CHAPTER 4

RESULTS AND ANALYSIS

The main objective of this research was to develop students' competencies through a cooperative education framework consistent with international manufacturing standards. The research took 2 years and 2 months from November 2008 to December 2010 and involved collecting data from 2 batches of co-op students. The results and analysis are presented in 4 main parts, along with detailed explanations.

1. Co-op framework construction results.

This part explains the steps involved in constructing MMIT co-op model. An initial model was created, then validated, adjusted, and improved again after the 1st batch was completed. This part also explained the tools used to follow up the students' competencies.

2. Results from the implemented co-op framework.

This part illustrated the results from implementing the MMIT co-op model using 2 batches of co-op students (code 49 and 50). This will be shown in the format of students' competencies development which emphasized behavioral and work performance competencies.

3. Initial findings.

This part revealed the initial findings from the implemented MMIT co-op model of 2 batches of co-op students. They were divided into 3 groups: student, workplace, and the co-op process.

4. Analysis of the results.

This part illustrates the analysis of results from the research. This was done from 2 perspectives: the key success factors that impacted on students' competencies development, and the evolution of students' competencies.

4.1 Co-op Framework Construction Results

To construct the MMIT co-op model, in 2007 MMIT set up a core team to work with EU partners. The core team was comprised of MMIT lecturers who have educational background in industrial engineering and business administration, and have some industrial work experience. The EU partners involved many co-op experts from IUT Lumière and BA. (See in Appendix C)

A working team established the initial prototype co-op model after several meetings and discussions. Information about the requirements from industrial sectors in Lumphun was collected by many methods such as; initial studies on industrial requirements (refer to chapter 2 part 2.2), making appointments with companies' representatives in their workplace, and inviting company key personal (normally HR managers) to discuss their requirements. After creating the initial prototype model, it was validated by EU experts and adjusted to suit the Thai cultural context (see details in 4.1.2). In 2008, the 1st batch of 22 MMIT co-op students and their mentors from 10 companies was implemented (see details in 4.2.1).

To improve the MMIT co-op model implemented using the 1st batch, many meetings were conducted applying follow-up process of the ETHICS-FED project. Most companies that participated in the MMIT co-op program were visited by an ETHICS-FED team. A lot of data/information was gathered at this time. Additional data/information was also collected through student's assessments, observations, informal interviews, and group discussions. These data were analyzed and the initial findings were used to improve the co-op model. The improved model was

implemented in 2009 with the 2nd batch of 23 co-op students and their mentors in 9 companies (see details in 4.2.2).

Details of all co-op model construction are described in the following.

4.1.1 The Initial Prototype MMIT Co-op Framework

A first draft of the co-op framework was constructed by using an IUT Lumière co-op model as a prototype. Some of the PPP activities from the French were adapted to the MMIT co-op model. In addition, some limitations of the MMIT curriculum were also considered such as, the number of co-op course credits that totaled 15 but occurred in 3 parts which included 3 credits in semester 2 of 3rd year (co-op I), 6 credits in semester 1 of 4th year (co-op II), and 6 credits in semester 2 of 4th year (co-op III). The apprentice period required the students to work at least 45 hours/credit/semester and had to fit with the overall credit program.

The initial prototype co-op framework had two main categories of students' activities during their four years study in MMIT. First, student study involved five main course categories: general education, core courses, required courses, major elective course, and free elective courses (refer to chapter 2 part 2.3.6), and second, co-op activities, adapted from the PPP activities of IUT Lumière were used to prepare students. There are many activities including finding an interesting (job fair), site visiting, the recruiting process, basic technical knowledge preparation, technical visiting, matching process, and a professional project. In addition, other essential elements of the IUT Lumière co-op model such as the assessment system, the managing with companies and mentors method were also adopted into MMIT co-op framework. Details of the overall framework are shown in table 4.1.

Table 4.1 The initial prototype MMIT co-op framework

Year	Semester	Time-line	Normal Study Activities		Co-op Activities		
			Course Work	Total credits	Main Co-op Process	Objectives	PPP Activities
First year	1	4 months	General Education, Core Course	15	-	-	-
		1 month	Holiday (No courses)				
	2	4 months	General Education, Core Course	15	-	-	-
	3	3 months	Holiday (No courses)	-	-	-	-
Second year	1	4 months	General Education, Core Course, Required Courses	18	-	-	-
		1 month	Holiday (No courses)				
	2	4 months	General Education, Core Course, Required Courses	18	Preparation process	To prepare basic work competencies	Job fair and site visit
	3	3 months	Holiday (No courses)	-	Preparation process	To prepare basic work competencies	Coo-op students recruitment
Third year	1	4 months	Core Course, Major Elective Courses	18	Preparation process	To prepare basic work competencies	Basic technical knowledge preparation, technical visit, and matching process
		1 month	Holiday (No courses)				
	2	4 months	Required Courses, Major Elective Courses	18	Co-op I apprenticeship	Adaptable to workplace	Work practice and find the Professional Development Project topic (Draft proposal)
	3	3 months	Holiday (No courses)	-	Holiday (No work)		
Fourth year	1	4 months	Required Courses, Major Elective Courses, Free Elective	15	Co-op II apprenticeship	Coordinate a Professional Development Project	Work practice, do proposal & pre – project (Project feasibility) + allocate project required resources, and starting implement project
		1 month	Holiday (No courses)				
	2	4 months	Required Courses, Major Elective Courses, Free Elective	15	Co-op III apprenticeship	Systematize new work function	Work practice, implement project, project report and present final project
Remark	semester 1 = June - September, semester 2 = November - February, semester 3 (summer) = March - May						
	Nomally, university is off in October (short holiday) and summer (long holiday but student can register to study in summer term)						

The initial co-op framework was used as a guideline for MMIT staff to develop a co-op program, but of course, it was still very new and untested in the Thai context. Hence, before applying this co-op framework in a real situation, especially in the Thai industrial context, validation by experts was required. The validation process and its results are presented in the next section.

Additionally, for PPP activities, the initial co-op framework showed merely rough concepts (not much detail). After the validation process, PPP activities were clarified and some learning activities of "Learning in Action" theory were added to the PPP activities. Details are in section 4.1.3.

4.1.2 Validation of the Initial Prototype MMIT Co-op Framework

The validation process was conducted by MMIT staff together with 2 co-op experts from IUT Lumière and 3 representatives from industrial companies in Lumphun province who were experts in industrial work and held management positions. In the validation meeting, all participants had a group discussion on deciding how to produce a proper framework that would benefit all key members and how to implement the MMIT co-op framework.

Recommendations from both IUT Lumière and company experts in the validation process dealt with various concerns and are now explained.

1) Learning activities and the learning process
-   Games, simulations, and projects should be designed for the purpose of motivating the students to learn more effectively. Examples include: the beer game, a visiting trip (students go abroad), a research project that requires students to conduct a survey, create a database, calculate statistics, and so on.
-   Should require the use of English in some activities or some assignment such as writing a report in English for practice and stimulate students to use foreign languages.

-       Student evaluation should be based on a work done and reports based on performance and problem solving. The idea is to see if the level of students' understanding of the work has gained a lot, some, or not much at all. This will allow them to be able to solve-problems and create a plan in the future.

-       The project must be feasible. Before the students start their project, they should complete the required internship in order to understand the various processes and balance between routine work and project work.

    2) Competencies demand

-       Communicating in a language (especially English) that is in strong demand is a necessity due to that company being operated and owned by foreign management. Foreign owned companies reserve the right to hire qualified candidates who can communicate in a language that is deemed important to make all operations run smoothly. Confusion would create a setback for the working procedures as well as the operation.

-       Arranging a training workshop to fulfill the needs of the required technical skills related to a particular work position. This is due to the lack of basic courses that are required in the curriculum. Each job position requires its own basic skills. Basic knowledge about a company's business is also required.

-       The students should be congenial and dress appropriately.

    3) Length of apprenticeship

-       Companies find the length of time in doing the apprenticeship to be too long. This could cause some problems for supervisors who are in charge of overseeing the students' work performance and have to manage the financial budget to compensate the student.

-       The holiday during apprenticeship (in summer of third year) must be abandoned because the student should work continually to gain employee attitudes.

    4) Cooperative Education Operation

-       Select the right students for the position with the right kind of work function and environment. If the students don't match with the right working position this could cause some difficulties for the students to adapt to the working

environment. This could result in the student being ineffective in carrying out the assigned task.

- Demonstrate the importance of having a mentor by allowing him/her to provide guidance and valuable insight to the students' performance. If the mentor lacks the time in developing or advising the students this would result in a hectic situation for them. Furthermore, this would be an obstacle in empowering the student.

- When teaching a course, if possible 25% of the lesson must be done by the experts from the company (invited lecturers) to transmit experiences and practical knowledge from the workplace.

In a group discussion, all experts agreed that the co-op framework can be implemented. It appears they saw that the framework being developed would enable the students to achieve the competencies required. However, there were some adjustments necessary to produce a more suitable co-op framework. The changes along with PPP and learning activities of "Learning in Action" theory are described in the next section.

4.1.3 The Revised MMIT Co-op Framework and Its Implementation on the 1st Batch

According to experts' recommendations in the previous section, the MMIT co-op framework revised some processes and details. The main adjustment was to abandon the long holiday during the summer of the 3rd year to help students gain employee attitudes. In addition, the competencies gap analysis results in the initial study (in chapter 2 part 2.2.4.4) revealed a need to generate and design activities for developing students' competencies. Also adding the learning activities of "Learning in Action" (Garvin, 2000) into PPP activities was considered.

All activities in the MMIT co-op framework can be divided into two major periods: before apprenticeship in company or "preparation period" and during the apprenticeship in a company. The co-op apprenticeship period, can be divided further

into 3 sub-periods: co-op I (2nd and 3rd semester of 3rd year), co-op II (1st semester of 4th year), and co-op III (2nd semester of 4th year). The revised overall co-op framework is shown in table 4.2. There are many activities in each period as described in the following.

Table 4.2 The revised MMIT co-op framework with PPP and "Learning in Action" learning activities (for use in the 1st batch)

Year	Semester	Time-line	*Normal Study Activities*		*Co-op Activities*			
			Course Work	Total credits	Main Co-op Process	Objectives	PPP Activities	Learning Activities of "Learning in Action"*
First year	1	4 months	General Education, Core Course	15	-	-	-	-
		1 month	Holiday (No courses)					
	2	4 months	General Education, Core Course	15	-	-	-	-
	3	3 months	Holiday (No courses)	-	-	-	-	-
Second year	1	4 months	General Education, Core Course, Required Courses	18	-	-	-	-
		1 month	Holiday (No courses)					
	2	4 months	General Education, Core Course, Required Courses	18	Preparation process	To prepare basic work competencies	Job fair and site visit	Search, Inquiry, and Obervation* Reflection & Review*
	3	3 months	Holiday (No courses)	-	Preparation process	To prepare basic work competencies	Coo-op students recruitment	Reflection & Review and Simulation*
Third year	1	4 months	Core Course, Major Elective Courses	18	Preparation process	To prepare basic work competencies	Basic technical knowledge preparation, technical visit, and matching process	Search, Inquiry, and Obervation* Reflection & Review, and Simulation*
		1 month	Holiday (No courses)					
	2	4 months	Required Courses, Major Elective Courses	18	Co-op I apprenticeship	Adaptable to workplace	Work practice and find the Professional Development Project topic (Draft proposal), Students' assessment	Search, Inquiry, and Observation* Reflection & Review* / After Action Review (AAR)* Exploratory or Hypothesis-testing*
	3	3 months	Holiday (No courses)	-	Co-op I apprenticeship**	Adaptable to workplace**	Work practice and find the Professional Development Project topic (Draft proposal), Students' assessment**	
Fourth year	1	4 months	Required Courses, Major Elective Courses, Free Elective	15	Co-op II apprenticeship	Coordinate a Professional Development Project	Work practice, do proposal & pre – project (Project feasibility) + allocate project required resources, and starting implement project, Co-op seminar, Students' assessment	
		1 month	Holiday (No courses)					
	2	4 months	Required Courses, Major Elective Courses, Free Elective	15	Co-op III apprenticeship	Systematize new work function	Work practice, implement project, project report and present final project, Students' assessment	

Remark * the additional learning activities of "Learning in Action" theory that insert into PPP activities or during co-op apprenticeship for contribute students' competencies development

** adjusted from first draft co-op framework (in Table 6.1) from holiday (no working) to no holiday (work continually)

4.1.3.1 The Preparation Period

The objectives of this period are to prepare students to discover their actually interest and enhance their technical knowledge before going to work in a company. Each activity and its objectives are explained below.

1) *Finding an interesting job (Job fair)*; this activity is conducted in semester 2 of 2nd year and its objectives are:

1. Students understand the available job market, different businesses, and the process of job application.
2. Students getting to understand their own job preferences and the qualifications required.
3. Students analyze their knowledge and abilities in comparison with job requirements and identify how to acquire those skills and knowledge.

The students are assigned to go to a job fair (exhibition) when many companies come to Chiang Mai University to recruit new graduates. The students must find a job of interest to them by visiting the prospective employers. They specify one job that is most interesting to them and identify the job specifications. After this, students will return to MMIT and separate into small groups (7 – 10 students) to reflect on and discuss their interesting job and its requirements. At the same time, they must analyze their knowledge and abilities in comparison with job requirements and present to the group how to acquire those skills and knowledge (see job fair guideline in Appendix F). The "Learning in Action" activities applied in this activity are search and inquiry of intelligence learning, and also reflection and review of experience learning.

2) *Site visit*; this activity is conducted in semester 1 of the 2nd year after the job fair. Its objectives are to help students to:

1. Be more aware and understand what work life is all about

2. Understand an organization's structure, components, and other business details

MMIT takes students to visit/observe 2 companies (usually in the industrial sector). They spend ½ day at each company. They are required to submit a report on each visit. This focuses them to gather information, ask questions, and summarize what they have learned (see site visit guideline in Appendix F). The "Learning in Action" activities applied in this activity are inquiry and observation of intelligence learning, and also reflection and review (through report writing) of experience learning.

3) *Recruiting process*; this process was conducted in the summer term (3ʳᵈ semester of year two), and the objective was to select those students in the MMIT curriculum that were most interested in following a work/study program in 3ʳᵈ and 4ᵗʰ year. The initial criteria used to determine the best qualified students were:

1. Grade Point Average (GPA) ≥ 2.00 (GPA ranges between 0.00 - 4.00). This is the lowest GPA Chiang Mai University required for graduation.
2. No failed or dropped courses.
3. Mature behavior and no penalties from the university, faculty, or MMIT

Students who qualified sent an application form (see Appendix F) to their MMIT lecturers. Then an interview day was conducted to select students for the co-op program. Each interview session (normally 3 sessions) consisted of 2 MMIT lecturers and 1 company representative to simulate a real application atmosphere. The marks each student got from the application form and interview were combined. Those who passed this selection process attended a preparation process as described next. "Learning in Action" activities that were applied in this process were reflection and review of experience learning by completing an application form and reporting their experiences in the interview session. To simulate a real interview, HR managers or company representatives were invited to join the interview sessions. This gave students an opportunity for experiential learning.

4) *Basic technical knowledge training*; this activity trained students to have basic technical knowledge to do their job in a company. The instructors were MMIT lecturers who had an industrial background and special lecturers from industry who had work experience. The courses included several types of technical knowledge for industrial work such as 5S, Kaizen, QCC, production systems, payroll systems, basic production cost accounting, and some details of modern management concepts such as Enterprise Resource Planning (ERP).

5) *Technical visit*; this second site visit differs from the first visit, and the objectives of this activity were:

1. To gain in-depth understanding about job position and work details.
2. To be able to assess their own area of interest.

The students visited the company to observe and gain insight into the different jobs, such as Quality System Management, Human Resources Management, and/or Information Technology Management. This helped students to understand more about the context of each job so they could specify the job(s) they found the most interesting. The "Learning in Action" activities that were applied in this activity were inquiry and observation of intelligence learning, and reflection/review of experience learning.

6) *Matching process*; the matching process in the 1st co-op batch tried to simulate a real work application. The process started by MMIT staff going to each targeted company and asking them to participate in the co-op program. The interested companies were asked to provide job descriptions and specifications to the MMIT staff. This information was made available to the co-op students and they submitted a maximum of 3 applications to the MMIT staff. These were in turn passed on to the relevant companies. The companies used their own process to decide which students to hire. The whole process took about 3 months, so the co-op framework was improved by using a recommendation from the expert involved in the ETHICS-FED project to reduce the time used (see part 4.1.4.2). The "Learning in Action" activities

applied here were search, inquiry of intelligence learning about the company and detailed information of positions of interest before sending an application form. Some experience learning was gained from simulating the recruitment process. All activities involving the preparation period, timeline, and the learning in action activities are shown in table 4.3.

Table 4.3 All activities in the co-op preparation period

Time line		Activities	"*Learning in Action*"
Year	Term		
2	1	Finding interesting job (Job fair)	*search, inquiry, reflect & review*
	2	Site visit	*inquiry, observation, reflect & review*
	3	Recruiting co-op student	*reflect & review, simulation*
3	1	Basic technical knowledge training	*- (classroom)*
	1	Technical visit	*inquiry, observation, reflect & review*
	1	Matching process	*search, inquiry, simulation*

4.1.3.2 The Co-op Apprenticeship Period (co-op I, II, and III)

Applying the experts' recommendations, the work was changed from stopping in the summer of year 3 to continuing and working a total of 16 months. The 16 months included three learning periods.

1. First, co-op I (months 1 – 7), students adapt to the work environment, understand work and responsibilities, and choose their professional project topic. This period, the students worked 3 days in the company and studied 2 days at the university.

2. Second, co-op II (months 8 – 12), students have autonomy in their work, can plan and allocate resources, and begin their professional project. During this period, the students worked 4 days in the company and studied 1 day at the university.

3. Third, co-op III (months 13 – 16), students applied the knowledge learned in their work to evaluate, analyze and improve their work, and finally, finish their professional project. The work/study pattern for this period is the same as co-op II.

During the co-ops I, II, and III apprenticeship periods, many learning activities were conducted to help the students to develop and evaluate their competencies. They are described in the following.

1) *Sign contract*; this is the process to ensure that the company will give each student an appropriate job and learning environment. The activity was conducted in the first work period of the co-op apprenticeship (after 2-3 weeks). The university advisor ensured that the student understood the job description and signed the cooperative education contract. The students, company mentors, and university advisor met together to clarify job descriptions, job details, student expectations, knowledge and skills required for the workplace, and the necessary resources such as tools, applications, technology or budget.

2) *After Action Reviews (AARs)*; after students passed their activities or work in a company, they must "*reflect*" and share their experiences by reviewing the situation using guideline questions such as:

- What did you learn and receive from the workplace?
- What problems and difficulties have you encountered?
- What problems have you already solved and how did you solve it?
- What are the problems which are not resolved and why?
- What will you plan to do next?

MMIT used this activity throughout the co-op learning period. It is one of most important activities of "Learning in Action" because it helps students to continuously assess themselves, review their assignments, identify successes and failures, and decide how they can improve their performance going forward.

3) *Assessment process*; the student's assessment book (explained more in part 4.1.5) was created for use in this activity. For the 1st batch MMIT required 7 assessments (one every 2 months). As explained in chapter 3 part 3.4.1, the assessments started with students explaining their work and evaluating their own competencies. Then, the company mentor, assisted by the faculty advisor discussed student behavior and work performance and assigned a grade of 1-4 to each student's competency. The grades ranged from 1 (unsatisfied), 2 (needs improvement), 3 (good), to 4 (excellent). Each student is assessed on two competency categories, behavior and work performance. All competencies are shown in part 4.1.5. This assessment activity is consistent with reflection and review in "Learning in Action" theory where each student has an opportunity to reflect on their own abilities and their job.

4) *Professional project*; plays an important role in students' learning process. All students must do a professional project to complete their co-op apprenticeship. One advantage is that students have a learning framework in their career path (management and IT in industrial). The project objective is to improve students' skills and prepare them to be a proficient "modern supervisor" upon graduation. The professional project should demonstrate how IT can be utilized to support industrial work, such as the use of an application program for solving rework problems. Other examples of an IT project are replacing some HR training programs through multimedia, and producing some databases to support production work.

Students started deciding on their professional project after the first 3-4 months of apprenticeship in company. It must be accepted by both the company mentor and the university advisor. After students have decided on their project topic, during co-op II they have to plan a proposal and allocate resources using a project feasibility study by considering necessary resources such as the budget, tools, timeline, project difficulties. They began to implement the project near the end of this period. In the final period (co-op III) they continue the project, send a final project report, and present it at the end of this period. The "Learning in Action" activities

adapted in doing this professional project included search, inquiry, and observation of intelligence learning, reflection and review of experience learning, and also exploratory or hypothesis-testing experiments in some cases.

5) *Co-op seminar*; during the co-op apprenticeship, a co-op seminar is conducted during month 10 or 11. The objective is to present all student professional projects. Students explained their project problems and possible solutions. It gave them an opportunity to share their experience and knowledge. Another advantage of this seminar is that it allows for a period to collect feedback information about the co-op program from students, company mentors, and university advisors.

All activities in the preparation period, timeline and the learning in action activities are shown in table 4.4.

Table 4.4 All activities in the co-op apprenticeship period

Time line		Activities	"*Learning in Action*"
Year	Term		
3	2	Sign contract	- *(meeting)*
3-4	continue	After Action Reviews (AARs)	*reflect & review*
		Assessment process	*reflect & review*
		Professional development project	*search, inquiry, observation, reflect & review, exploratory or hypothesis-testing experiments (in some cases)*
4	1	Co-op seminar	- *(group discussion)*

These are all learning activities adapted from the PPP concept of IUT Lumière and some additional learning activities from "Learning in Action" theory. It was used to train the MMIT co-op students to improve their competencies. The results using this co-op framework are presented in part 4.2.

4.1.4 The Improved MMIT Co-op Framework for the 2nd Batch of Co-op Students

Using the initial analysis and findings from the 1st co-op students generation (see part 4.3), the co-op framework was adjusted so some processes and activities were more appropriate. The main co-op framework remained the same. There are two main types of activity that were added or changed: activities improving student competencies *directly* and *indirectly*. An overview of the improved co-op framework is shown in table 4.5 and include the details of the activity of each participant (student, CAMT, company) along with its timeline, which is illustrated in figures 4.1 and 4.2.

4.1.4.1 Activities Directly Improving Student Competencies

These were the activities added to the co-op framework to help accelerate the process of co-op students adapting themselves to the work environment, know their responsibility, and understand the work system. These activities include:

1) *The student ice-breaking activity.* This activity was conducted over a period of two days by an outside instructor who was an expert on human resource management. The objective was to prepare the student to work in a real situation. The contents and activities included work attitude, planning, communicating, teamwork, target setting, and the fundamentals of labor law. After these two days, students had to attend a co-op orientation that took three hours. The MMIT lecturers explained the co-op process activities including regulations, the professional project, how to use reports and the assessment book. In addition, the students were trained to use system thinking and personal vision.

Table 4.5 Improved MMIT co-op framework for the 2nd batch

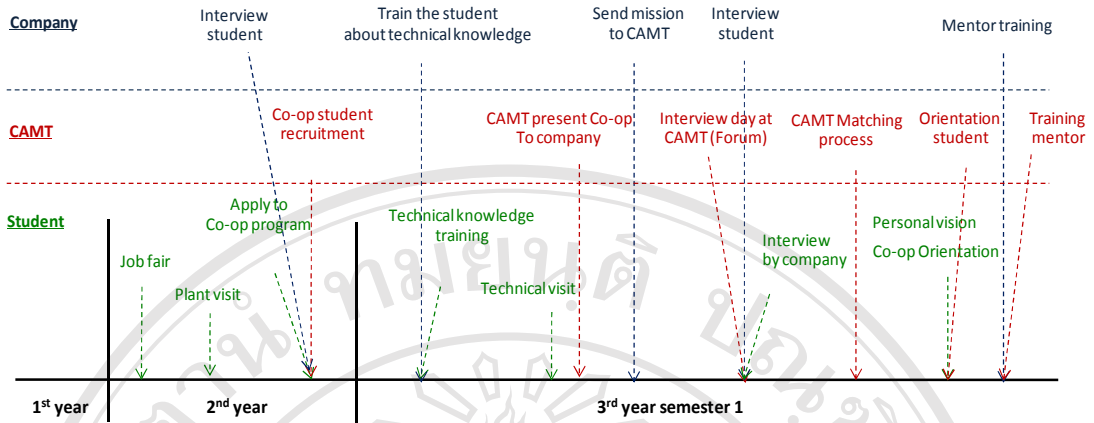| Year | Semester | Time-line | Normal Study Activities | | Co-op Activities | | | |
			Course Work	Total credits	Main Co-op Process	Objectives	PPP Activities	Learning Activities of "Learning in Action"*
First year	1	4 months	General Education, Core Course	15	-	-	-	-
		1 month	Holiday (No courses)					
	2	4 months	General Education, Core Course	15	-	-	-	-
	3	3 months	Holiday (No courses)	-	-	-	-	-
Second year	1	4 months	General Education, Core Course, Required Courses	18	-	-	-	-
		1 month	Holiday (No courses)					
	2	4 months	General Education, Core Course, Required Courses	18	Preparation process	To prepare basic work competencies	Job fair and site visit	Search, Inquiry, and Obervation Reflection & Review
	3	3 months	Holiday (No courses)	-	Preparation process	To prepare basic work competencies	Coo-op students recruitment	Reflection & Review and Simulation
Third year	1	4 months	Core Course, Major Elective Courses	18	Preparation process	To prepare basic work competencies	Basic technical knowledge preparation, technical visit, and **matching process***	Search, Inquiry, and Observation Reflection & Review, and Simulation
		1 month	Holiday (No courses)				**Student-ice breaking, Personal vision activity, Company mentors training ****	
	2	4 months	Required Courses, Major Elective Courses	18	Co-op I apprenticeship	Adaptable to workplace	Work practice and find the Professional Development Project topic (Draft proposal), Students' assessment, **Systems thinking ****	
	3	3 months	Holiday (No courses)	-	Co-op I apprenticeship	Adaptable to workplace	Work practice and find the Professional Development Project topic (Draft proposal), Students' assessment	Search, Inquiry, and Observation Reflection & Review/ After Action Review (AAR) Exploratory or Hypothesis-testing
Fourth year	1	4 months	Required Courses, Major Elective Courses, Free Elective	15	Co-op II apprenticeship	Coordinate a Professional Development Project	Work practice, do proposal & pre – project (Project feasibility) + allocate project required resources, and starting implement project, Students' assessment	
		1 month	Holiday (No courses)					
	2	2 months	Required Courses, Major Elective Courses, Free Elective	15	Co-op III apprenticeship	Systematize new work function	Work practice, implement project, project report and present final project, Students' assessment	
Remark		* = Changed matching process, ** = added activities						
		Yellow highligth = adjusted time-line						

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Figure 4.1 The preparation period (students year 2 and year 3 (first semester))
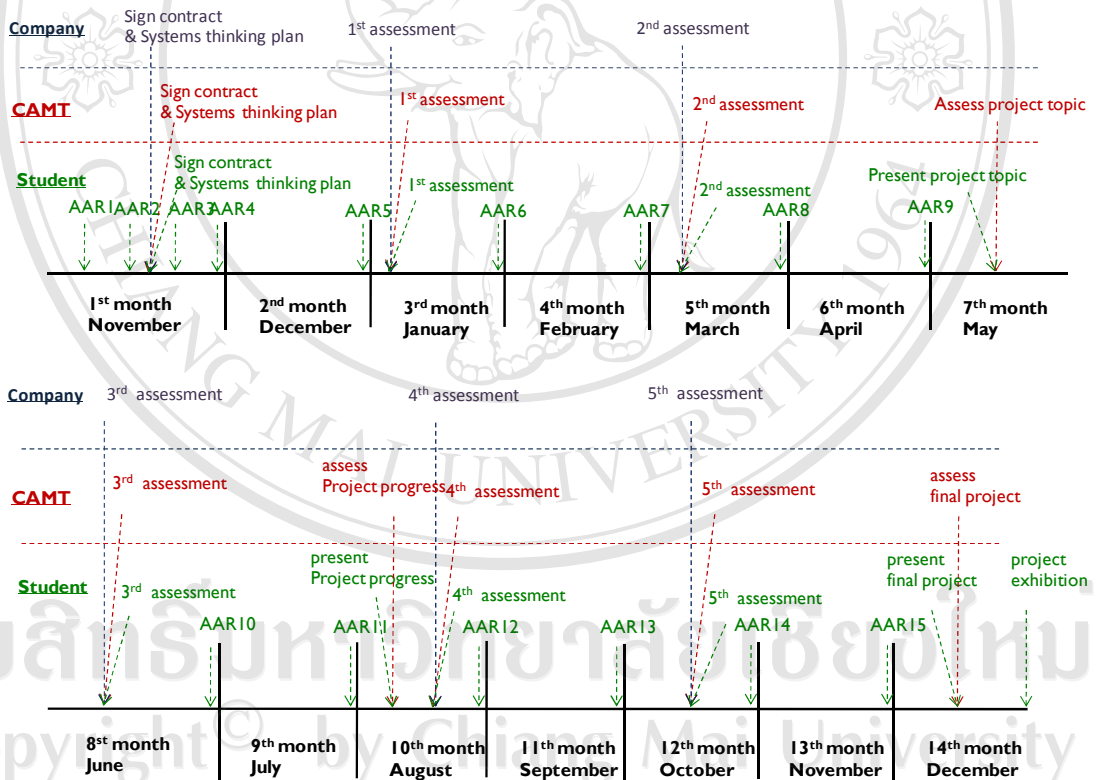
Remark   AAR = After Action Review

Figure 4.2 The apprenticeship period
(14 months; since semester 2 year 3 until finish year 4)

2) *The personal vision activity*. This activity helps the student to be aware of their real needs and start planning their future. It helps them to focus on their work and career. The students were asked to explain their personal vision. Each student answered questions by writing their future goals utilizing the 4 steps from "Drawing Forth Personal Vision" (Senge et al., 1994).

Step 1: Creating a result; this step focuses on the student's personal vision. The students were asked what they really want to achieve and ignore whether it was possible or impossible. After that, they were asked to imagine it had happened and describe in writing what it looks and feels like, and what words would describe it.

Step 2: Reflecting on the first vision component; the students were asked to reflect on their vision: Was their first vision close to what they actually wanted? The students gave a variety of responses such as: "I can't have what I want", "I want what someone else wants", "It doesn't matter what I want", "I already know what I want", "I am afraid of what I want", "I don't know what I want", and "I know what I want, but I can't have it at work". The students had to choose one response and reflect on why they chose it. This step aimed to consider how the current reality differed from their vision.

Step 3: Describing your personal vision; the students were asked again to explain their first vision in more detail by using the following topics as a guideline: Self-image, Tangibles, Home, Health, Relationships, Work, Personal pursuits, Community, and Life purpose. This process helped to make their vision more consistent with their deeper desires.

Step 4: Expanding and clarifying your vision; in this final step, the students were asked if they could attain their vision now, would they take it, and if not, why. They were also asked why they wanted it. This step reveals the real reason(s) why they chose their vision.

3) *The systems thinking activity.* This activity was adapted from "The Fifth Discipline" theory of Senge (1990). It aimed to train students so they can consider an "overall view" of a system rather than each piece in the system separately. This activity trained students to understand the interrelationships and the cause and effect between groups of activities in the system. They will have an overview of their job and be aware of the results affected by their performance. The training was done by an MMIT lecturer. Next, students were assigned to produce a systems thinking diagram of their company's job in the first 1-2 months of the co-op apprenticeship. The aim was for them to quickly gain on an "overall view" of their job and understand the interrelationships and the cause and effect of each part.

4.1.4.2 Activities to Indirectly Improve Students' competencies

1) *The company mentor training.* This training explained the history and an overview of the MMIT curriculum, and the cooperative education program (activities, professional project, regulation, mission planning, and how to use student's report & assessment book). The company mentors were invited to share their experiences with the code 49 students (the 1st batch of co-op student).

2) *Matching process changes.* The initial findings (see part 4.3) revealed that the method used to match the 1st batch students with a company took too much time (3 months) and energy from both the companies and students. Hence, the co-op framework for the 2nd batch was changed using suggestions from the French partner in the ETHICS-FEDS project. The matching process was changed and a comparison between the old and new method is shown in table 4.6. These changes allowed companies and students to match more easily and reduced the time required from 3 months to 2 weeks.

Table 4.6 Matching process changes

X-method (co-op framework of the 1st batch)	New method (improved co-op framework)
CAMT asked companies to send students' mission to CAMT	CAMT asked companies to send students' mission (by mission form) to CAMT (went into each company to convinced them to joined co-op program)
CAMT announced the mission to students	CAMT announced the mission to students
Students send application to CAMT and CAMT send forward to companies	Students send application to CAMT and CAMT send forward to companies
Companies make an appointment with students	CAMT invited all companies to interview the student in the same day
Companies interview students at their companies	**CAMT conducted an interview day (invited all companies to CMU)** - Companies present their profile to the students - Companies interview students that send application form to them - Companies will rank the student and the students also rank company
Student decided to joined each company (some companies didn't get the student because the student applied many companies and they choose just one company)	After interview day CAMT will match the appropriate student to appropriate company by use ranking to be a direction
Time taken 3 months	**Time taken 2 - 3 weeks**

3) *Reduction of apprenticeship time.* After reviewing the results of implementing a co-op framework for the 1st batch the apprenticeship period was reduced from 16 to 14 months. The reasons were:

1. Students needed time in the final period (the last 2 months of year 4) to finish their professional project and report in order to graduate on time.

2. From the company point of view (mentor), it was sufficient for the students to work autonomously for 14 months. Moreover, in some

cases, companies allowed students to reduce routine work because they expected to use the student project immediately after finishing.

4) *Reducing the amount of student assessments.* The co-op framework of the 1st batch included 7 student assessments. After implementing this, it became apparent that company work requirements made it difficult to arrange meetings. Emergency situations and increasing business were often the cause. Therefore, the number of assessments in co-op framework for the 2nd batch was reduced to 5.

These then are all the added and adjusted activities to improve the co-op framework for the 2nd batch. The results from implementing these changes are shown in part 4.2.

4.1.5 Tools to Follow-up the MMIT Co-op Students' Competencies

Part of the co-op framework construction included the students' assessment and report books which were used to monitor students' competencies development. A description follows.

1) *The assessment book*: the assessment book was adapted from the IUT Lumière booklet. The objectives were to ensure that students have a precise job plan and to use it when assessing students' competencies progress. The major parts in this book consisted of the schedule of students' activities, the cooperative education rules and regulations, job descriptions, the co-op agreement, and the students' assessment form. The students' assessment form comprised of a comparison table between plan and actual, a sheet to assess a student's presentation, and the criteria used to assess the students' competencies. The student is assessed on: behavior and work performance as shown in table 4.7. The assessment method was already explained in chapter 3 part 3.4. To ensure they were proceeding appropriately (see student assessment book in Appendix D) after the assessment process, students had to explain their future plan.

Table 4.7 The competencies used for assessing MMIT co-op students

No.	Behavioral perspective	Work performance perspective
1	Enthusiasm	Learning & Understanding
2	Sense of responsibility	Planning & Managing
3	Adaptability	Knowledge applying
4	Manner	Creativity
5	Communication	Problem solving
6	Leadership	Follow work instruction
7	Patience	Handle emergent problems

2) *The report book:* this tool was used to stimulate the students to reflect on their work experience and give explicit evidence. They had to write daily, weekly, and monthly reports. The daily report was used merely to get the students to start writing and was required only in the first month of the apprenticeship. Report details comprised of activities descriptions, problems, and difficulties. Weekly reports were also required just in the first month to force the students to reflect and make observations of their own job and activities during each week. Guideline questions for students were:

- What did you learn and get from the workplace?
- What are your problems and difficulties?
- What have you already solved and how?
- What are the problems which are not resolved and why?

After writing their reports, students had to send them to their mentor and university advisor to get some feedback. This process helped students to be aware of what they plan to do next. The monthly report was similar to the weekly report and the students had to reflect on and draw some conclusion(s) from their monthly experience until they finished the co-op apprenticeship. (See student report book in Appendix D)

4.2 Results from the Implemented MMIT Co-op Framework

This part shows the results of implementing the co-op framework, it's impacted, and how it affected students' competencies progression for the two co-op batches. The data for analysis were collected from all students' assessment books. The collected data were analyzed using a quantitative and qualitative approach.

1) Quantitative approach; used to analyze the data of students' competencies level rated by their company mentors. The average value of each competency was calculated and represented by a radar graph using the MS Excel program. These values and the graph were used to elicit qualitative data (comments from company mentors) to analyze the progress of students' competencies.

2) Qualitative approach; the comments of company mentors were input data for analysis. All comments from company mentors collected throughout the students' assessment process were combined and categorized into each competency using MS Excel. Then, the comments were reviewed so they could be categorized. Next, a coding process was conducted to establish a theme (group of events) to explain students' competencies progress. This was the initial qualitative analysis to observe the trends of student's competencies progression. For an in-depth analysis of the other qualitative data (informal interview, observation, and group discussion), grounded theory was used as a main approach to analyze and explain the group of categories and their interrelationships (see part 4.4).

Results from analyzing the student's assessment books of both co-op batches are shown as follows.

4.2.1 Results on Competencies' Progress of the 1st Batch

In the beginning there were 22 students apprenticeship in 10 participating companies, but along the way 6 students from 2 companies withdrew to follow an IS program at MMIT. This left 16 students working in 9 companies (see table 4.8).

Table 4.8 Companies and their student numbers and positions (1st batch)

No.	Company nationalities	Begin of co-op		End of co-op	
		Number of students	Positions of the students	Number of students	Positions of the students
1	Japanese (KH)	3	1 HR, 2 QS	3	1 HR, 2 QS
2	Japanese (TSL)	2	1 HR, 1 QS	2	1 HR, 1 QS
3	Japanese (TKN)	1	1 QS	1	1 QS
4	French (S)	6	2 HR, 2 QS, 2 Production	**4**	**2 HR, 1 QS, 1 Production**
5	English (ABC)	1	1 HR	1	1 HR
6	Thai (SP)	2	1 HR, 1 IT	2	1 HR, 1 IT
7	Thai (LP)	1	1 Shipping + IT	1	1 Shipping + IT
8	American (PC)	1	1 HR + IT	1	1 HR + IT
9	American (HN)	4	1 HR, 1 Planner, 1 QS, 1 Admin	**0**	**-**
10	Germany (BC)	1	1 QS	1	1 QS
	Total	**22 students in 10 companies**		**16 students in 9 companies**	

Remark: (KH), (TSL), (TKN), (S), (ABC), (SP), (LP), (PC), (HN), (BC) are the company name codes. The real company names were not used in order to protect their privacy and reputations.

Due to time availability of company mentors and university advisors it was not possible to have 7 assessments, so only 2-3 were processed during the 16 months. The assessment plan and assessments are shown in table 4.9.

Table 4.9 The original assessment plan compared with the actual one (1st batch)

Year	Months	Plan	Actual
2008	November	Sign contract	Sign contract
	December		
2009	January	1st Assessment	1stAssessment
	February		
	March	2nd Assessment	
	April		2nd Assessment
	May	3rd Assessment	
	June		
	July	4th Assessment	3rd Assessment
	August		
	September	5th Assessment	
	October		
	November	6th Assessment	
	December		
2010	January	7th Assessment	Present final project
	February		

During the co-op apprenticeship there were some difficulties collecting the data. Some documents disappeared or were incomplete because some company mentors and university advisors changed. The research was gathered from 12 assessment books involving 8 companies. These sample groups are shown in table 4.10.
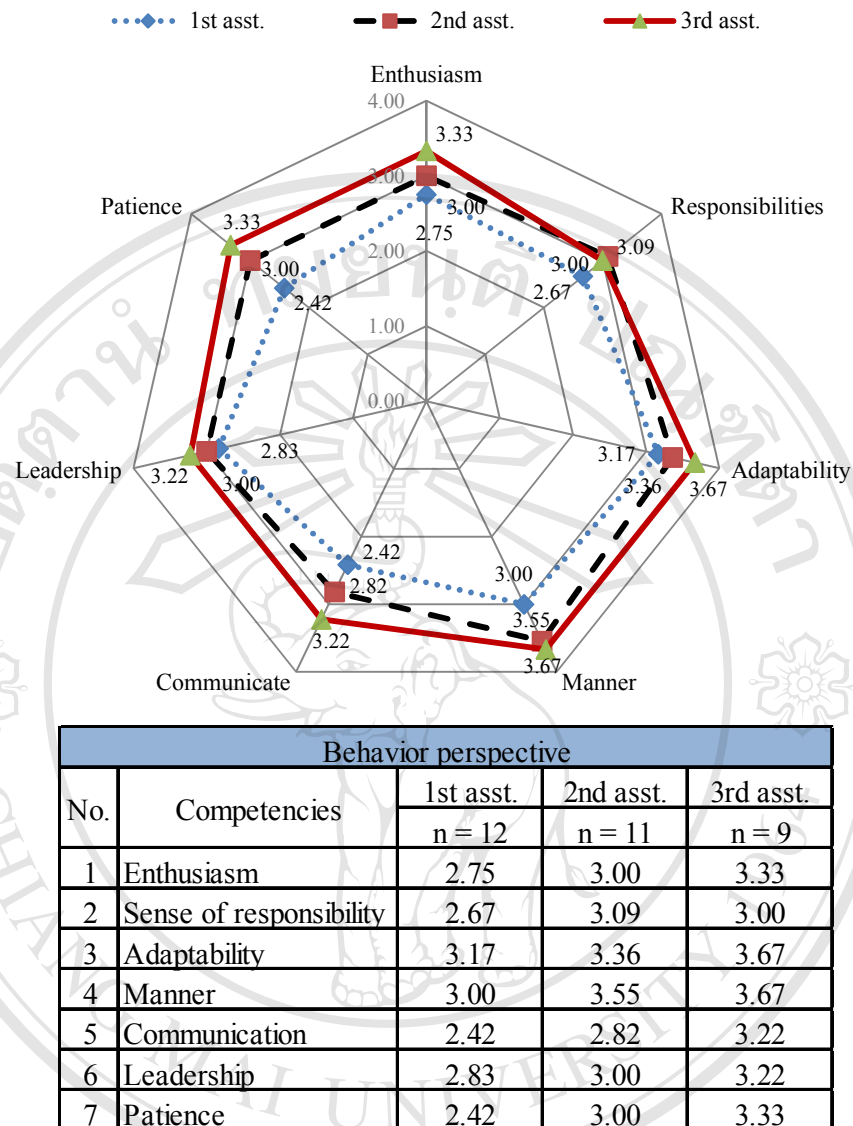
Table 4.10 The sample group of the 1st batch

No.	Company nationalities	Number of students	Positions of the students
1	Japanese (KH)	1	1 QS
2	Japanese (TSL)	2	1 HR, 1 QS
3	Japanese (TKN)	1	1 QS
4	French (S)	3	1 HR, 1 QS, 1 Production
5	English (ABC)	1	1 HR
6	Thai (SP)	2	1 HR, 1 IT
7	Thai (LP)	1	1 Shipping + IT
8	American (PC)	1	1 HR + IT
	Total	**12 students in 8 companies**	

Analysis of the assessment books was done from two perspectives of competencies according to the assessment criteria: behavior and work performance. The competency grade and meanings assigned were: 1 (unsatisfactory), 2 (needs improvement), 3 (good) and 4 (excellent). The main assessor was the company mentor, with some assistance from the university advisor. The results are illustrated in the following.

4.2.1.1 Behavior Perspective of the 1st Batch

Figure 4.3 shows an overview progression of students' behavioral competencies. It describes each competency by analyzing the trend and gives some comments from company mentors.

Behavior perspective			
No.	Competencies	1st asst.	2nd asst.	3rd asst.
		n = 12	n = 11	n = 9
1	Enthusiasm	2.75	3.00	3.33
2	Sense of responsibility	2.67	3.09	3.00
3	Adaptability	3.17	3.36	3.67
4	Manner	3.00	3.55	3.67
5	Communication	2.42	2.82	3.22
6	Leadership	2.83	3.00	3.22
7	Patience	2.42	3.00	3.33

Figure 4.3 Average behavioral competencies level of the 1st batch

1) Enthusiasm competency; the first assessment result was 2.75 (mid-level). Most company mentors were fairly satisfied with this students' competency. Some sample comments and the related company from mentors were "student pays attention in his/her job and tries to seek related knowledge to do their job" (S), "when she got a task, she was enthusiastic and motivated to perform well" (TSL), and "she concentrated on a given task immediately and has enthusiasm for the task" (TKN). However, there were some weak ones that required improvement, such as "she should report to the mentor after finishing the task" (TSL), and "he should be more

enthusiastic and ask questions" (SP). In some cases where students worked together in the same position the company found that "they talked (not related to their task) during working" (S). The second assessment showed improvement in this competency (3.00). Some comments from company mentors were "he has more enthusiasm on a given task" (SP), "better enthusiasm" (TSL), and some negative comments were "lack of finding information from other sources" (S), "insufficient task follow-up" (TSL, SP), and in some cases the mentor had to remind the student that they are an employee not a student (S). The third assessment found most company mentors were more satisfied with students' enthusiasm (3.33). Other comments from mentors were "he changed, he always asks for some advice from me" (S), and "more enthusiasm, more attention in the given work" (TKN), but there were also some negative comments about "task follow-up" (S, SP).

2) Sense of responsibility competency; the first assessment was 2.67 (mid-level). Most company mentors thought students had a fair sense of responsibility but some of them complained about "coming to work late" (ABC, LP) and "submitting a task after the due date" (SP). The second assessment was 3.09 and was an improvement. It revealed that some students "came to work before work time" (ABC), and most students came "on time". Surprisingly, the third assessment of this competency revealed a grade of 3.00 (a decrease from the previous assessment). It showed that some students were "frequently absent" (S) and "submitted tasks late" (SP). The main reason was that students were tired from their work. During the long period of co-op apprenticeship the students must do their work and project simultaneously, and this made it difficult to finish on time. However, company mentors noted that other students were still "on time, and had excellent response to tasks" (TKN, ABC).

3) Adaptability competency; there were no major problems here, with grades 3.17, 3.36 and 3.67 respectively. Most company mentors agreed that students have good adaptability skill. Some mentor comments were "students adapt well to other people" (S), "able to adjust themselves, polite speaking" (KH), and "able to work with others, able to work as team" (TKN).

4) *Manner competency*; similar to adaptability, the manner competency received good grades, 3.00, 3.55 and 3.67 respectively. Most company mentors thought most students "always had a good manner" (TKN), and "respect, manner, always greeting" (TSL). However, a few comments (but not serious) were mentioned, such as, "doesn't say hello when receiving a telephone call" (ABC), and some students "should improve greeting to be more friendly" (LP).

5) *Communication competency*; the first time, this competency received a low grade of 2.42. Most company mentors thought this competency should be improved. Sample comments were "speaking is confusing, poor sequence" (ABC), "explanation too long, more compact may be better" (TSK), and "student has problems communicating, and should practice speaking technique" (SP). In the next assessment, students had improved themselves (2.82) and some mentor comments were, "good communication because they follow-up their task" (S), and "communicates better, participates more with other persons within the department" (TSL). However, there were still some problems with "direct and clear communication" (SP). The third assessment was 3.22 and showed great improvement, but there were a few problems, example, "verbal reports lacked detail".

6) *Leadership competency*; this competency improved continuously from 2.83 to 3.00 and finally 3.22. Most company mentors agreed that the majority of students displayed sufficient leadership. They readily accepted opinions from others but hesitated presenting their own opinion. Sample opinions were, "student should take more risk in leading" (SP) and "student is a good listener but should also try to present his/her thoughts" (KH). There were a few comments about students being reluctant to speak their mind.

7) *Patience competency*; this also had a low grade (2.42) similar to the communication competency. Some company mentors gave a low grade because student patience could not be observed in the beginning as they had not yet met with difficulties in their job. Some comments on this competency from the first assessment were, "she still lacks maturity and enough patience to control herself, she must develop herself to be more in control" (S), "she has maturity but should improve her

patience" (LP), and "he never faces problems and still has childish habits" (S). The next two assessments showed increases in this competency (3.00 and 3.33), and some mentor comments, "has maturity, good patience on problems and obstacles" (S), and "more patient, more mature" (ABC).

4.2.1.2 Work Performance Perspective of the 1st Batch

Figure 4.4 shows an overview progression of students' work performance competencies. It describes each competency by analyzing the trend and gives some sample mentor comments.

1) Learning & Understanding competency; in the first assessment, students got a high (3.00). Most company mentors commented "students are able to learn quickly" (S, ABC, SP, LP) because they use general knowledge for basic work. The second assessment level decreased to 2.82 and one sample comment was that "students are confused about their work" (S). One explanation is that as time passes, students have more complex work but it also had some knowledge gaps when dealing with some work details. The third assessment was much improved (3.56), and sample comments were "he works like a competent employee" (S) and "she understands and can work autonomously" (ABC).

2) Planning & Managing competency; the first assessment of the competency was quite low (2.42). Two reasons for this are that this was their first real work experience and they found it difficult to prioritize tasks (ABC, SP). The next two assessments improved to 3.00 and 3.11 respectively. They were able to plan better but still had some problems following through. They had difficulty dealing with problems that occurred and were late completing some tasks.
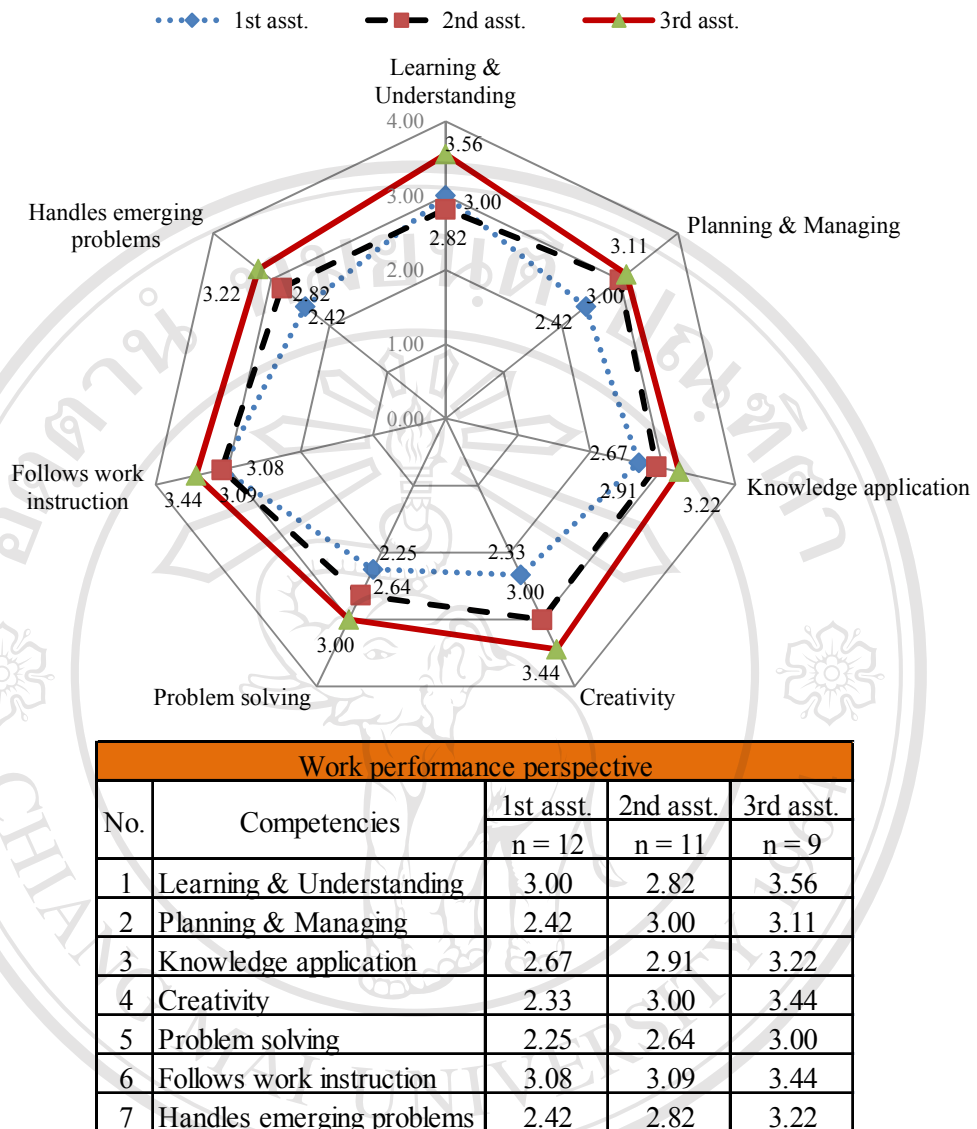
Figure 4.4 Average work performance competencies level of the 1st batch

3) Knowledge application competency; the first grade was 2.67 mostly because students did not clearly understand their job, so had little opportunity to apply their knowledge (TSL). Most students used just basic knowledge in this first period, such as MS office. However, the next two assessments, increased to 2.91 and 3.22. Two comments were "she does well on adapting knowledge into her project" (ABC), and "she understands the problem and can apply knowledge by herself" (S).

4) Creativity competency; the first assessment was low at 2.33. One comment was "the students are in an adaptation period, and they need to listen to the

mentor's advice and apply it" (TSL). The second grade improved to 3.00. Comments such as "he is showing more creativity in his presentation" (PC), and "she has an idea to improve the work operation and it looks feasible" (TKN) showed that students were developing this competency. Mentors also said that some students needed to develop more and improve (S). The third assessment increased to 3.44. Some students applied their university knowledge creatively. One comment was "after further university study students gained more information, and were able to apply it to solving company problems" (SP). The professional project helped most students to develop this competency.

    5) Problem solving competency; the first grade was 2.25, and was low because there were no problems the students had to solve by themselves in this first period. Some comments were "does not solve the problem exactly" (TKN), "this period is not in-depth work" (TSL), and some "students made mistakes when they tried to solve problem" (S). The second assessment was 2.64. Mentor comments were "there was only a slight increase in problem solving" (TSL), "insufficient knowledge of tools for problem solving" (S), and "the analysis wasn't clear" (S). The third assessment (3.00), showed that some students were "more effective on analysis and solving the problem" (TKN), "able to use tools/methods to help in their work and solve problems directly" (S). However, there were still some problems with some students. Some comments were "less analysis and not clear" (S), and "lack ability to use tools in their work" (S).

    6) Follows work instruction competency; it had a high assessment for all 3 periods (3.08, 3.09 and 3.44). Most company mentors agreed that "the student is able to perform tasks according to assigned" (TKN, S, TSL, SP, KH), and "the student can work and follow the system" (LP). There were few problems with this competency.

    7) Handles emerging problems competency; the first assessment of this competency was low (2.42). Most students did not deal well with an emerging problems, and when one occurred they "still ask many questions about the problem" (ABC), and "were always asking others and not able to solve the problem" (S). The

second assessment found that students improved to 2.82, but some company mentors still commented "he should search for more knowledge" (S), and "she should be more careful in her work" (TSL). The third assessment improved to 3.22.

4.2.2 Results on Competencies' Progress of the 2nd Batch

The 2nd batch began with 23 students in 9 companies. One student changed to an independent studies program (IS), so the program included 22 students working in 9 companies (see table 4.11).

Table 4.11 Companies and their student numbers and positions (2nd batch)

No.	Company nationalities	Begin of co-op		End of co-op	
		Number of students	Positions of the students	Number of students	Positions of the students
1	English (ABC)*	2	1 HR, 1 IT	2	1 HR, 1 IT
2	Germany (BC)*	3	1 QA, 1 HR, 1 Purchase	3	1 QA, 1 HR, 1 Purchase
3	French (S)*	2	1 HR, 1 Production	**1**	**1 Production**
4	French (IM)	2	1 R&D, 1 QA	2	1 R&D, 1 QA
5	Dutch (DAIS)	5	1 HR, 1 IT, 1 Production support, 1 Customer coordinator, 1 Planner	5	1 HR, 1 IT, 1 Production support, 1 Customer coordinator, 1 Planner
6	Swiss (BNN)	1	1 HR + IT	1	1 HR + IT
7	Swiss (SN)	3	1 HR, 1 QA, 1 Production	3	1 HR, 1 QA, 1 Production
8	Swiss (FB)	3	1 Production prepare, 1 Import-export, 1 Production scheduling	3	1 Production prepare, 1 Import-export, 1 Production scheduling
9	Thai (SC)	2	2 HR	2	2 HR
	Total	**23 students in 9 companies**		**22 students in 9 companies**	

*Remarks: * are the companies that participated in the 1st batch. (ABC), (BC), (S), (IM), (DAIS), (BNN), (SN), (FB) and (SC) are the company name codes. Their real names were not used to protect their rights and reputations.*

Six of the nine companies that participated in phase two were new. The reason for this was that some of the companies still had 1st batch co-op students working and due to budget/business constraints they could not take on new students.

In spite of these problems they still wanted to continue participating in the co-op program.

Similar to the 1st batch, students' competencies progression both behavioral and work performance were assessed. In the 2nd batch, the number of students' assessments was reduced from 7 to 5. Although there were more assessments than the 1st batch, problems of availability and timing continued to occur, and as a result most students were assessed only 3-4 times. The assessment plan and what actually happened are shown in table 4.12.

Table 4.12 The original assessment plan compared with the actual one (2nd batch)

Year	Months	Plan	Actual
2009	November	Sign contract	Sign contract
	December		
2010	January	1st Assessment	1st Assessment
	February		
	March	2nd Assessment	2nd Assessment
	April		
	May		
	June	3rd Assessment	3rd Assessment
	July		
	August	4th Assessment	
	September		
	October	5th Assessment	4th Assessment
	November		
	December	Present final project	
2011	January		Present final project
	February		

During the 2nd batch apprenticeship, there were still some data collection difficulties. Some students changed company mentors and/or university advisors during the co-op apprenticeship, and as a result some assessments' documents disappeared or were incomplete. A total of 14 student assessment books involving 9 companies were collected. The details are shown in table 4.13.

The assessment books were analyzed using the same perspectives as the 1st batch: the behavioral and work performance. For this batch, the research will focus on the main problems affecting students' competencies development and observe the main results supporting and/or different from the 1st batch. The results follow.

Table 4.13 The sample group of the 2nd batch

No.	Company nationalities	Number of students	Positions of the students
1	English (ABC)*	1	1 HR
2	Germany (BC)*	2	1 HR, 1 Purchase
3	French (S)*	1	1 Production
4	French (IM)	1	1 R&D
5	Dutch (DAIS)	4	1 HR, 1 Customer coordinator, 1 Production support, 1 Planner
6	Swiss (BNN)	1	1 HR + IT
7	Swiss (SN)	2	1 HR, 1 Production
8	Swiss (FB)	1	1 Production prepare
9	Thai (SC)	1	1 HR
	Total	**14 students in 9 companies**	

Remarks: * are the companies that participated in the 1st batch

4.2.2.1 Behavioral Perspective of the 2nd Batch

Figure 4.5 shows an overview of students' behavioral competencies progression. The trend of each competency was analyzed and sample comments from some mentors are presented.

1) Enthusiasm competency: the first assessment found that the students have a lot of enthusiasm when they start work (3.07). Mentor comments were "very good, student has enthusiasm to do a given task and the result is satisfactory" (S), "student works hard and has enthusiasm when working on a new task" (SC). In some cases some students had too much enthusiasm. One comment was "she needs to do difficult tasks but she should practice on easy tasks first" (DAIS). This perspective continually improved in the next three assessments (3.29, 3.43, and 3.50).

2) Responsibility competency: most students had a high level of responsibility (3.14) when they started work, however some students had punctuality problems. This competency gradually improved in the next three assessments (3.36, 3.46, and 3.67). However, near the end of apprenticeship period some students spent most of the time concentrating on their professional project. One comment was "cannot complete some given tasks" (SN).

Figure 4.5 Average behavioral competencies level of the 2nd batch
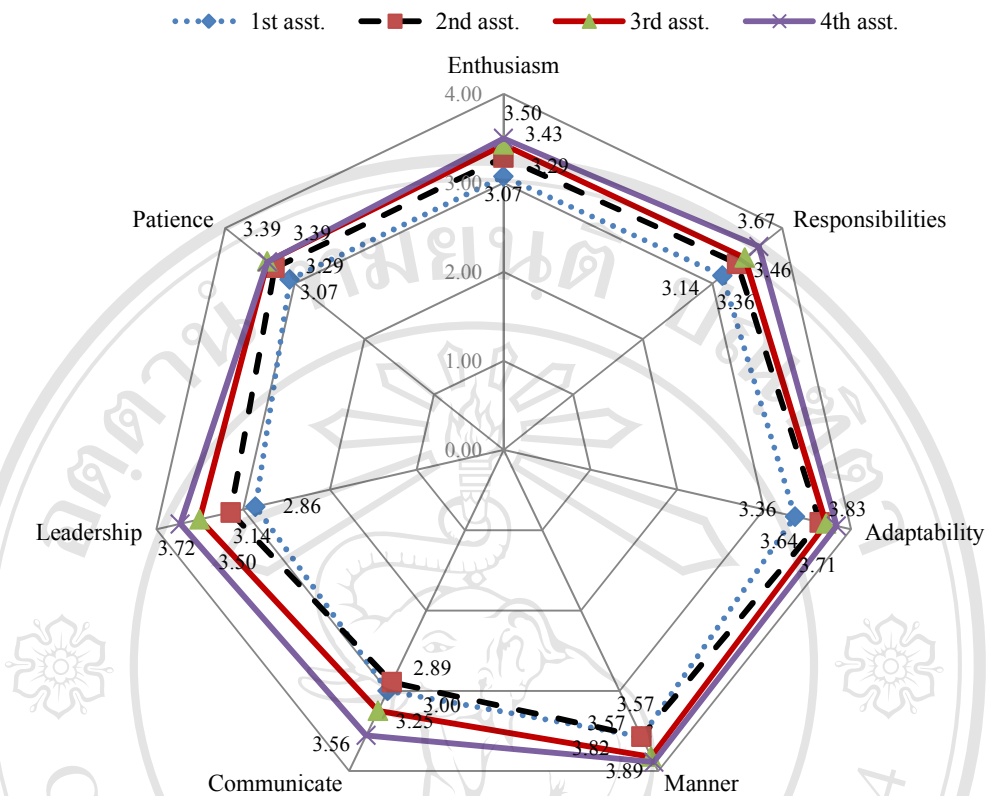
Behavior perspective					
No.	Competencies	1st asst. n = 14	2nd asst. n = 14	3rd asst. n = 14	4nd asst. n = 9
1	Enthusiasm	3.07	3.29	3.43	3.50
2	Sense of responsibility	3.14	3.36	3.46	3.67
3	Adaptability	3.36	3.64	3.71	3.83
4	Manner	3.57	3.57	3.82	3.89
5	Communication	3.00	2.89	3.25	3.56
6	Leadership	2.86	3.14	3.50	3.72
7	Patience	3.07	3.29	3.39	3.39

3) *Adaptability competency*: similar to the 1st co-op students' batch the grades were very good (3.36, 3.64, 3.71, and 3.83). Most mentors commented that "students adapt themselves quickly" (SN, BC), and "student works with all people" (S, DAIS, ABC). Other comments about some students were "afraid to ask questions

about the job" (DAIS), and "students still lack self-confidence and should improve" (IM). This is normal for students who are adjusting to a new environment.

      4) Manner competency: this had the highest assessment levels of behavioral perspective (3.57, 3.57, 3.82, and 3.89). Most company mentors were very satisfied. They commented "student was humble and very polite" (SN, BC, IM, SC), and "spoke very politely and observed people before asking for some advice" (SN). It was noted that some students needed to be careful how they dressed (DAIS).

      5) Communication competency: the first assessment was good (3.00) but they still had to learn more about "technical terms" (SN), and also had "some problems with communicating" (BC, DAIS). This competency decreased the second time from 3.00 to 2.89. It was found that some students had some problems communicating with foreign managers. Some comments were "students should improve their second language skill" (IM), and "she can communicate in English, but not good enough" (BC). However, this competency increased in the next two assessments (3.25. 3.56).

      6) Leadership competency: although this competency received the lowest grade (2.86), it increased slightly in the next assessments (3.14, 3.50, and 3.72). Most mentors agreed that students "dare to present their thoughts and are good listeners" (BC, DAIS, BNN). However, some students "should attempt to present their thoughts" (SN), and in some cases observed that "students fear to communicate with foreigners" (BNN).

      7) Patience competency: all the assessments were very good (3.07, 3.29, 3.39, and 3.39). Sample comments were "student has patience when faced with problems and obstacles" (SC, BC, BNN), and "at first the student was somewhat discouraged, but after the adaptation period she worked very well" (BC, SN).

4.2.2.2 Work Performance Perspective of the 2nd Batch

      Figure 4.6 shows an overview of the progression of students' work performance competencies for the 2nd batch. The competencies were analyzed to see the trends and sample comments from company mentors are presented.

Figure 4.6 Average work performance competencies level of the 2nd batch
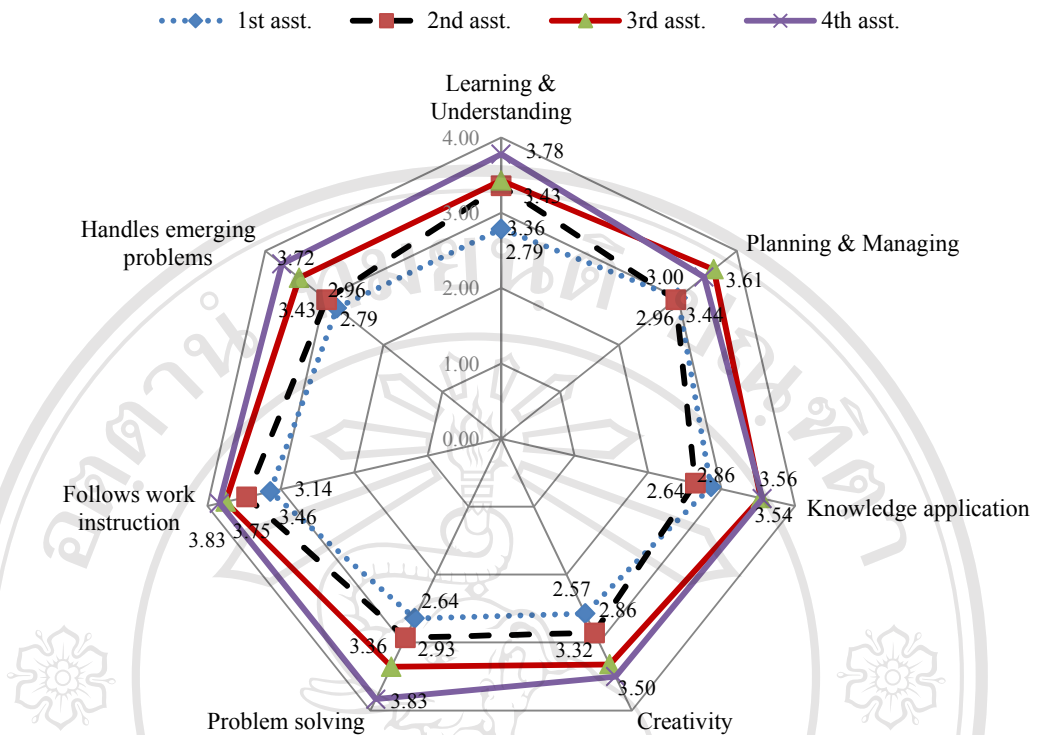
	Work performance perspective				
No.	Competencies	1st asst.	2nd asst.	3rd asst.	4nd asst.
		n = 14	n = 14	n = 14	n = 9
1	Learning & Understanding	2.79	3.36	3.43	3.78
2	Planning & Managing	3.00	2.96	3.61	3.44
3	Knowledge application	2.86	2.64	3.54	3.56
4	Creativity	2.57	2.86	3.32	3.50
5	Problem solving	2.64	2.93	3.36	3.83
6	Follows work instruction	3.14	3.46	3.75	3.83
7	Handles emerging problems	2.79	2.96	3.43	3.72

1) Learning & Understanding competency; the first assessment found that students can learn and understand their tasks quite well (2.79), but they needed to improve "self-learning" (BNN), and "trying to understand a task more in-depth" (ABC). The assessment results gradually improved in the next assessments (3.36, 3.43, and 3.78). Mentors comments were "student learned more than the company mentors' expected" (SN), and "students can understand more complicated tasks and

work by themselves" (DAIS). However, some students needed more time to improve their ability to deal with the many details in some tasks like production preparation and production scheduling.

2) Planning & Managing competency; this competency had a good assessment the first time (3.00). It was observed that some students tried to use the "systems thinking" concept to help with analyzing work systems and job planning at the beginning of the apprenticeship (DAIS, FB, IM, SN). It helped students to see an overview of their task and the relationships involved. However, prioritizing tasks and decisions were still the main problems for students. The second assessment was 2.96. Some reasons were "lacked careful planning" (DAIS), and "student had a plan, but did not follow it" (ABC), and "task prioritizing was lacking" (DAIS). This competency increased in the third assessment (3.61), but then decreased again in the fourth assessment (3.44). This was due to job/study time constraints that did not permit them to follow their professional project plan in a timely manner.

3) Knowledge application competency; before the first assessment students used IT basic knowledge to do a basic job (power point to create a presentation and Photoshop for some graphic tasks). Hence, the assessment level was quite good (2.86). The second time, the assessment level decreased to 2.64 because students were faced with more complicated jobs and some students did not have sufficient background to do their job, such as purchasing (BC) and R&D (IM). Thus there were some difficulties in applying knowledge in this case. However, the assessment rebounded to 3.54 and 3.56 in the third and fourth assessments respectively. The main reason was because they had to create their professional project which uses their specific knowledge, especially IT. Most company mentors were very satisfied with the students' project. Some comments were "student's project is very satisfactory" (BNN), and "students were able to apply their knowledge very well, with few mistakes" (DAIS).

4) Creativity competency; had a low assessment level the first time (2.57). The reason was because this competency was not easy to observe during the first period because early on they were not presented with situations that required

creative skills. Most company mentors wanted students to practice basic jobs. Their comments were "student should take time to understand job details" (SN), and "it is necessary for students to practice routine jobs first" (ABC). Nevertheless, this competency increased to 2.86, 3.32, and 3.50 when students began their professional project. Mentors comments were "students are able to do their project creatively" (FB), and "she can initiate project by using an existing problem" (SN).

5) *Problem solving competency*; the first assessment level was 2.64 because students were still not familiar with their job and also did not have many problems to solve in this period. The next 3 assessments gradually increased on this competency level (2.93, 3.36, and 3.83), primarily because students began to apply IT to solve their problems (using MS excel to calculate the skill level of employees (SC) and create pay slips for student trainees (SN)).

6) *Follows work instruction competency*; similar to the 1st batch this competency assessment was high during the whole apprenticeship period (3.14, 3.46, 3.75, and 3.83). The students made some mistakes and were a little late sometimes. All mentors were completely satisfied with this student competency.

7) *Handles emerging problems competency*; the first assessment for this competency fell in the mid-level (2.79). Most students didn't have a chance to deal with emergent problems alone. Company mentors still helped students when problems occurred. This competency needed time to improve. One mentor comment was "this competency would improve over time" (FB).

4.3 Initial Findings of This Research

As explained in chapter 3, along with student's assessment books, the observations, informal interviews, questionnaires, group discussions were conducted simultaneously to collect data for this research. During the process of gathering these data from two co-op students' generations and also during analyzing the student's assessment books in part 4.2, the initial findings were separated into three points of

view, including student, workplace, and co-op process. They are illustrated in the following.

4.3.1 Initial Findings of the 1st Batch

Students

1. Student humbleness (manner) was the first thing company representatives noticed.

2. Students who were leaders in university activities such as student's chairman, cheerleader, activities' group leader, etc. adapted very quickly to the company and also developed leadership competencies more easily than other students who just participate. Moreover, this group of students showed patience and could work under pressure.

3. Students who are good with computers and have at least one skill such as using VBA on MS Excel for calculations or graph representations, using a graphical programs to design some tasks, or using multimedia in job-training, can do their tasks more effectively and rapidly. Company mentors were satisfied with this type of student.

4. Students who have a clear career target and future plan (know what they want to be in the future) work very well and continue to improve in their job. In contrast, students who didn't know exactly what kind of job they prefer, had no plan for the future or thought about further education (but didn't make any decision) were mostly confused and not interested in landing a good job.

5. Regarding students' communication, in the beginning students had some problems with technical terms and industrial language. It takes time to learn this, because words and phrases used depend on the type of business and manufacturing. Most students take 2-3 months to develop this competency, mainly through on-the-job practice.

6. Some students had problems with punctuality throughout the program. Unfortunately, many companies often tolerated students coming to work late and just

gave a warning because they were dealing with students. They also did not have a real working contract with the students. Consequently companies did not enforce the same penalty on students as with their real employees.

7. Some students still had difficulty understanding their work systems. In a new work environment, it takes 2-3 months to become familiar with the work systems.

8. Some students still lacked some specific knowledge (such as students in the QA/QC department). The curriculum provides just one QA (Quality Assurance) course that totals 45 hours. The content consists of an overview of the basic knowledge needed for quality assurance and quality control. The subject material did not cover enough detail to allow students to analyze and solve problems involving engineering statistics and industrial quality control.

9. Some students still lacked skill to use technical tools/activities for industrial work such as 7 QC tools, QCC and 5s. It was difficult for students to use these tools/activities without any help or advice if they had never had any previous experience.

10. Student patience was the biggest concern of many company mentors. This competency directly affected a student's chance of co-op success. Patience was an important quality companies used when choosing which students would be hired after graduation.

11. The grade point average (GPA) of most students (93%) tended to be higher after they joined the co-op program. They were better at planning and prioritizing their jobs/tasks both in companies and at university.

Workplace

12. The work environment also had an effect on students. Students wore a university uniform when they worked, had wages but no benefits and no specific work place felt they were not important to company. This affected their spirit and work performance.

13. Students who worked with a company that had future plans for them (plans to hire after the apprenticeship) were very motivated to improve themselves.

14. Company mentor understanding of the co-op process and the MMIT curriculum directly affected students' competency progression. They were the key persons to help with planning jobs, assign tasks, and give advice to the student.

15. Changing of mentors also affected students. They lost time explaining their work and objectives, and also had to adjust to their new mentor.

Co-op process

16. The matching process between students and companies took too long. It took 3 months to finish this process and used up valuable time and energy.

17. Alternating between company work and study at the university provided both pros and cons. The students were tired and found it difficult to adapt themselves but after further study to enhance their knowledge and seeking advice from academic experts, they were able to apply it to company problems immediately.

18. The professional project motivated students to be more enthusiastic during the long co-op apprenticeship period, because if they did not finish their project they could not graduate. As a result, all students made appointments with their company mentors and university advisors to ask for advice during the project period. This process also directly helped students to improve their planning and managing competency, and adapting their knowledge in the workplace.

19. Similar to company mentors, the changing of university advisor also affected student planning and work progress.

20. The assessment process was shortened due to company time constraints.

4.3.2 Findings from the 2nd Batch

Comment: Only findings different from those of the 1st batch will be presented.

Student

1. During apprenticeship, students not only apply their knowledge in the workplace but also get specific knowledge at an advanced level such as advanced database design and construction, and using the ERP program at a practical level.

2. Students are more aware of CAMT/MMIT reputations because of 1st batch positive reports and complaints. They were also more conscious of how their behavior might affect the reputations.

3. Some activities added in the second batch stimulated students to be more enthusiastic and motivated before starting work. Ice-breaking improved students' work attitude, personal vision helped them to be more focused in their future plan, and systems thinking helped them to see an overview of their job. These activities changed their expectations and encouraged them to try and work effectively.

Workplace

4. Most students worked in an international company (81% of 1st generation and 91% of 2nd generation). This gave them an opportunity to work in an international environment. They had to use English at times to communicate with some foreign managers.

5. The company mentors' coaching style (derived from company culture) affected students' work competency progress. Most western companies (including EU and American) use a learning by yourself (student themselves) approach, while most eastern companies (including Japanese and Thai) use a step-by-step style. When students get work in a company that has a coaching approach consistent with their culture, their work performance competencies improve quickly.

6. Company mentors who had a clear understanding of the MMIT curriculum and co-op process had a positive effect on students. They assigned tasks consistent with MMIT students' backgrounds. This had a direct affect on their work performance and the quality of their professional project.

7. Some mentors lacked interest in the training and did not attend some sessions due to business reasons. Consequently, this group of mentors had some problems understanding the co-op program.

8. Some students had two or more mentors (normally a mentor's assistant). These assistant mentors were important for students because they worked more closely with the students.

Co-op process

9. The main objective of the MMIT curriculum was to produce students to work with international manufacturing companies. Most students worked in positions consistent with their knowledge, but some had to work in positions not directly related to their specialty, such as purchasing, and research and development (R&D). Some found it difficult when they started work because they didn't have basic knowledge of that field.

10. The matching process between students and companies finished in 2 weeks. The most critical point in this process was to match student preferences to a company's work culture and style. This had a direct affect on student enthusiasm, willingness, motivation, and competencies development.

4.4 Analysis of Results

The aim of this research was to create a co-op framework (adapted from IUT Lumière) using the LO concept to develop students' competencies especially in international manufacturing. From part 4.2, we saw that most MMIT co-op students worked in an international manufacturing company and they developed their competencies gradually throughout the co-op process.

This section presents the analysis results which focused on how the co-op process and LO concept helped students to develop their competencies. Grounded theory was adapted as the main methodology to analyze the qualitative data collected from informal interviews, observations, questionnaires, and group discussions (refer

to chapter 3). The analysis process started with gathering all qualitative data together in an MS excel program. Then, reading through all data was required during the process of open coding to categorize data (i.e., needed skills, students' adjustment, co-op program management, and required knowledge). Next, the why-why diagram was used to explore the interrelationships of categories in the axial coding process which determines the "central phenomenon" (or the core theme). This theme is "the key to success for co-op students". After that, each factor and their relationship with others was described (selective coding). From this analysis, there are two main perspectives used in illustrating the analysis results. First, key success factors that affected students' competencies development are shown in the form of a why-why diagram and the interrelationships in each category are explained. Secondly, the evolution of students' competencies is shown in the form of a competencies' maturity model and the competencies progress in each time period are explained.

4.4.1 Key Success Factors for MMIT Co-op Students' Competencies Development

Research revealed that the development of students' competencies involved many factors. To categorize these factors within grounded theory methodology, this research used a why-why analysis as the main tool to identify the key success factors and show their interrelationships. The why-why analysis showed that the key success factors can be separated into 5 main perspectives: student, company mentor, university advisor, company, and university (MMIT). The why-why diagram is illustrated in figure 4.7 and the analysis follows.
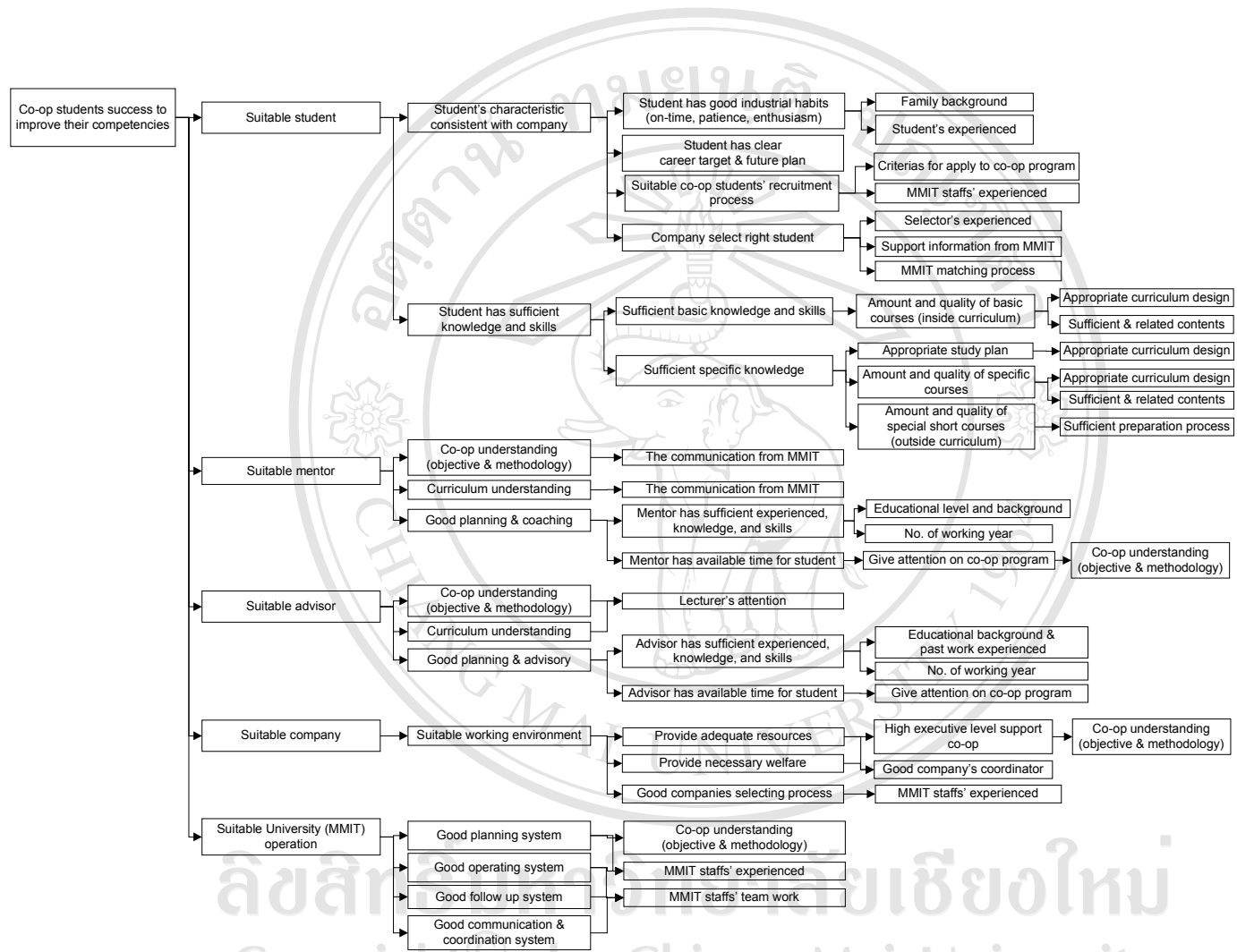
Figure 4.7 Why-why diagram (analyzes the key success factors for developing co-op students' competencies)

1) *Student perspective*

Students who succeeded in the MMIT co-op had two essential trait components: characteristics (personality, attitude, patience, etc.) consistent with company requirements, and sufficient knowledge.

1.1) Student characteristics consistent with company needs

There are 4 main factors: students with good industrial habits, a clear future plan, MMIT needed an effective co-op students' recruitment process, and the company selection of appropriate students.

1) Students with good industrial habits

Generally, companies prefer to hire employees who have industrial habits (on-time, patience, responsibility etc.). The MMIT co-op program provided a long period for students to improve their industrial habits both before and during the apprenticeship. Prior to the apprenticeship, the preparation process started in the 2nd year of study to prepare them to be more familiar with the industrial environment. This included introducing them to a variety of work positions in the company, visiting industrial organizations to see the real work environment, and attending many courses involving industrial knowledge etc. This was the first step to test the student. Only students really interested in industrial work would show patience and attend all activities. During the co-op apprenticeship in companies which took more than one year (2nd semester of 3rd year – 2nd semester of 4th year), students had to deal with routine jobs, study, and a project at the same time. Undergraduate students had to organize their time schedule efficiently and have the discipline to handle all three things. Students who went through this apprenticeship period gradually improved their characteristics (refer to section 4.2, results from the implemented MMIT co-op framework) to meet industrial demands. Even though student's industrial habits improved, other factors affected them. Two of them were family background and past experience.

For family background, if parents spoil their son/daughter, it may be generate inappropriate habits such as impatience. In some cases parents very easily allowed their son/daughter to resign from a company because he/she didn't like the working environment. MMIT lecturers had difficulties convincing students to continue working in a company. MMIT has no control over parent/student decisions.

Regarding past experience, this research found that students who were leaders in university activities or worked a part time job had more opportunities to gain experience than those who did not participate. MMIT provided students an opportunity to gain experience by creating projects such as an enterprise operated by students for organizing any events related to MMIT. Students with such experience adapted quickly to the workplace and had fewer problems at work.

2) Students have a clear career target and future plan

In this case, students who have a vision or desired future (personal vision: Senge, 1990) are ambitious and eager to do an effective job and continually improve in their career. The MMIT co-op process helped students to find themselves (what they want to be) by many activities such as finding an interesting job at the job fair, requiring in-depth research information on their job of interest before applying for the position and proceeding to the company matching process, and also having the students write their personal vision to check their current reality and desired future. Although MMIT tried to help students to think and plan for their future, there were still some difficulties. Students who could define their interest quickly worked very well and continued to improve in their career, and had an opportunity to work with a company after graduation. Students who didn't know what they wanted worked at an average level to pass the program, or resigned from the company to study in another program (IS). However, during the co-op apprenticeship, some students who didn't make future plans gradually gained knowledge and the confidence to work on their career, though they didn't get an opportunity to continue with the same company.

3) A suitable co-op student recruitment process

This is an important step for filtering the students who have characteristics consistent with industry needs. This process stimulated students who were interested to join the co-op program to focus on paying more attention in the classroom to make a good grade, and try and improve their personalities. During the recruitment process, it was easy to consider basic requirements such as grade point average and pre-requisite courses required for co-op work, but difficult to determine student habits or depth-characteristics such as patience, attention, and responsibility. To help with this, information from a variety sources such as advisors and friends was required, and the recruitment committee's experience also displayed an important role.

4) Selecting appropriate students

This process was critical for finding students that would be suitable for a specific company. HR managers and/or company representatives interviewed students by themselves. Students faced a real recruitment situation and attempted to present their potential as much as possible. This stimulated students to decide on their career target before applying to any positions in companies, and they also attempted to improve their personalities before being interviewed. A key factor in selecting students consistent with company organization and culture was the interviewer's experience. Each company had a different working and coaching style, and it directly influenced student competencies development (refer to part 4.3, initial findings). Support information from MMIT such as student resumes and study results along with a well organized matching process was very helpful.

1.2) Student has sufficient knowledge and skills

To succeed in the MMIT co-op apprenticeship, students must develop their knowledge/skills for work in their jobs/tasks.

1) Basic knowledge and skills such as mathematics, statistics, business and industrial basics, English for communications, and skills to use office equipment are needed for general tasks.

During the first period students had to perform basic tasks such as copying documents, sending faxes, e-mailing (in Thai or English), data analysis, a report, and presentations. Before going to work, some knowledge/skills were acquired by the MMIT curriculum and the co-op preparation process, such as basic math, statistics, and English. In spite of this, some students had difficulty when faced with a real situation such as communicating with foreign managers. Students needed more confidence to talk and some took a long time to enhance their listening and speaking abilities. The research found that because many co-op students worked in international companies (especially EU companies), they improved their ability gradually throughout their co-op apprenticeship (refer to part 4.3, initial findings).

MMIT was unable to provide office equipment training due to constraints, and there were some company complaints during the first apprenticeship period. However, most students acquired these skills in the first two months.

Another essential basic skill for industrial work is "systemic thinking", because most industrial process are repeating systems. If the student can see the whole process as a system and understand the causes and effects, they can work more easily and effectively. Most mentors need students to see the overall process as soon as possible because they had little time to repeat explanations of jobs/tasks. MMIT inserted the "systems thinking" activity into co-op process to help students quickly see an overview picture of their jobs/tasks. Students who used it in their job planning when they started could understand the work process better, and some were still confused on how to create this and needed support from their university advisors and company mentors.

2) Specific knowledge in industrial work

Concepts such as ISO9001, ISO14001, quality systems, human resource management, and especially advanced computer programming (or IT) were also key to the success of the students. MMIT co-op students acquired this knowledge at the university and special courses during the co-op preparation period. This studied provided knowledge but no practical element. Thus, students had some problems when they applied this knowledge during their first apprenticeship period. Research found that the "professional project" was a turning point. Students tried to initiate their professional project by linking their university knowledge (especially IT and modern management) with their job functions such as QC, HR, etc. Students well skilled in IT had an advantage (refer to part 4.3, initial findings). Most company mentors were very satisfied with the professional projects (refer to part 4.2, results from the implemented MMIT co-op framework). Projects helped jobs/tasks to be more effective and efficient (all projects are IT applications) and normally the company didn't have enough time and personel to do this kind of project, but students did. Moreover, students also transferred their university knowledge after being trained by company employees to use the application program.

2) Company mentor perspective

Company mentors also played an important role in the co-op program. Their close coaching helped students to be become good future employees. MMIT co-op model required companies to designate a specific mentor for co-op students. Key to this success was mentor suitable planning, coaching, and understanding of the MMIT co-op process and curriculum.

2.1) MMIT co-op understanding

Research found that some company mentors thought the co-op was the same as a normal apprenticeship which ran 2-3 months and was less demanding than the co-op program. This negative view affected the student plans, job details, and

professional project. Mentors assigned just normal tasks to students even after a long time had passed (6-7 months), such as copying and scanning documents, organizing the employee time-attendance cards, destroying recycled paper and so on. This made students bored and want to quit the co-op program.

2.2) MMIT curriculum understanding

Company mentors played an important role helping students to apply their knowledge. Company mentors with a clear picture of MMIT curriculum's objectives and targets, could assign appropriate tasks which were not difficult for students to accomplish. As a result, students were happy to do the work and slightly increased their confidence. This also affected student professional projects, so students could complete their project on time when there was good support by company mentors.

Research found that many companies were still confused about both the MMIT co-op process and the curriculum during the starting period because it was a new training methodology and curriculum. However, after MMIT conducted many meetings with company representatives and trained some company mentors for the 2nd batch, company understanding improved (refer to part 4.3, initial findings).

2.3) Suitable planning and coaching

This research found that mentors with many years of experience coaching and training their subordinates were also good at coaching their co-op students. They could plan well, coach, and follow the students. Educational background/levels also influenced the effectiveness of their coaching. Fortunately, most international companies noticed this (they recruited suitable employees for the positions). Available time was also very important. Industrial companies always have a lot of work and meetings. If company mentors (most of them are managers/assistants or senior supervisors) did not organize their coaching sessions, students were reluctant to interrupt their mentor and not clear about their job. This

also affected assessments and many companies postponed the assessment because of business reasons. MMIT advisors actually assessed students just 2 - 4 times (refer to part 4.2, results from the implemented MMIT co-op framework). This directly affected student progress both on work and competencies because they didn't know their competencies level and some students didn't know their real work plan. MMIT is still working on solving this problem.

3) University advisor perspective

Similar to company mentors, university advisors (MMIT lecturers) were also important to help students develop their competencies. Their main responsibility was to support everything necessary for students to pass their co-op apprenticeship. Research found that two main factors impacted on this perspective.

3.1) MMIT co-op and curriculum understanding

This was very necessary to create an appropriate co-op process to develop students' competencies and give advice and information to students and companies. Most MMIT staff were new lecturers (with no university teaching experience). Therefore, the first priority for them was to understand the MMIT curriculum and co-op program. In the beginning there were some problems such as some MMIT lecturers had little or no experience with the industrial environment. Consequently, they had some difficulty understanding the curriculum's context and its requirement. Some lecturers had industrial engineering and business administration backgrounds and they acted as a core team to construct and operate the MMIT co-op process along with co-op experts from the EU (according to ETHICS-FED project). They also communicated co-op information to companies and students.

3.2) Planning and coaching abilities

University advisors who had an educational background or work experience consistent with the industrial context had an advantage when advising

students. They could communicate well with students, and when students had problems they were comfortable seeking advice. Also, when university advisors went to a company to sign a contract, assess students, and met with company mentors, their background helped them to collaborate easily with the company to plan students' tasks, the scope of the work and the type of professional project required. University advisor time availability and the small number of co-op students helped to make the process successful.

4) Company perspective

This perspective was important for encouraging students to understand a real work environment. The research found that this perspective involved three key factors.

4.1) Co-op participation and understanding of a company's executive hierarchy

The executive level had the authority to pay students wages and assistance, and help to provide sufficient compensation for their work. This made students feel like an actual employee and they worked diligently. The co-op program would be more successful if the companies included the co-op students in their future manpower planning. Students who worked in a company and had an opportunity to be hired after graduation made a strong effort to work with patience and attention during their apprenticeship period.

4.2) Good company coordinators

The co-op coordinator in the company (normally an HR manager) was also important. Their role was making contacts with the university and relaying information back to the company. Hence, this person had to clarify co-op objectives and details as well as having good communication with other relevant people in their company, for example, company mentors who dealt with the students.

4.3) The MMIT company selection process

In the beginning, for the MMIT co-op program the criteria for selecting companies included considering wages, how the company would make use of the students, and if a mentor would be designated to help provide an appropriate work and learning environment. For the 1st batch the program was new and many companies were not interested in participating in the co-op because they did not know/understand the curriculum. This occurred in spite of MMIT staff efforts to promote the curriculum to each company. Consequently, there were only a few companies involved. Nevertheless, there were enough positions for students and most companies were international (consistent with MMIT aims) and had adequate standards, although some companies paid less wages and offered no social welfare. For the 2nd batch, the situation improved because there were more companies interested in joining the MMIT co-op program.

5) University (MMIT) perspective

The main responsibility of MMIT is operating the co-op program as efficiently and effectively as possible. This included planning, operating, following the system, and communicating and coordinating with companies. EU experts (ETHICS-FED project) helped to create the co-op model to produce graduate students who could work for international companies.

5.1) Planning, operating, and following the system

The planning process was very important for the MMIT co-op program. Planning began in 2007 and the 1st batch started in 2008. During this period, EU experts (especially from IUT Lumière) provided knowledge, know-how, and techniques to help MMIT set-up a co-op model (refer to part 4.1, co-op framework construction results). Therefore the planning process ran smoothly with few problems.

After implementing the co-op process some essential issues were revised and adjusted because there were some constraints from students and companies. These involved alternating between work and study, the change of apprenticeship length, and the matching process. During the 1st batch the best way to adjust study and work times was not clear because students needed more time to study for mid-term and final exams or complete study plans they missed. Thus, the 2nd batch had to follow the work/study schedule more strictly. The lengthy apprenticeship of the 1st batch (16 months) also affected students. Some found it difficult to follow the program and deal with study, work and the professional project all at the same time. Some students had difficulties organizing their life schedule. From the company point of view, the long period was a strong point of the MMIT curriculum. They preferred long apprenticeships rather than just 2-3 months because students continued to work and did not leave after training and were useful to the company. The company also recognized this gave them an opportunity to recruit suitable employees. For the 2nd batch, the co-op apprenticeship was reduced from 16 to 14 months because of students' constraints (agreed by companies, refer to part 4.1.4.2). The matching process of the MMIT still needed to improve to be more effective (details in part 4.1.4.2).

In order to follow the program, MMIT established an annual co-op seminar to collect feedback from both companies and students (details in part 4.1.3.2). This activity helped to form a closer relationship between companies and the university.

5.2) Communicating and coordinating with companies

This process was very important for the companies to have a clear understanding of the MMIT co-op and curriculum, and to build on the relationship between the companies and the university.

When the co-op was first implemented MMIT staff invited many companies to a presentation of the curriculum, co-op objectives and processes. Many company representatives did not have time to join in this meeting. Therefore MMIT staff made appointments with the HR managers in each company. However, the MMIT working team could not explain details to all relevant personnel, such as some company mentors who did not attend these meetings. Hence, company mentor training (see part 4.1.4.2) was necessary to explain/clarify the MMIT curriculum and co-op process. As a result, company mentors for the 2nd batch had more understanding of the MMIT curriculum and co-op program than the 1st batch.

From these analyses, using five main perspectives, we can see that the MMIT co-op model adapted from the French model combined with LO theory provided an appropriate learning environment for students to develop their competencies. From the student perspective, co-op encouraged them to develop their characteristics consistent with company needs and gain specific knowledge in their field. From a company mentor and university advisor perspective, co-op established regulations and directions for them to teach/coach students. From a company and university perspective, co-op helped them to work together with the same target of producing graduate students to meet industrial demands.
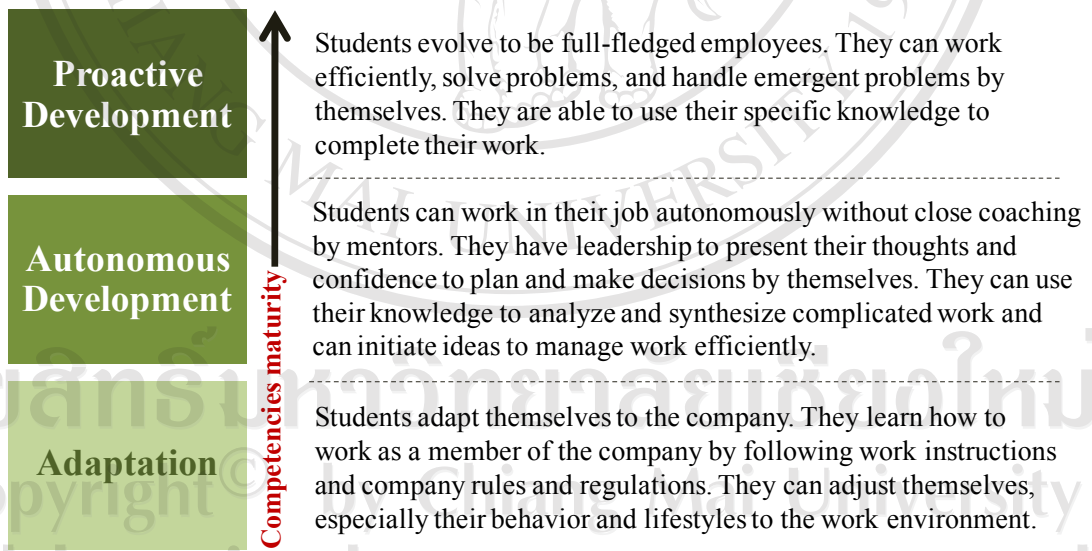
4.4.2 Evolution of MMIT Students' Competencies

This section presents an analysis of the results of implementing the MMIT co-op model in the form of a competencies' maturity model which shows the evolution of MMIT students' competencies development. This maturity model separated competencies evolution into three phases: adaptation, autonomous and proactive development. This is shown in figures 4.8, 4.9 and table 4.14.
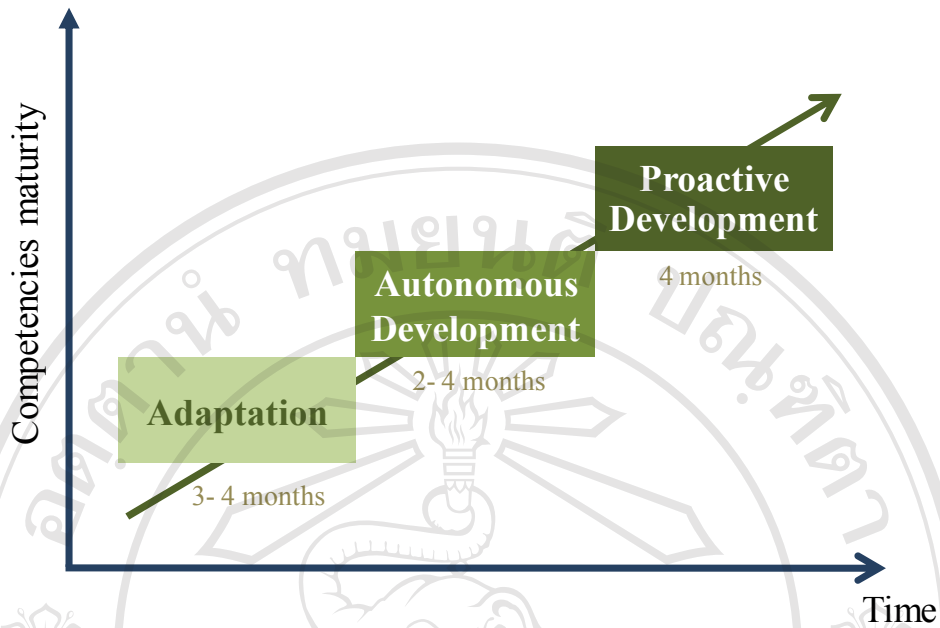
Figure 4.8 The relationship between competencies maturity and time

Figure 4.9 The maturity model of MMIT co-op student competencies' development

Table 4.14 The MMIT co-op student's competencies for each maturity period

Competencies	Adaptation	Autonomous	Proactive
Behavior competencies	-Manner -Adaptability -Patience -Enthusiasm -Responsibility -Communicate	-Leadership	
Work performance (general) competencies	-Learning & Understanding -Follow work instruction	-Planning & Managing -Knowledge applying -Creativity	-Problem solving -Handle emergent problems
Knowledge and specific skills	-Basic IT (MS excel, word, power point, outlook) -Basic math / statistic (Mean, Variance, STD.) -Basic knowledge of job position (**HRM**-job recruitment, job training, performance appraisal / **QM**- drawing, ISO, quality control, QC tools, production control / **IM**- LAN setting, System maintenance)	- Advanced IT for job (create basic database, basic programming) - Specific knowledge of job position (**HRM**- pay roll, social welfare / **QM**- advanced statistic [ANOVA, correlation], GR&R, TQM / **IM**- SAP R/3, MS Navision, LN6)	- Advanced IT for professional project (VBA on Excel or Access, Web database, Web design, Multimedia programming) - Modern Management: ERP, SCM, CRM, PLM, CBM, etc.
Additional necessary skills	-Basic languages (English, Japanese) for daily work (communicate, e-mail) -Office jobs/tasks (Using office instruments [fax, copy machine, etc.] & Document management) -Systems thinking (overview of how company work) / Work flow analysis	-Advanced languages (especially English) for presentation and communicate with foreign manager	

1) Adaptation (3 - 4 months): this was the first phase when co-op students had just arrived in the real workplace. Students needed to build various competencies to get through this period. They started to evolve from "student" to "employee". They woke up early in the morning and came home late in the evening, in others word, they changed their lifestyle. It was critical for students to adapt themselves to fit in with company culture, rules and regulations, and the working environment. Behavioral competencies were mostly required at this time. Student's manner and adaptability

competencies were very necessary to make a good first impression. Enthusiasm and willingness to learn helped students understand their jobs/tasks quickly. As a result, they worked with more confidence and made fewer mistakes. Responsibility and patience was important for students to be a professional because company mentors assigned more difficult or important jobs/tasks after students did general jobs satisfactorily. For communication, companies needed students to understand and communicate using technical terms and industrial language as soon as possible. Thus students were responsible to study and learn about this quickly.

In the adaptation phase, work performance competencies necessary were learning and understanding abilities, and following work instructions. At this time, students learned many new things including work systems, tools, and equipment use essential for performing their jobs/tasks. Students tried as much as possible to learn and understand them at the beginning, and as time passed they were able to work efficiently. However, most student tasks in the beginning were basic jobs/tasks to help them adapt as an employee. They mainly had to follow company work instructions.

The knowledge and skills necessary in the adaptation phase were basic IT such as MS Word, Excel, Power point and Outlook, which were generally used for many work tasks. Some applications were: daily/weekly/monthly reports of departments, calculating productivity rates and summarizing data in a spreadsheet, and preparing presentations for meetings. Each job position required basic knowledge for routine jobs/tasks. Some positions and required knowledge were: Human Resources Management (HRM) jobs (students needed knowledge of job recruitment, job training, and performance appraisal), Quality Management (QM) jobs (students needed to use standard systems (ISO9001), drawings to check for customer specifications, basic quality control, and production control), and Information Technology Management (IM) jobs (students need knowledge of LAN setting and systems maintenance).

Additional necessary skills were basic languages such as English and/or Japanese for daily work including communicating with foreign people in the company and sending e-mails both internally and externally. Basic skills to work with office instruments were also required, such as sending faxes, copying and scanning documents. Document management (categorizing documents, filing papers) was also important for this period. Another important necessary skill was "systemic thinking" or "systems thinking" to get an overview of their work systems. This helped them to quickly understand their jobs/tasks and be aware of their responsibilities and roles that impacted company work systems. Work flow analysis was important to understand how the company worked at the micro level (flow of each job/task).

2) Autonomous Development: it took 2-4 months for students to work in their job autonomously without close-coaching by mentors. All behavioral competencies in phase one (the adaptation phase) were needed here but they had to develop their leadership competencies in this period, especially self-confidence, so they could present their thoughts because most companies need to get some feedback from newcomers to improve their work. Students with leadership had the self-confidence to plan their jobs and make decisions by themselves. They were more helpful doing jobs/tasks and this relieved some of the mentor burden.

For work performance competencies, during this phase students began to work in-depth in their function and initiate their professional project. Thus, students' planning and managing capabilities were important at this time. Creativity and the ability to apply knowledge were also key competencies for students to maximize their output.

Similar to work performance competencies, students required more advanced knowledge and skills. More advanced IT such as basic database construction and computer programming were needed for students' jobs/tasks, such as creating a new application database in MS Access or correcting coding in some company application. Knowledge and skills to deal with more complex problems/details was required at this

time. In Human Resources Management company mentors assigned students to do payroll and social welfare. This had to be handled carefully with good judgment. In Quality Management some students had to use advanced statistics such as Analysis of Variance (ANOVA), correlations, Gauge Repeatability and Reproducibility (GR&R) and Total Quality Management (TQM). In Information Technology Management some students had to use an advanced application program the company used in their work, such as SAP R/3, MS Navision, and LN6.

In this period more advanced English was very necessary. More than 90% of students worked in international companies (refer to part 4.2), and sometimes had to present their jobs/tasks in English (especially EU companies) and also communicate with foreign managers.
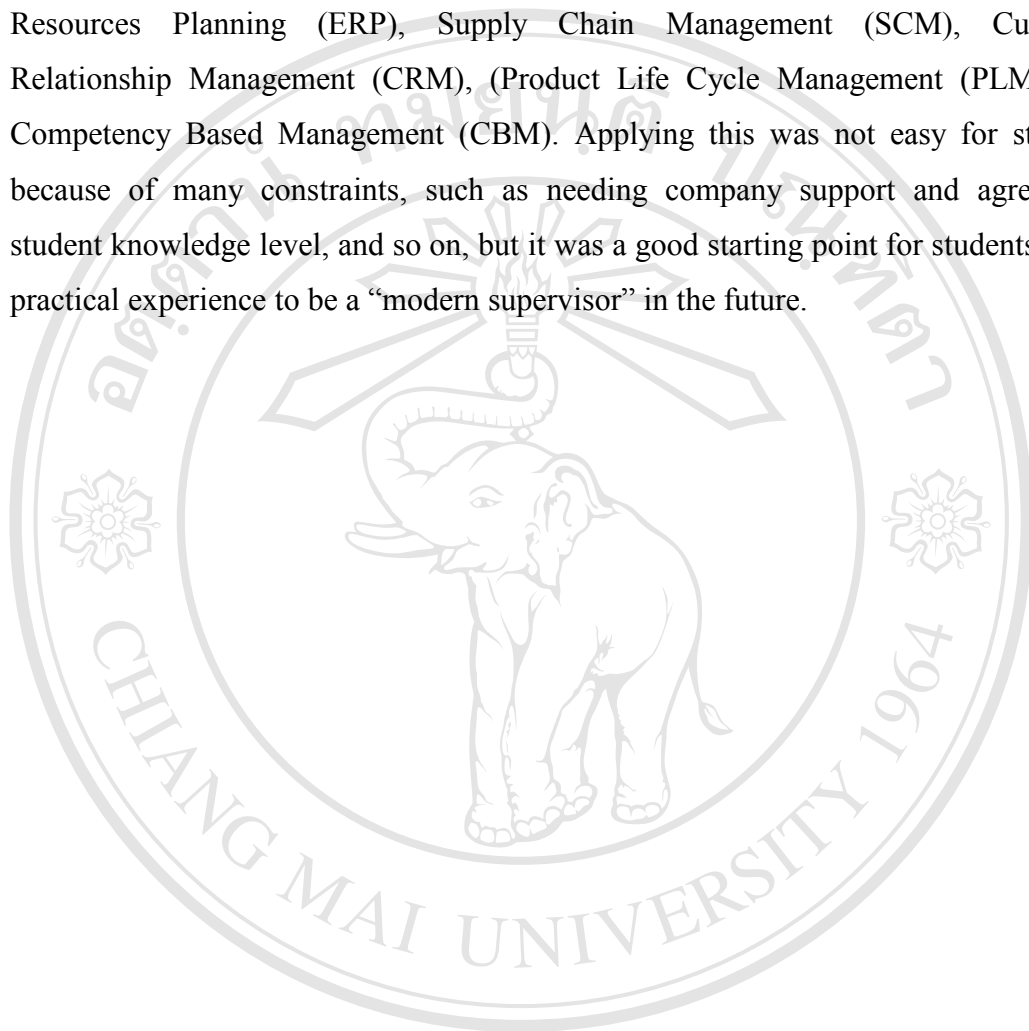
3) Proactive Development (took about 4 months): in this phase students developed as real fulltime employees. Most students were able to complete developing all behavioral competencies (refer to part 4.2). This was also shown by some student actions, such as they went to work and joined in important company events even on their holiday (normally Saturday and Sunday) and fewer complaints about alternating between study and work.

For work performance competencies, there were some competencies too difficult to develop completely during the 2 phases of adaptation and autonomous development, namely problem solving and handling emerging problems. At this time most students had more experience and confidence to made decisions by themselves. As a result, in some cases they were able to solve problems or sought other alternatives to complete the work without any advice from their company mentors.

The knowledge and skills necessary in this final phase were advanced IT for use in their professional projects. This included Visual Basic for Application (VBA) on Excel or Access, web database, web design, and multimedia programming. Modern management knowledge was also important in this period, and after they

practiced all basic and in-depth jobs/tasks in their functions during the first 2 phases they adapted new knowledge from university studies into their work after obtaining company approval. This modern knowledge included the concept of Enterprises Resources Planning (ERP), Supply Chain Management (SCM), Customer Relationship Management (CRM), (Product Life Cycle Management (PLM), and Competency Based Management (CBM). Applying this was not easy for students because of many constraints, such as needing company support and agreement, student knowledge level, and so on, but it was a good starting point for students to get practical experience to be a "modern supervisor" in the future.