.2	Propose solutions	Propose solutions
2.3	Plan and implement	Plan, decide and implement
2.4	Monitor adjust and evaluation	Monitor
		Adjust
		Evaluate

2.2 Experiential Learning

The underlying concept of EL is not new. Confucius already said: “Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand” (cited in Kujalová 2005, 1). The perspectives of EL also mentioned on published works of John Dewey, Jean Piaget, Kurt Hahn, Lev Vygotsky and later publications such as Kolb, Lublin, Spoth & Baker (1984);

Van Velsor & Gurvis (2007) and Beard & Wilson (2013). This paper identifies the term "experiential learning" according to two approaches:

Experiential learning is the process of learning through experience and is more specifically defined as "learning through reflection on doing" (Felicia 2011). "These experiences actively immerse and reflectively engage into the inner world of the learner , as a whole person (including physical-bodily, intellectually, emotionally and spiritually) with their intricate 'outer world' of the learning environment (including belonging and doing – in places, spaces, within social, cultural, political context etc.) to create memorable, rich and effective experiences for and of learning" (Beard & Wilson 2006).

Experiential learning is the participation of learners directly in the learning process to form and develop interpersonal experiences. The learning process consists of various activities such as simulation-based learning, project-based learning, learning games, story-telling, creative play and so on (Van Velsor & Gurvis 2007).

Based on the two approaches above, this paper proposes the working definition: "Experiential learning is the learning process from experiences in which learners participate directly in practical or simulated learning tasks to form and develop new experiences".

The term "organize" is defined as "arrange systematically" or "order". This article also suggests other working definition: "Organizing EL activities is to arrange systematically experiential teaching and learning activities to attract learners to participate directly in practical or simulated learning tasks to form and develop new experiences".

Parallel with indicating the terms of EL and organizing EL activities, ways of organizing EL activities have also drawn researchers' attention. Schwartz (2012) and Cantor (1995) organized EL activities via five main stages: planning, designing, implementing, reflecting and assessing. These stages are summarised below:

Stage 1: Planning experiential learning activities

- When beginning to think about a way of integrating an experiential component into a course, there are 3 main steps should be taken into consideration:
- Determining learners' expectations and analyzing learners' prior relevant experience, knowledge, skills, etc.,
- Identifying appropriate activities for learners and course content,
- Identifying prospective issues when integrating experiential learning.

Stage 2: Designing experiential learning activities In this stage, teachers should:

- Define contents to be structured into EL activities,
- Think about how to create potential activities to match with learning outcomes,
- Determine places to organize EL activities: inside or outside classroom,
- Identify assessment tools and criteria.

EL activities should be structured into leaning projects, assignments, or learning tasks. Students should participate in more challenging EL activities to self-construct their knowledge and skills.

Stage 3: Implementing experiential learning activities

Unlike a traditional classroom, in an experiential classroom, an instructor has the role of a guide, a cheerleader, a facilitator or scaffolder to carry out activities in stages 1 and 2. Michelle Schwartz (2012) also mentioned that when carrying out EL activities, teachers should:

- Provide students with essential information such as purposes, objectives, main contents, contents related to experiential activities,
- Establish general and specific rules to implement EL activities,
- Prepare learning and teaching aids to implement EL activities,
- Instruct students of how to join in EL activities,
- Inform students about criteria of EL activities.

Stage 4: Reflecting experiential learning activities

Reflection stage is an essential stage in organizing EL activities. The stage helps students understand exactly what reflection is and how to use the process to deepen their learning. To help students reflect effectively, teachers need to organize two stages. The "presenting reflection" helps students to be accustomed with the concept and methodology of reflection by providing examples and let them apply some small exercises. The second stage deepens students' understanding of reflection and helps to improve their ability to reflect on a more complex level.

Stage 5: Assessing experiential learning activities

Assessment is an indispensable stage of the EL process. It provides instructors and learners with basic information about what has been achieved and what needs to be improved. Some assessment methods are often used to assess EL activities such as: short answer questions, portfolio, and rubrics.

To make 5 stages of organizing EL activities above comes true, instructors need to apply specific EL activities such as: watching a video or simulation, demonstration, group work, instructional puzzles, games, role plays, working in simulate or real situations, on-the-job training, laboratory/workshop practice, group assignments, problem – solving, project-based learning, situated learning, field trips, internship, self and peer assessment, interactive lecturers, and so on (Van Velsor & Gurvis 2007; Burnard 1989; Sugar & Kostoroski Sugar 2002; Schwartz 2012).

Based on the real teaching and learning conditions in Vietnamese technical higher education institutions, 6 EL activities are chosen to train engineering students' CPS including observation, active learning, project-based learning or assignment, practice or hands-on learning, self-assessment and peer-assessment, identity problems and make plans. These EL activities are applied inside and outside of the classroom and are linked very closely with a

proposed process of training engineering students' CPS competency through by organizing EL, which is explained in the last part of this paper.

3 Status of organizing experiential learning activities of lecturers and engineering students' participation in these experiential learning activities to develop their Collaborative Problem-Solving Competency

3.1 Organizing the research

The status of organizing EL activities of lecturers and engineering students' participation in these EL activities to develop their CPS competency is found by collecting and analyzing data from a survey at 3 universities in the South of Vietnam. These universities are Ho Chi Minh City University of Technology and Education (HCMUTE), Industrial University of Ho Chi Minh City (IUH) and Can Tho University (CTU). The scope of this paper only provides an overview of research organizing and main findings of the research on lecturer's organization concerning EL activities and engineering students' participation in these EL activities to develop their CPS competency.

Deriving from the international discussion on CPS competency and EL as well as proposed working definitions, organizing the research comprises the steps below:

Step 1: Designing students' questionnaires

The purpose of collecting data from students' questionnaire is to discover the following main issues: The status of students' participation in EL activities, the status level of engineering students' CPS competency, the relationships between technical students' participants in EL activities and the changing of CPS competency level.

To achieve these purposes, which are based on literature review on framework of CPS competency, EL groups of activities, and the students' questionnaire was developed. The content of the student's questionnaire included 2 main parts: (1) questions related to six EL activities, and (2) questions investigating twelve indicators in the CPS competency framework. Five level Likert scale (from level 1: strongly disagree to level 5: strongly agree) was used in all the questions of the second part.

Before conducting the main survey, a pilot survey was carried out with 97 engineering students at HCMUTE. The 1st factor analysis was applied to confirm designed items belonging to 6 groups of EL activities as well as 12 indicators of CPS competency framework or not. The 1st reliability of individual items (Cronbach's Alpha index) was also implemented to eliminate inappropriate variables. All the valuable items were selected, and some verification items were added in the formal survey.

The formal questionnaire was distributed to 1050 students at 3 universities in Vietnam, including HCMUTE, IUH and CTU. However, only 705 reliable responses were selected for data analysis. The 2nd factor analysis and 2nd reliability of individual items were again

implemented to remove invalid variables in the formal questionnaire. Finally, 29 items in 6 groups of EL activities and 63 items in 12 indicators of CPS competency were eligible for selection.

Step 2: Designing lecturers' questionnaire

The main purpose of collection data from lecturers' questionnaire is to explore the status of stages in organizing EL activities, including: planning, designing and organizing EL activities.

The questionnaire was a qualitative test and was adjusted before conducting the official survey. More than 130 questionnaires were delivered to lecturers from 3 universities in Vietnam, but only 97 responses were reliable.

Step 3: Analyzing data

The appropriate statistical package, including: Compute variables (all items in a group or indicator were computed into a variable), frequency and percentage, mean, correlation, regression was applied to analyze the reliable data collected from lecturers' and students' questionnaire.

To find a scientific base for developing a process of training the CPS competency of engineering students by organizing EL activities, this paper will concentrate on two main findings from the status:

- Status of organizing EL activities of lecturers and engineering students' participation in these EL activities to develop their CPS competency.
- Status of relationship between engineering students' participation in EL activities and CPS competency of engineering students.

3.2 Findings of status of organizing experiential learning activities by lecturers' and engineering students' participation in these experiential learning activities to develop their collaborative problem-solving competency

3.2.1 Status of organizing EL activities by lecturers and engineering students' participation in these EL activities to develop their CPS competency

Table 2: **Mean of organizing EL activities of lecturers and engineering students' participation in these EL activities**

No.	Groups of EL activities (1)	Mean (*Lecturers*) (2)	Mean (*Students*) (3)	Difference (+/-) (4)
1.	Do observation	3.22	2.92	0.3
2.	Do active learning	3.64	3.38	0.26
3.	Do project based learning or complex assignment	3.31	3.12	0.19
4.	Practice and hands-on learning	2.62	2.19	0.43
5.	Self-assess and peer-assess learning results	3.37	3.26	0.11
6.	Identify problems and make plans	3.68	3.39	0.29
Pearson Correlation value		**0.82**		

The column (2) of the Table 2 indicates the mean of organizing EL activities of lecturers. Figures show that mean value of "practice and hands-on learning" is only 2.62 and is the lowest level among the 6 activities, while the mean value of "identify problems and make plans" is the highest (mean = 3.68). Among 6 EL activities, mean of two activities, including "identify problems and make plans", "do active learning" are 3.68, 3.64 respectively and are all higher than 3.4. Means of other activities are lower than 3.4. It can be noted in general that, lecturers frequently organized 2 among 6 EL activities (active methods, identify problems and make plans) and only occasionally organized activities such as "do observation", "do project based learning or complex assignment", "self-assess and peerassess learning results" and "practice and hands-on learning" for students to take part in.

The column (3) of the Table 2 illustrates the mean value of student's' participation in 6 EL activities. Numbers indicated that no mean value in of the 6 activities is higher than 3.4. The mean value of "practice and hands-on learning" is only 2.19 and the only one below 2.6. The others mean values vary from 2.92 to 3.39. These figures reveal that engineering students participated in these EL activities such as "do observation", "do active learning", "do project based learning or complex assignment", "Self-assessed and peer-assessed learning results", "identify problems and make plans" more occasionally than "practice and hands-on learning" activity.

The column (4) of the Table 2 points out the difference between mean of lecturers' organization and students' participation in EL activities. All values are positive proving that there is a significantly difference between lecturers' organization and students' participation in all EL activities. The tendency is that the level of organizing El activities of lecturers is higher than the level of participating students. Furthermore, correlation analysis between mean of teachers' organizing and students' participation was 0.82 (high correlation). It means that the more lecturers organize EL activities, the more students take part in.

In short, the findings revealed that lecturers occasionally and frequently organized EL activities but students occasionally and rarely participated in these EL activities. Although there were differences between levels of organizing EL activities of lecturers and engineering students' participation in these EL activities but organizing EL activities of lecturers has a great influence on the students' participation.

3.2.2 Status of relationship between engineering students' participation in EL activities and CPS competency of engineering students

Status of relationship between engineering students' participation in EL activities and CPS competency of engineering students will focus on two major issues: the correlation between each group of EL activities with CPS competency and the correlation among groups of EL activities with CPS competency.

- The correlation between each group of EL activities and CPS competency.

The Pearson correlation was applied to discover the relationships between each group of EL activities with CPS competency. The analysis result is as follows:

All Sig. values in Table 3 are .000, all Pearson correlation values are positive and there are two stars (**) in all Pearson correlation values. So, there are significant correlations between the 6 EL groups of activities with CPS competency. More exactly, the frequency of the participation in EL activities is in direct proportion to CPS competency. The correlation values of two EL groups: "identify problems and make plans" and "self-assess and peerassess learning results" are higher than the others (r = .616 and .524). It can be deduced that engineering students' CPS competency will develop through the participation in all EL activities, especially the participation in 2 EL activities, including "identify problems and make plans" and "self-assess and peer-assess learning results".

Table 3: **Pearson correlation between each group of EL activities and CPS competency**

No.	Experiential learning activities	CPS competency	
		Pearson Correlation	**Sig. (2tailed)**
1	Do observation	.421**	.000
2	Do active learning	.423**	.000
3	Do project based learning or complex assignment	.457**	.000
4	Practice and hands-on learning	.323**	.000
5	Self-assess and peer-assess learning results	.524**	.000
6	Identify problems and make plans	.616**	.000
	**. Correlation is significant at the 0.01 level (2-tailed).		

- The correlation among EL activities and CPS competency

The Regression analysis was carried out to explore which groups of EL activities will have an effect on the development of CPS competency. The tables below will describe the results of the analysis.

Table 4: **Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
4	.659[d]	.434	.430	.33832

[e] Predictors: (Constant), Identify problems and make plans, do observation, do project based learning or complex assignment, do active learning

Table 5: **ANOVA**

Model		Sum of Squares	df	Mean Square	F	Sig.
4	Regression	61.365	4	15.341	134.033	.000[e]
	Residual	80.121	700	.114		
	Total	141.485	704			

Adjusted R Square value in the model 5 of Table 4 is .43. It means that 4 groups of EL activities (identify problems and make plans, do observation, do project-based learning or complex assignment, do active learning) together can explain 43.0% of the CPS competency change. Although having correlation with CPS competency, but the 2 remain groups of EL activities “practice and hands-on learning”, “self-assess and peer-assess learning results” do not belong to the regression model.

F-statistics were carried out to find the overall strength of the model. The value of F-statistic 108.891 and Sig. = .000 < 0.005 shows that the model is highly significant.

Table 6: **Coefficients**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
5	(Constant)	2.133	.070		30.569	2.133
	Identify problems and make plans	.289	.023	.451	12.769	.289
	Do observation	.080	.017	.156	4.781	.080
	Do project-based learning or complex assignment	.063	.018	.125	3.482	.063
	Do active learning	.043	.020	.078	2.189	.043

B value of all 4 groups of EL activities in the model are in positive direction, T and Sig. value are also significant. Therefore, there are a positive relationship among 4 groups of EL activities in the regression model, including: “identify problems and make plans”, “do observation”, “do project based learning or complex assignment”, and “do active learning” with CPS competency.

The beta values in Table 6 show that “identify problems and make plans” get the highest number (.289). The beta value of “do observation”, “do project based learning or complex assignment”, and “do active learning” are .080, .063, .043 in that order. Thus, it can be predicted that four EL activities in this model will have influence on CPS competency in a positive way. Moreover, it can also be inferred that if engineering students participate in all four factors in the regression model, there will be a change of about 43.0% of their CPS competency in positive way, in which activities belonging to “identify problems and make plans” have the strongest influence on.

In brief, six EL activities have an impact on the development of engineering students’ CPS competency in a positive way. In which, EL activities such as “identify problems and make plans”, “do observation”, “do project based learning or complex assignment and “do active learning”) contribute 43.0% to the development. The findings also prove a necessity of integrating these EL activities in a process of training the collaborative problem-solving competency of engineering students through organizing experiential learning activities in Vietnamese technical higher education institutions.

4 Develop a process of training the Collaborative Problem-Solving Competency of Engineering Students by Organizing experiential Learning Activities

Based on the proposed CPS competency, the working definitions such as EL and organizing EL activities and the status of organizing experiential learning activities of lecturers and engineering students' participation in these experiential learning activities to develop their collaborative problem-solving competency in Vietnam, this paper suggests a process of training the collaborative problem-solving competency of engineering students by organizing experiential learning activities.

The suggested process comprises four main stages: (1) designing El activities; (2) implementing EL activities; (3) organizing reflection, abstract conceptualization and active experimentation; (4) assessing student's performance. Each stage includes some steps or activities as illustrated in the figure 1. Furthermore, the process also indicates main roles of teachers or students in conducting each step/task in the direction of arrows. If the arrow comes from the teacher, it means that the teacher has a key role in the implementation of activities. If the arrow goes outcomes from the students, they will have a leading role in conducting activities.

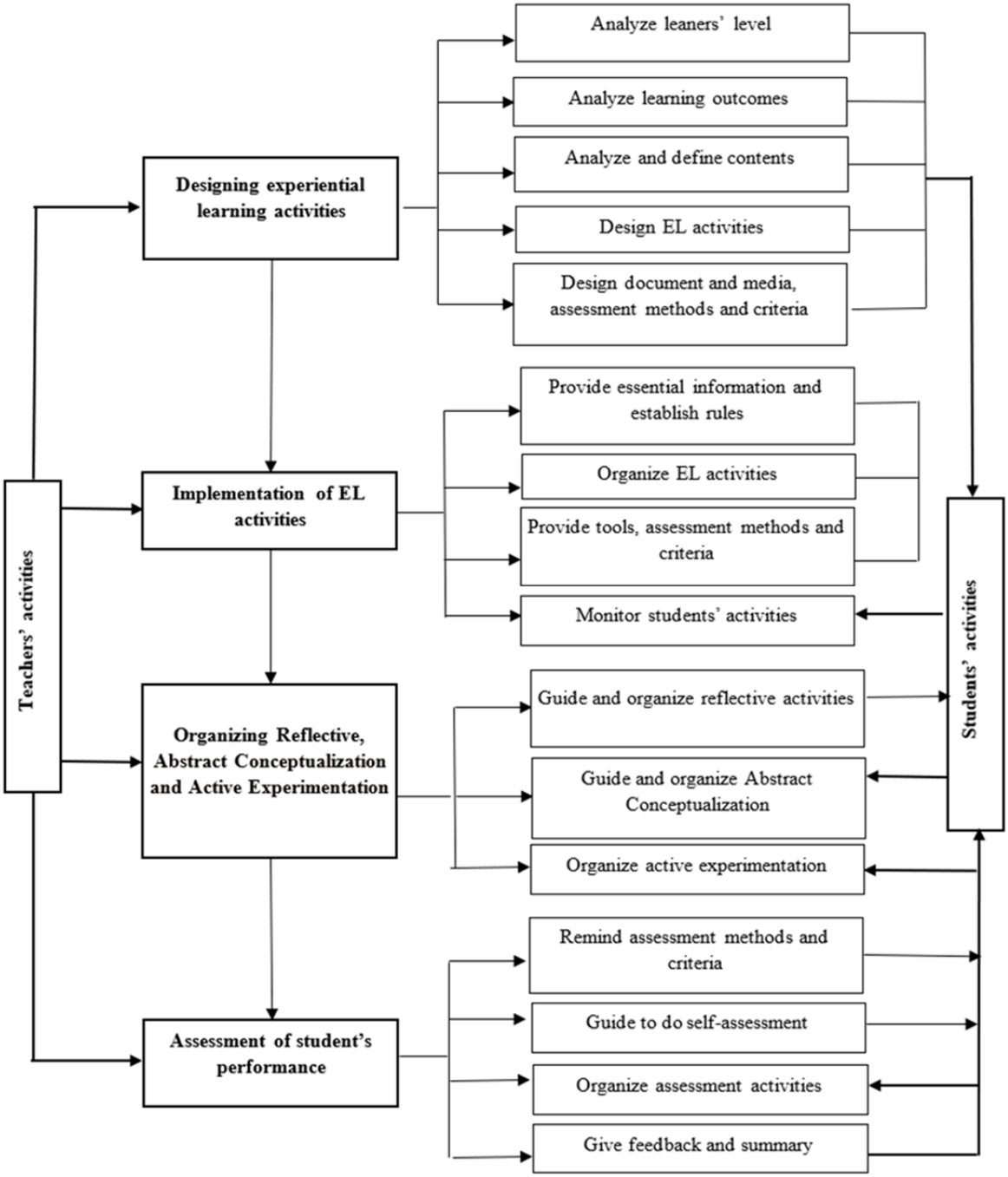

Figure 1: The process of training the CPS competency of engineering students through by organizing EL activities

Stage 1: Designing experiential learning activities

Lecturers should conduct the five following steps:

- Analyzing leaners' level: Determining the level of the learners is very important because it helps the teacher to select the appropriate EL activities for their students. Lecturers should know about learner's prior experience, knowledge, skills, attitude, and

needs related to the content as well as student's abilities in working in group and solving problem.

- Analyzing learning outcomes: Lecturers have to analyze all learning outcomes of the subject not only the ones related to content that will be taught but also is the ones relevant to CPS framework components.
- Analyzing and defining contents: Lecturers have to define which subject's contents are suitable to organize EL activities for student working in group to solve problems.
- Designing EL activities: Designing activities may be the most difficult and important step in this stage. In this step, teachers have to:
    - Select one or more specific and suitable EL activities: observation, active learning, project-based learning or assignment, practice or hands-on learning. It is better for lecturers to combine flexibly some EL activities together in a project or assignment.
    - Think of and decide on suitable places where EL activities can take place: inside/ outside/ or inside and outside classroom.
    - Design or add activities that require students to work with CPS components such as: organizing their group, participating, sharing knowledge, especially defining the problem and designing a plan, etc.
    - Think about how the potential activity complements the overall aim of study. o Prepare enough and suitable materials, media, and rules for organizing EL activities.
- Designing assessment methods and criteria: Develop criteria and assessment tools matching the proposed EL activities and EL methods. These tools should consist of students' self – assessment, peer – assessment and lecturers' assessment of students' performance in collaboration, problem solving as well as their relevant learning outcomes.

Stage 2: Implementing EL activities.

Lecturers should do four main tasks:

- Provide essential information and establish rules: lecturers provide students with sufficient information which is relevant to EL activities such as: learning outcomes, main content, requirements, grading criteria and evaluation methods, and so on. Furthermore, general and detail regulations, time, interaction ways, and others should be set up.
- Organize EL activities: lecturers apply various EL methods to organize EL activities. Lecturers function as a guide, cheerleader, facilitator or scaffolder to help students' orientation, solve problems and self-construct their own knowledge and skills.
- Provide tools, assessment methods and criteria:
- Lecturers supply tools for students to participate in EL activities such as group work, summary skills, feedback, etc. Besides, how to work with the CPS competency framework (organize the group and set up ways to contact, participate in the group,

manage the group, identify and define problems, propose and select feasible solutions, implement plans, monitor and assess results) should also be guided.
- Lecturers provide students with assessment methods and criteria (self-assessment, peer-assessment)
- Monitor students' implementation: lectures keep in track with students' implementation and give feedback constantly.

Stage 3: Organizing reflection, abstract conceptualization and active experimentation
Lecturers should:

- guide students how to do reflection on students' experience
- organize groups of students to reflect on what has been experienced through the learning content as well as collaboration and problem-solving ways
- instruct and organize students to work in group to conceptualize theory based on what they have experienced and reflected on
- organize another EL activities for students to apply the theory so that they develop abstracted conceptualization

Stage 4: assessing students' performance

The main purpose of the stage is to know about students' performance related to learning outcomes and CPS competency, to find out if students work well or not and give students positive feedback. The third part includes students themselves, group members and teachers. They should participate in this stage. Furthermore, lecturers also should:

- repeat assessment methods and criteria for students
- guide students to do self-assessment to develop students' self-reflective ability
- organize assessment activities, in which students do self and peer-assessment
- give positive feedback, summarize EL activities and with a conclusion

In summary, the four-stage process of training the CPS competency of engineering students through organizing EL activities were developed based on the theoretical basement on the CPS competency and organizing experiential learning activities and the status of organizing EL activities and engineering students' participation in EL activities to develop their CPS competency at technical higher education institutions in Vietnam.

5 Conclusion

To develop engineering students' CPS competency for meeting requirements of engineers' competencies in the workplace, technical higher education institutions in Vietnam need to find a process to train this competency in the entire learning process.

This paper develops the process of training engineering students' CPS competency through by organizing EL activities based on studying on the international discussions on CPS competency and EL as well as findings of the status of organizing EL activities and

engineering students' participation in EL activities to develop their CPS competency at technical higher education institutions in Vietnam.

To apply this process in the Vietnamese technical higher education institutions, some minor following suggestions should be implemented:

For Vietnamese technical higher education institutions:

- Redesigning project -based learning and curriculum.
- Integrating EL activities into project -based learning and curriculum.
- Designing and organizing EL activities that are more relevant to technical students and their learning in and outside of the classroom.

Lecturers should shift from content-based teaching approach to competence-based teaching approach in which the teaching concentrates is focused on learners and their learning activities. EL activities need to be integrated into learning and teaching activities. Students need to change from learning alone to collaborative learning through experience to self-construct their knowledge and skills.

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