FORMING AND INTEGRATING SKILL SET IN COURSES AND PROGRAM

Bac Le, Thanh Le, Thu Nguyen

University of Science - VNU, Ho Chi Minh City, Vietnam

ABSTRACT

In the process of building and developing training programs based on CDIO model, the managers are not only concerned about the building of the knowledge chain but also about the integration of skill set into the program. The skill set is one of the key factors determining the success of a training program, especially CDIO-based ones. The integration of skills in the courses helps students understand the knowledge easily, efficiently, and effectively. However, it is not trivial to integrate the skill sets so that the benefits are maximized. In this paper, we describe a training model which has been deploying in our faculty. First, we systemize the skills in CDIO specification and select the ones that are necessary and should be implemented priority. Then, we consider and distribute such skills into each course as well as recommend the expected mastering level. The distribution must be equally and suitable in order not to overproduce pressure and difficulty for lecturers and students. Finally, for verifying the effectiveness of our model, we collect and analyze the evidence of the process of teaching and learning, following the chain of courses in the program. The evaluation shows that the integration of skill set is essential.

KEYWORDS

Knowledge, Skill, Integration, Assessment, Standards: 3, 8, 10, 11, 12

INTRODUCTION

Universities expect students apply what they learned well in the real life after they graduated. Currently, the teaching and learning activities in almost universities focus on teaching students on knowledge. Lecturers are focusing much to the content of the course. It is thought that when they are equipped with strong background knowledge, they can apply it easily to real-world problems after graduating. Thus, the school focuses much to the knowledge rather than the skills. However, this worked in the early days in which tasks did not require much creativity and adaptation. In the era of information and technology, things get changed very quickly, almost every day. Employees need to update their knowledge and skills continuously. Products get more complicated and sophisticated. Thus, it requires new knowledge and technology with appropriate skills. Even to maintain or gain the market share, capitalization and profitability, manufacturers are demanding more creativity as well as rapid and continuous innovation. To have highly qualified graduates, knowledge is necessary but not sufficient.

In 21st century, industry requires the effort and intellect of not only an individual, but also a team, or even sometime the participation of end-users. Students must be supported in

mastering both knowledge and skills.Therefore, in addition to knowledge, students need to be equipped with skills such as critical thinking, inquiry and analysis, creative thinking, quantitative literacy, integrated learning, lifelong learning, ethics and professional behaviors.“A set of achievements – skills, understandings and personal attributes – that make graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy.

We also argue that the integration of skills in teaching and learning program is very important. So, we have been trying to integrate some key skills into curriculum in our faculty, which is Information Technology Faculty, Ho Chi Minh University of Science – Viet Nam Natural University (HCMUS-VNU). However, the integration of skills into technical courses is challenging. The problems are what the process of teaching and learning skills is appropriate; and how they are evaluated. In addition, the program should avoid making students overloaded with the school work. Our observations show that there are very few models of integrating skills into curriculum proposed now. Besides, the assessment methods applying for the model are not enough. Therefore, this paper focuses on how to design the curriculum combines between content and skills and how tobring the specific skills to the courses in our faculty.

The rest of this paper is organized as follows. Section 1 identifies the key elements of skill which are necessary for the curriculum. Section 2 presents the important of integrating skills in education program. Section 3 presents ITU (Introduce/Teach/Utilize) assignment for each key element to ensure their compliance with course objectives or learning outcomes. The level of skills is clarified in section 4. In section 5, we describe to form skills sequence with bloom taxonomy verbs and the teaching/learning activities are developed to demo the integration skills into courses. Section 6 defines the sources of evidence which are collected for assessment. Section 7 shares the evaluation criteria which helps students to understand what to do and how much effort to achieve the course objectives. Finally, we describe the collusion and research in the future in section 7.

THE IMPORTANCE OF INTEGRATING SKILLS

Donna Price (Donna Price, 2015) looks at the essential ‘soft skills’ expected by employers, and suggests strategies for how these skills can be integrated in the classroom to prepare students for the 21st century workplace. Soft skills (also called people skills, transferable skills, and employability skills) are general skills necessary for success at all employment levels and in all sectors of the labor market. Two documents — SCANS and the Framework for 21st Century Learning — identify skills necessary to be successful in today’s workplace. There is renewed interest in integrating workplace readiness skills in education as a result of recent US legislation — the Workforce Innovation and Opportunity Act (WIOA) — as well as the College and Career Readiness Standards (CCRS) for Adult Education.

A 2013 report from the Seattle Jobs Initiative indicates that 75% of businesses surveyed reported that soft skills were as important or more important than technical skills in securing entry-level employment. The 2013 Job Outlook report says that employers want good communicators who can make decisions and solve problems while working effectively as part of a team.What are some of these soft skills employers refer to? Are they really ready to work?a consortium of four corporations asked over 400 employers across the US, “What

skills are necessary for success in the workplace of the 21st century?". The essential soft skills cited by these employers are ones that are echoed by employers across the US: professionalism/work ethic, oral and written communication, and critical thinking/problem solving. What can we design the curriculum to integrate some of these essential soft skills?

Basing on the *"Curriculum and Instruction: A 21st Century Skills Implementation Guide"* report of Partnership for 21st Century Skills (Partnership, 2015), student mastery of 21st-century skills should be recognized as one of the most critical outcomes of the teaching and learning process. Therefore, it is necessary to develop and implement curriculum and instructional strategies that—by design—enhance these skills.And to meet the needs of the 21st century learner, schools will need to adopt a 21st century skills curriculum and employ methods of instruction that integrate innovative, research proven teaching strategies, modern learning technologies, and real world resources and contexts.

Career development learning is concerned with helping students to acquire knowledge, concepts, skills and attitudes which will equip them to manage their careers, i.e. their lifelong progression in learning and work. It is important to note that the current focus on the delivery of employability skills has also appeared to stimulate general interest in curriculum design.Therefore, program leaders or educational developers who are responsible for program need to ensure that those programs make a clear contribution to student employability. It is probably going into more detail than senior policy-makers want. The main idea is that employers value achievements that we find it hard to assess in traditional ways. The argument is that we need a more differentiated, program-level approach to assessment. This involves disrupting the assumption that assessment has to be about measurement and numbering and substituting the view that assessment is about judgment, which can take many forms (Peter T Knight, 2004).

As a result, we recognize that it is very important to integrate skills into curriculum in our faculty. Specifically, we have applied CDIO and deployed the process of integration into the undergraduate Computer Science program since 2011. Each year over 400 students come to our program. They are divided into small classes of 50 to 80 students. There are about a lecturer and two teaching assistants for each class.

The process of intergration can begin by making a survey to find out what skills are necessary for our students in Vietnam social context now. The result of the survey shows in Figure 1. Basing on the survey result, we designed the curriculum which these skills are integrated in. Besides, these skills are also designed from low to high level in both each course and courses sequence in program. We also build assessment method to evaluate the effective of designed program. This work is presented in more detail in the follow sections in this paper.

THE TECHNICAL SKILL SET TO DEPLOY IN PROGRAM

When designing curriculum and integrating key elements into courses, it is important to specify the courses' context. For instance, in which year of the program are the courses taught? What are the levels of the students? Based on this, the importance of each factor could be identified in order for the students to achieve them all. Please note that the integration could be specified through the spiral model. That is to say, moving from lower to

higher level through years; the skills must be higher and assessed accordingly. As the integration, CDIO (Crawley et al, 2010) suggests the three levels of acquired knowledge: I(Introduced), T(Taught), U(Used). Level I is about the knowledge that should be introduced to students without going deeply in explaining why and how. Usually at this level, lecturers do not need to evaluate students. Level T requires lecturers to teach in a way that focuses on helping students understand thoroughly the content so that they can use it later in practice. The third one, level U, assumes students already understand the knowledge; as a result, the lecturers expect students to be able to apply or to enhance the ability to apply in other areas. In the same course, different levels can be applied to each element. Besides, different skill levels are also increase in courses sequence. For example, marking I/T means that the lecturers will both introduce and teach that element to students. It might be the case that students are at initial stages of knowing and understanding new concepts. For example, in integrating key elements of "teamwork skills" into courses in computer science major. We mark ITU and levels that student should be archived for each element as shown in Figure 3.

LEVEL OF EXPECTED ACHIEVING SKILLS

In program's syllabus, we identified skills which we want to prepare students for future careers. Being aware of these works is, however, not enough. We also need to define level of expected achieving skills. Each skill will be measured in the scale of 5 based on Bloom Taxonomy (Anderson et al, 2001). Program leader, faculty and stakeholders will be involved to determine the most appropriate level of achieving skill which meet the requirements of the jobs. Besides that, program leader also need to consider space or equipment necessary for deploying and developing the skills of full. Average scores after balancing the availability of facility will be used as final level of skill which students achieve upon graduation. Figure 1 illustrate level of some skills in IT program at our university.

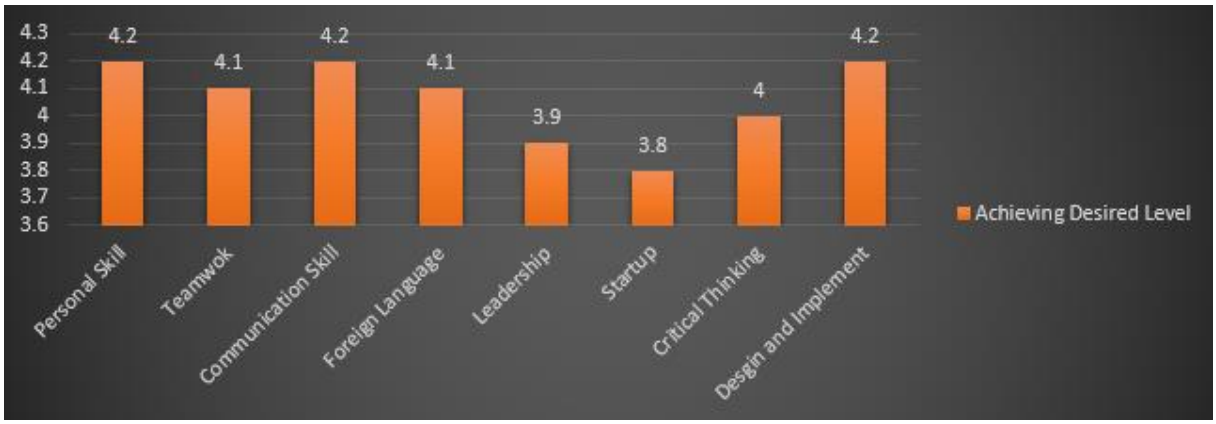

Figure 1. Survey about achieving desired level of skills in IT Program at VNU-HCMUS

This scores can be evaluated and modified each year based on statistical data which we gather from course results. Moreover, we have plans to invest in facilities and equipment, and enhance faculty performance to improve the level of skills. Next sections, we present how the skills are expressed in the form of intended learning.

FORMING SKILLS SEQUENCE WITH BLOOM TAXONOMY VERBS

With expected achieving skills, we select some importance courses which almost students will recommend to choose. That courses are also integrated skills which we would like to assess. In addition, the courses need to be selected through the learning process of students from first year to last year. Next, we construct skill sequence from the courses. For instance, in our Information Technology (IT) program, we select at least one course per semester in courses which are integrated skills. Figure 2 show courses which have teamwork skill.

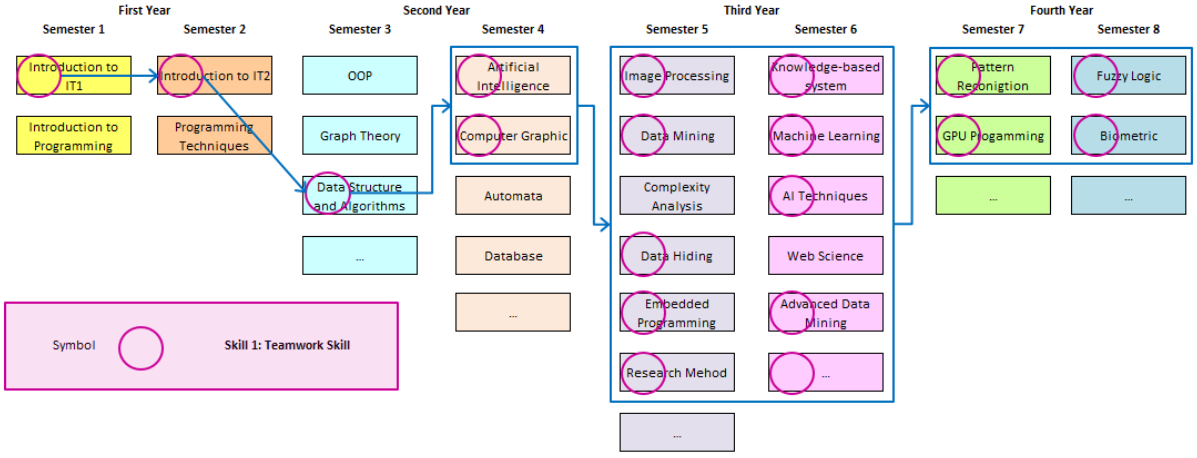

Figure 2. Teamwork skill is integrated into IT program

Ideally, we will select all courses for collect data and assessing the skill. However, that is overloaded with the number of courses and students in our program. Therefore, the selection of important courses helps us assess the skills with the limited resources. Moreover, we use ITU to present expected achieving at the sequence. Bloom's taxonomy used to provide the description of "what students should do if they are to achieve the intended outcome", for example, know, comprehend, apply, analyze, synthesize, or evaluate. The *introduce* (I), *teach* (T), *use* (U) categories may be mapped by the Bloom's taxonomy. When the learning is *introduced* may imply that students will know facts, concepts, principles or conventions. Thus, level I typically correspond to *observe* level in Bloom's taxonomy. *Model*, the next level, requires students to understanding what was learned. It means lecturers must teach (T) them. Similarly, the rest such as *recognize*, *correct*, and *apply* implies level U in ITU-matrix. Table 1 shows the Bloom's taxonomy which we reference in (Anderson et al, 2001) with modified. It requires more efforts from students for higher levels.

Table 1. Some verbs in bloom taxonomy (Anderson et al, 2001)

Bloom Taxonomy	Level	Verbs
	**1.Observe**	identify, watch, observe, hear
	2.Model	attempt, follow, imitate, try

	3.Recognize	discriminate, perceive, select
	4.Correct	adapt, adjust, develop, improve, modify, practice
	5.Apply	build, construct, create, design

With the verbs, lectures can be identified learning outcomes about the skill in their courses more easily. It means that learning outcomes in courses plays a certain role in the process of achieving desired levels. Courses in first semesters often begin with introduction to skill. In this phase, the students acquire basic knowledge about skill such as listing key elements, determining the order of execution. The students are required to apply the skill, modify it, or construct new process into specific circumstances in later years. Some requirements can be repeated across several semesters. That is similar to the spiral model (Crawley et al, 2010) in which it does not require learners achieve everything in the first round.

We put the verbs, ITU all together in skill sequence with ITU.x convention, where x takes value from 1 to 5 level in bloom taxonomy. Figure 3 shows teamwork skill sequence in IT program with ITU and level.

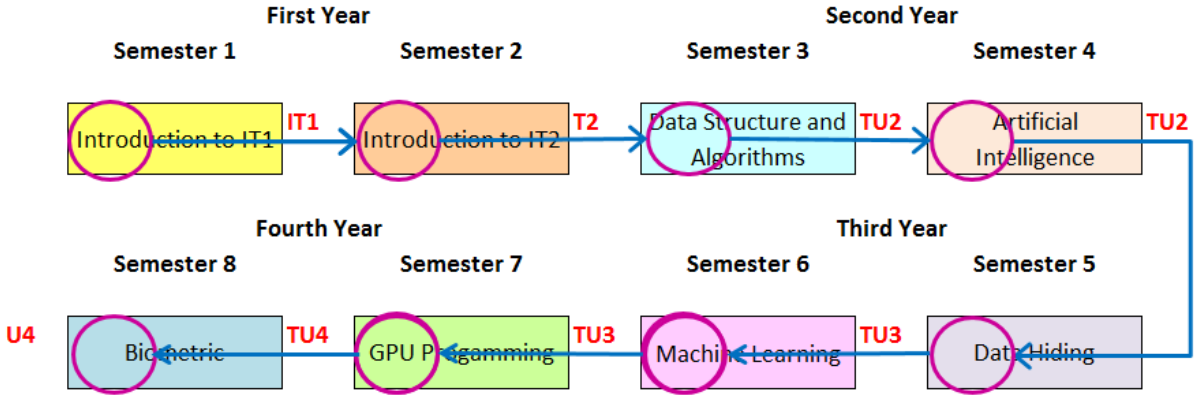

Figure 3. Selected courses to assess teamwork skill sequence with achieving desired levels

There are some points we have to consider when choosing courses in skill sequence:

- The skill is integrated appropriate courses which supporting the learning process. It means that student will use the skill to get essential knowledge and gain their interest in learning.
- All most students (about 70% to 80%) will register the courses in the sequence. Some courses in our program are fundamental, so we can focus on them to assess skills. However, some other courses are not required. It makes this factor can be difficult to implement. One of the workaround we applied is to change courses in the sequence based on the registration statistics at the beginning of each semester but must ensure that alternative courses have to integrate this skill.
- Lecturers in the courses, especially adjacent courses, are required to discuss about teaching and learning activities to ensure students are not overloaded or perform at the same skill level.

- Resources such as equipment, teaching assistants, faculty, … need to prepare for teaching and collecting frequency data for the target behavior.

After completion of the skill sequence, we need to consider how to integrate the skill into each course. This is important phase in skills development. In next section, we will describe our approach in detail.

INTEGRATING THE SKILL INTO COURSES

When integrating skill into courses, it is important to specify the courses' context. For instance, in which year of the program are the courses taught? What are the levels of the students? Based on this, the importance of each factor could be identified in order for the students to achieve them all. Note that the integration could be specified through the spiral model (Bac Le et al., 2013). That is to say, moving from lower to higher level through years; the skills must be higher and assessed accordingly. As the integration, CDIO (Crawley et al, 2010) suggests the three levels of acquired knowledge: I (Introduced), T (Taught), U (Used). Level I is about the knowledge that should be introduced to students without going deeply in explaining why and how. Usually at this level, lecturers do not need to evaluate students. Level T requires lecturers to teach in a way that focuses on helping students understand thoroughly the content so that they can use it later in practice. The third one, level U, assumes students already understand the knowledge; as a result, the lecturers expect students to be able to apply or to enhance the ability to apply in other areas. In the same course, different levels can be applied to each element. For example, in integrating teamwork skill into "introduction to IT1", we mark IT2 (Figure 3) means that the lecturers will both introduce and teach that element to students. It might be the case that students are at initial stages of knowing and understanding new concepts. We express all in learning outcomes of the course syllabus (Table 2).

Table 2. Learning outcome associated with teamwork in Introduction to IT1 syllabus

LO	Description	Mapping To CDIO Program Outcomes	ITU
LO1	*Identify* roles in a team and *observe* how to construct a teamwork	3.1.1, 3.1.2	I
LO2	*Follow* the guides to build a team and work in discussing about IT history.	3.1.2, 3.1.3	T

In learning outcome description (Table 2), we use verbs corresponding to desired levels which the course is assigned in skill sequence. Because this is almost the first course in the curriculum, students will be learned the teamwork skill at simplest level. The lecturer propose the simple problem which need the group to discuss to solve it. The lecturer form group by randomly selecting members from the class. The next step, students in group are asked to identify roles, activities and rules in the group. Of course, they can wonder why they need to assign roles, which roles are needed, which activities should be done or why the teamwork

need rules, so on. They can make mistakes, but it is not important. After some experiences, we explain to students what they need to understand and can do better.We can give some group building in real life and show them how teamwork works. As a result, we helpstudents archive the course learning outcomes. That is the example where we develop teamwork skill at beginner's level in Introduction to IT1 course. The following courses will continue to teach at a higher level. This ensures that skills are fully implemented in each phase of process and that is also limit the extent to which the course undertaken.

THE PERFORMANCE ASSESSMENT

When the skill sequence and learning outcome in each course have been identified, we evaluate how far students achieve intended objectives. The first, lecturers gather information to assess students. The question is posed that what information should be gathered? What evidence can be collected to document achievements? Therefore, the list of evidence is mentioned for assessing student learning. There are many sources of evidence, such as short essays, assignments, reports, and so on (Biggs et al, 2011). That evidence is often associated with innovative teaching method. Lecturers can actively choose the appropriate method to teach and collect data for assessing. Besides that, the same activity or evidence can be used to show the achievement of different skills/behaviors. For example, *thought questions* can be used to illustrate the achievement of "identify" or "observe" in level 1 of teamwork and critical thinking skill. Table 3 presents some sources of evidence corresponding to levels in bloom.

Table 3. Behaviors and source of evidence

Level	Behaviors (verbs)	Source of evidence
1.Observe	Identify, Watch, Observe	Thought question Peer Observation
2.Model	Attempt, Follow, Imitate	Role playing
3. Recognize	Discriminate, Perceive	Group Discussion
4.Correct	Adapt, Adjust, Develop	Oral Presentation
5.Apply	Build, Construct, Create	Project-based learning

The next step is to identify criteria for assessing gathered evidences. Based on the criteria, the performance level is defined, such as capstones, milestones, and benchmarks. Each one is scored as a number. The criteria and the rubrics should be defined clearly for the students to understand and to be able to do a self-assessment. Moreover, the grading process must be valid, reliable, and fair (McMillan, 2000). For example, criteria are developed for evaluating *recognize* level including: discriminating clearly and comprehensively, give necessary information to show a deep understanding. With high competence, students are

required to ensure the sufficiency and even more than expectation. For example, if a student wants to achieve the capstone level, he/she must consider problem carefully, describe it clearly and comprehensibly, and deliver all relevant information necessary to show a deep understanding. However, if the student considers the problem without clarification or description details, he only reaches the benchmark level. Table 4 is used to illustrate rubric of the teamwork skill.

Table 4. Rubric for teamwork skill (Peter J. Gray, 2012)

	Capstone 1	**Milestones** 2	**Benchmark** 3
Working with Team	Rarely listens to,shares, is notpatient with, andis competitive withteam members.	Usually listens to,shares, patient with,and supports the efforts of the team members.	Always listens to,shares with, is patientand encourages teammembers.

In addition, the course must show the minimum passing level to ensure the desired quality. This is called the *passingstandard* of achievement. For example, students with scores of 5 (out of 10) or more will pass. Otherwise, he/she fails.

In the last step of the performance assessment, we aggregate data streams from assessment data in each course of skill sequence. As a result, we will face with different types of data from courses such as different forms for the same skill levels, different number of students, various criteria, and so on. We set up an expert group to perform statistical and data extraction. Their mission is to create the statistical graph (Figure 4), show the data points abnormalities, interview students and lectures, get feedback from the parties on the skills of students (Figure 5). Based on that, program leaders will evaluate this overall results and identify which outcomes have the lowest student attainment. And then they offer solutions and change plans to improve the weakest part of the program in next phase.

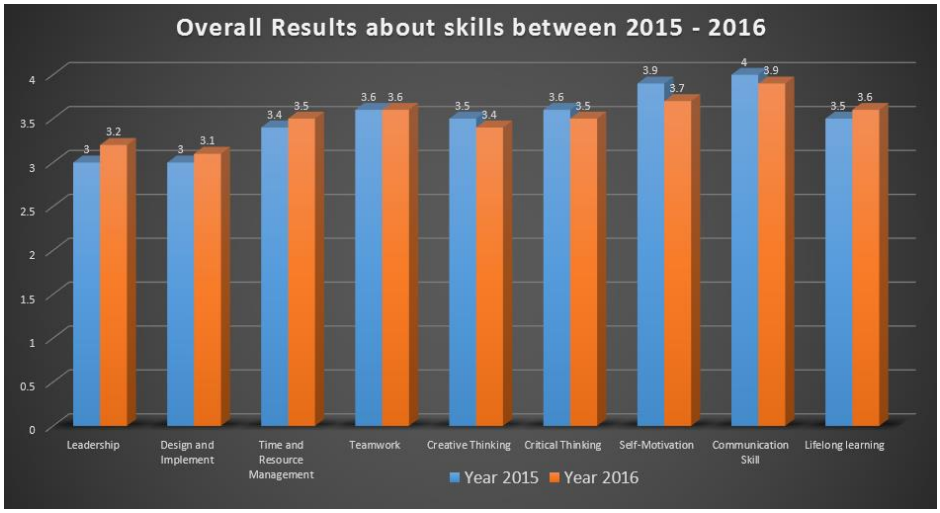

Figure 4. Overall Results about skills in 2015 and 2016

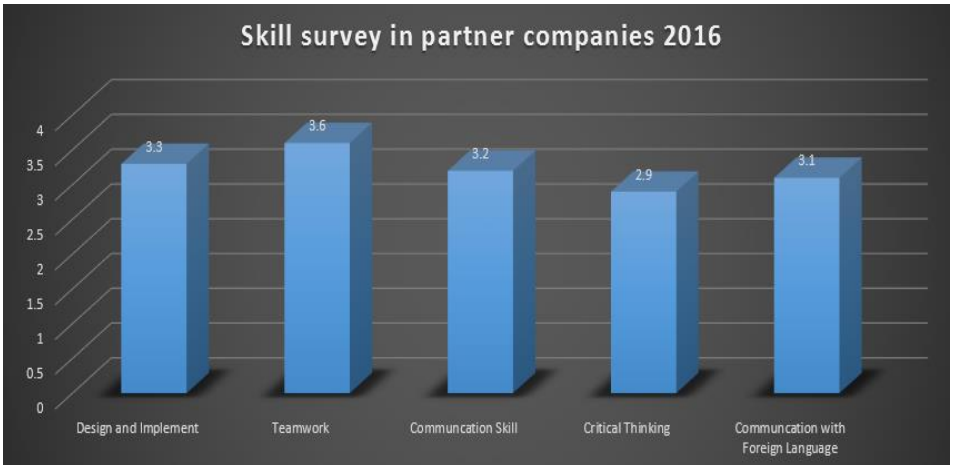

Figure 5. Skills survey from partner companies in 2016

CONCLUSION

The paper presents a process to integrate skills into courses based on CDIO approach. The process begins with identifying important skills which we intend to equip for students. Program leader, faculty and stakeholders discuss together to give achieving desired level for the skills based on facts. Next, we construct skill sequence with key courses which will be integrated the skill and chosen by almost student. The courses' syllabus presents the skill in learning outcomes with ITU and Bloom's Taxonomy. Then, teaching and learning activities are proposed to help students to achieve learning outcomes. In order to specify achievement levels, behaviors and sources of evidence are written down. In addition, criteria and standards are developed so that student can be able to understand clearly when he/she passes or fails; and what he/she should do to achieve desired objectives. Finally, we analyze data which collected from courses in skill sequence. As a result, we can identify areas for improvement in next phase of our education.

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BIOGRAPHICAL INFORMATION

Bac Le, Prof. Bac Le is the Vice Dean of the Faculty of Information Technology. He is monitoring and controlling the progress of the project and the deliverables. He is an active member in adopting CDIO in FIT. Prof. Bac research interests are in Data mining, Soft computing and AI

Thanh Le is a lecturer in the Department of Computer Science at University of Science (HCMUS). In addition to teaching, he also participated in the CDIO project at Faculty of Information Technology (HCMUS) from the beginning. Specifically, he was involved in the process of planning and structuring syllabus and material for some courses in the program following CDIO method. He and some colleagues researched about teaching methods especially active learning and has published papers in some international conference.

Thu Nguyen, Ph. D. is working in the Department of Information System, at Vietnam National University (VNU) – HoChiMinh City, University of Science.

Corresponding author

Prof. Bac Le
VNU – HCMC, University of Science.
227 Nguyen Van Cu Street
District 5, Ho Chi Minh City, Vietnam 700000
84-838354266 (ext: 803)
lhbac@fit.hcmus.edu.vn