The construction and verification of a baccalaureate curriculum to foster fundamental industrial technology competences

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ABSTRACT: In this article, the authors focus on the verification of a baccalaureate curriculum in order to foster fundamental industrial technology competences and to confirm the objectives of this baccalaureate curriculum. Moreover, in the research, the authors emphasise the development of the content of the curriculum in order to realise the situation regarding teaching and learning. The project is an experiment on the model of teaching and learning communication to help in understanding the results of the evaluation of the teaching and learning process, and confirm the systematic model of the teaching and learning quality. In order to achieve the purposes of the research, the two subjects of *quality management* and *the design and manufacture of finished products* were taken up by means of practical verification, exclusive interview and information collection. After the process of analysing the information, the conclusion of the research is also presented in the article.

RESEARCH BACKGROUND AND PURPOSE

With the rapid development and new approaches to Information Technology (IT), the Internet, organism and globalisation, economic capital does not place great importance on visible hardware, but instead sets up invisible knowledge, techniques and brand names. If future industries can combine knowledge with themselves, then profits can be increased. Therefore, the combination of knowledge and industry should be accelerated [1]. Making use of knowledge and information can promote the development of new industries to maintain both the major products and the development of traditional industries, and by headquartering marketing and financial management [2]. The economy, population, and career and technical education are closely related to how competitive a country is [3]. In particular, career and technical education are affirmed by the public and it is necessary to establish these on the basis of actual strength. The key to success lies in unique and competitive curricula, as well as teaching and learning.

Silver and Brennan indicate that the pursuit of a university does not lie in professional knowledge itself, but rather how to put it into practice in the level of techniques [4][5]. If theories of quality management, and the systematic development of teaching and learning can be applied for career and technical education and be managed well, then the quality of teaching and learning can be improved [6-8].

As a result, it is necessary to collect related information, determine students' needs and undertake job analysis and surveys when engaging in the design of a curriculum for career and technical education [9]. By doing so, the types, numbers, training types, and identification of bad working environment of jobs can be determined and made use of, thereby forming a basis of the needs of human resources [10].

The purposes of the projects are listed as follows:

- Confirm the objectives of the curriculum regarding fundamental industrial technology competences;
- Develop the content of the curriculum for fundamental industrial technology competences;
- Realise the performance of the teaching and learning of the curriculum concerning fundamental industrial technology competences;
- Carry out experiments on the model of teaching and learning communication of the curriculum for fundamental industrial technology competences;
- Understand the evaluation results of the teaching and learning process of the curriculum for fundamental industrial technology competences;
- Ensure the quality of the systematic model of teaching and learning in the curriculum for fundamental industrial technology competences.

RESEARCH DESIGN AND PERFORMANCE

The structure of the research is based on the research objectives and present research conditions to form the basis of the research performance. The research approach and steps undertaken are listed below. The structure of the research is based on the concept of complete quality management to confirm the systematic development and performing steps as key points of a curriculum that is focused on fostering fundamental industrial technology competences. The structure of the research is shown in Figure 1.

Research Tools

Research Tools of Quantity

During the elementary interview process, an analysis of the content was undertaken, including experimental observations of teaching and learning and in-depth interviews, so that the results of the research should be more objective and precise.

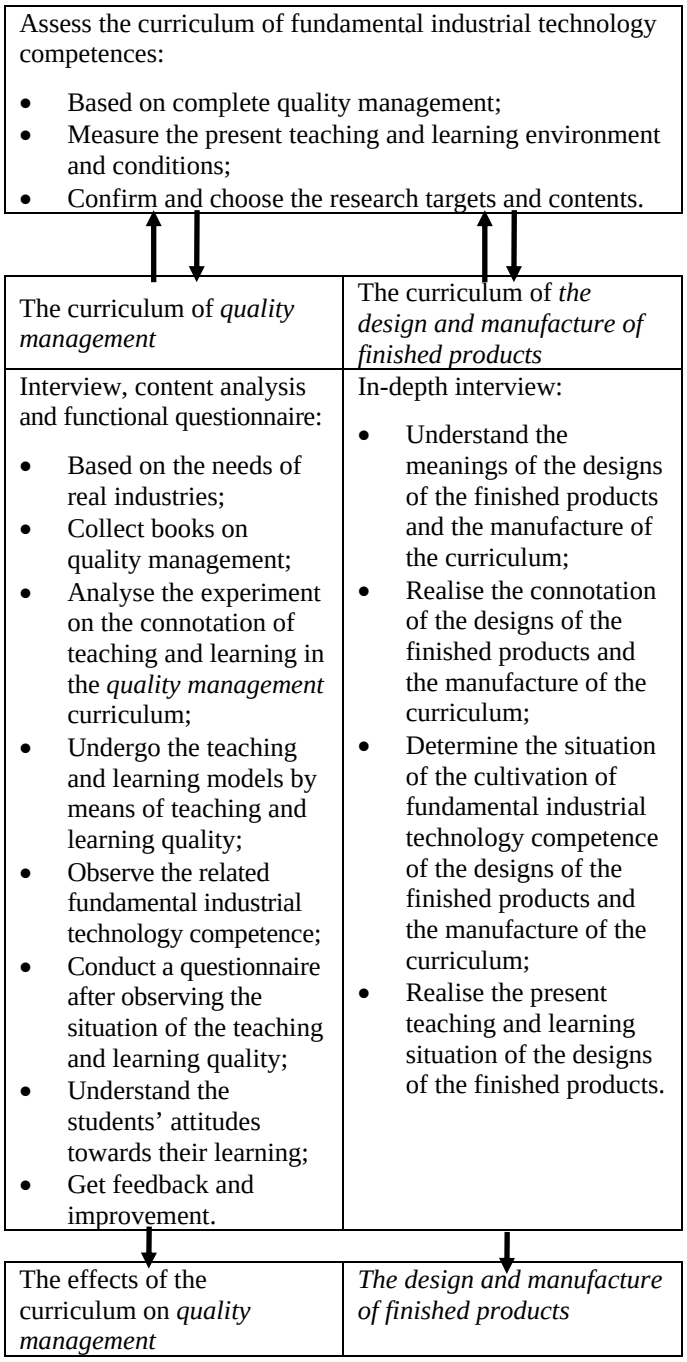

Figure 1: Structure of the research.

Experimental Research Tools

The research focuses on the subject of *quality management* in fostering fundamental industrial technology competences. The teaching and learning experiment is based on a teaching and learning manual to gain feedback and related information regarding students' teaching and learning in *quality management.*

Tools for Investigative Research

The first tool for investigative research is the investigative questionnaire of the functional connotation of the subject of *quality management* concerning fundamental industrial technology competences. There are 12 kinds of *connotation curriculum,* including 57 kinds of *functional connotation.* The investigative questionnaire has been designed in a half-opened manner to ask experts in quality management to fill out the forms. The major questions are to add or delete the connotation of the elementary plan of the research.

According to the result of the first functional questionnaire investigation, a second investigative questionnaire of the functional connotation of the subject of *quality management* of fundamental industrial technology competence is made. There are 10 kinds of *connotation curriculum,* including 50 kinds of *functional connotation* to be used as the connotation investigation of the subject of *quality management* of fundamental industrial technology competences.

The second tool is a questionnaire concerning the after-learning of the subject of *quality management* with regard to fundamental industrial technology competences. The targets of the questionnaire are those enrolled in the *quality management* subject. Their cognitive curriculum connotation after learning and the respondents' opinions regarding the teaching and learning systems were the focus of this. *The questionnaire of the after-learning of the subject of* quality management *of fundamental industrial technology competences* includes two main parts, which are detailed as follows:

- The after-learning perception of the content of the *quality management* subject:
  - Cognitive Dimension: There are seven questions related to some kinds of beliefs of *the content of quality management curriculum,* including opinions generally, good and bad evaluations, and elements with descriptive meanings. These beliefs are mainly about knowledge and information of one person towards a specific target;
  - Cognitive Dimension: There are six questions related to the likes and dislikes of a person towards *the content of the quality management curriculum.* The questions cover personal internal experience, such as likes/dislikes, acceptance/rejection and happiness/unhappiness;
  - Behavioural Dimension: There are seven questions related to the personal reaction of *the content of quality management curriculum.* That is, personal reaction relates to the preparatory state before the action of some specific target.
- The after-learning perception concerning the teachers giving the lectures:
  - Perception of teachers' preparation: There were seven questions about students' opinions on their teachers' preparation;
  - Perception of teachers' lectures: There were eight questions about students' feelings towards their teachers' applying effective strategies;
  - Perception of teachers' ending lectures: There were seven questions about the teachers' abilities to deduct and induct the lectures, and to extend the lessons;
  - Perception of teachers' assessment: There were eight questions about students' feelings towards their teachers' abilities to apply suitable assessment techniques and provide feedback.

The third aspect concerned the validity of the questionnaire of the after-learning attitude. After finishing the development of the questionnaire, three experts were asked to check it. Therefore, the questionnaire was based on content validity. In other words, according to expert validity, a good level of validity can be established.

RESEARCH RESULTS AND DISCUSSION

Analysis of Data from the Experts

The use of opinions from industry for the connotation of *quality management* of fundamental industrial technology competences provided reference points when constructing the questionnaire plus the teaching and learning experiments for quality management. The results are listed in Table 1.

Table 1: Data analysis of the experts.

No.	Competence of Connotation	Frequency
A01	Professional techniques	13
A02	Professional competence	3
A03	Theory-based competence	2
B01	Information application competence	8
B02	Management competence	5
B04	Innovation and development competence	1
B05	Re-learning competence	1
B07	Personal relationships	1
B08	Communication competence	1
B09	Capacity for professional ethics	4
B10	Career planning competence	1

Content Analysis

In order to plan the connotation of the subject of *quality management* for the practical fundamental industrial technology curriculum, an analysis was made of the related contents of relevant books when designing the functional questionnaire and for the teaching and learning experiments. The result of the analysis is listed in Table 2. The books are designated from A to T.

Results Analysis of the Connotation of the Subject of *Quality Management*

The major functional analysis of *quality management* identified there to be 10 kinds of connotation of *quality management* of the curriculum for fundamental industrial technology. A test revealed *quality system* and *statistics process control and pictures (I)* to be the most important ones. The average numbers were 4.80 and 4.67. Overall, the lowest grade was found to be *quality psychology*, with an average score of 3.85. This is listed in Table 3.

Table 3: Major connotation analysis of *quality management*.

Dimension	No. of People	Average	Standard Deviation
The introduction of quality management	12	4.33	49
Quality psychology	12	3.58	99
Quality origination, leadership and strategic planning	12	4.58	67
Random distribution and statistics analysis	12	4.41	67
Statistics process control and pictures (I)	12	4.67	49
Statistics process control and pictures (II)	12	4.42	67
Customers' satisfaction and Quality Function Deployment (QFP)	12	4.50	67
Taguchi quality experiment	12	4.30	75
Reliability	12	4.50	52
Quality system	12	4.80	45

The minor functional analysis of the *quality management* subject is listed below:

- In the connotation of the introduction of quality management, the most important thing was to understand the definition of quality management; the average number was 4.75;
- In the connotation of quality psychology, knowing the principles and spirits of complete quality management was more crucial; the average number was 4.50;
- Regarding the connotation of quality organisation, leadership and strategic planning, the most important ones were to realise and apply the organising functional abilities of quality control and quality leadership; the average number was 5.00.
- In the connotation of rate and statistics analysis, the two crucial aspects were the abilities to perform sampling examination and planning; the average number was 4.67;
- In the connotation of statistics process control and pictures (I), applying the methods of statistics process control and measuring pictures were the two important ones; the average number was 4.83.

Table 2: Content analysis.

Chapter	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	T	Total
Introduction	V	V	V	V	V	V		V	V			V			V	V	V		12
Quality psychology						V		V								V			3
Quality management and leadership	V			V		V		V	V							V	V		7
Complete quality management	V	V		V				V								V		V	6
Rate of distribution and statistics analysis	V	V	V	V	V	V		V	V	V							V		10
Statistics Process Control and Pictures	V	V	V	V	V		V		V				V						8
Reliability	V	V	V	V		V			V	V						V	V		9
Quality improvement and quality management circle	V		V	V		V			V							V	V		7
Taguchi quality experiment	V		V	V		V			V	V				V	V		V		9
Quality Function Deployment (QFP)	V			V		V		V	V								V		6
Needs of customers								V			V					V	V		4
Quality system and quality awards	V		V	V					V		V	V				V	V	V	9

- The abilities of designing pictures were crucial in the connotation of statistics process control and pictures (II); the average number was 4.67;
- In the connotation of customers' satisfaction and Quality Function Deployment (QFP), understanding the opening meaning of the quality function was deemed most important; the average number was 4.67;
- Concerning the connotation of Taguchi quality experiments, understanding the abilities of quality engineering was the most important; the average number was 4.42;
- Regarding the connotation of reliability, realising the definition of reliability and the lifecycle of products were the crucial ones; the average number was 4.58;
- In the connotation of quality guarantee, knowing the design systems for quality guarantee and examination were important; the average number was 4.58.

Analysis of the Observations and Records

The observations of the teaching and learning quality system provided opportunities to view actual situations of the process of teaching and learning. The researchers conducted actual observations in the classroom and recorded the whole process. The main parts included *teachers' situation*, *students' situation*, etc. this was followed by data collection and analysis. The results are shown in Table 4.

Table 4: Analysis of the observations and records.

Teaching Strategies	Code	No.
Confirm the teaching and learning objectives	1-1	11
Confirm the learners' background knowledge	1-2	3
Be familiar with the teaching and learning environment	1-3	2
Arouse the learners' motivation	2-1	11
Explain the learning objectives	2-2	11
Describe the learning contents and the method of assessment	2-3	11
Enforce teaching and learning communication	2-4	11
Organise the learning key points	3-1	11
Offer hints of an assignment's contents	3-2	1
Suggest the next schedule	3-3	11
Apply the assessment	4-1	4

The research focused on using *quality management* to cultivate the basic abilities of industrial techniques. This included the observation of the abilities used in the teaching and learning content of industrial techniques.

Analysis of the Teaching and Learning Experiment

There were four teaching and learning experiments. An analysis of the result of the review and test indicated the related analysis f quality control. By means of histograms and SPC pictures, students' individual differences and performances could be understood.

A comparison of the results of the former and latter tests in the teaching and learning experiments on *quality management* in fundamental industrial technology indicated that the grades of the latter tests were much better than the former ones. It is apparent that, after applying the connotation of the *quality management* of fundamental industrial technology, that is, applying the quality systematic strategies into teaching and learning, the effects of the teaching and learning and the connotation of fundamental industrial technology could be properly promoted. The results of the former and latter tests are shown in Table 5.

Table 5: Comparative results of the former and latter tests.

	No.	Average	SD	Freedom	t
Former	56	42.91	14.90	110	12.25**
Latter	56	73.61	11.38		

** <0.05

Analysis of the Questionnaire on Attitudes After Learning

Students' perceptions about the quality content after learning is shown in Table 6. Of the questions, the lowest average was for Question 15 (about 2.91), whereas the highest average was for Question 9 (about 3.57). The overall average was 3.38. It is shown that students' perceptions regarding the quality content after learning yielded positive results.

Students' Perceptions of Teachers Regarding Teaching and Learning

Regarding students' perceptions of teachers in the area of teaching and learning revealed the lowest averages of the numbers of the five questions to be 25, 36, 39, 40 and 23. Of these, Questions 25, 36 and 39 scored the lowest. The highest average was for Question 34. The overall average was 3.70. It is apparent that students have positive perception of teachers concerning teaching and learning.

ANALYSIS OF THE IN-DEPTH INTERVIEWS

The aim of the subject on making finished products is to cultivate the fundamental industrial technology competences. The highest frequency was *professional techniques* (about 12 times), followed by *the abilities of creative development* (about nine times), then *communication abilities* (about seven times), then *professional knowledge* (six times), then *personal relationships* (four times), then *abilities to apply information technology*, *re-learning abilities*, *human and social competences* all scored three, followed by *ethical theories* (twice), and *management ability* (once).

CONCLUSIONS

There are four objectives of *quality management* regarding fundamental industrial technology competences, namely:

- Understand the basic knowledge and meaning of complete quality management;
- Cultivate the abilities and opportunities to apply quality management;
- Cultivate the abilities of quality leadership and strategic planning;
- Understand the related regulations of quality systems.

There are four goals of *the designs and making of finished products*, as follows:

- Understand the process of design and development;

- Cultivate abilities for developing inventions and industrial production;
- Organise basic knowledge and techniques to be involved in the design and manufacture of industrial products;
- Cultivate teamwork and cooperation.

Table 6: Students' perceptions about quality content after learning.

No.	Questions	Average	S.D.
1	I think that the curriculum can cultivate talented persons	3.38	1.11
2	I think that the curriculum contains theories and practical knowledge	3.34	1.09
3	I think that the structure and coherence of the curriculum are excellent	3.25	1.12
4	I think that the content of curriculum is colourful and plentiful	3.53	1.01
5	I think that the content of the curriculum fits in with the basic level of the students	3.32	1.11
6	I think that the content of curriculum contains the range of quality management activities	3.49	0.91
7	I think that the content of curriculum fits in with the needs of the present industries	3.30	0.97
8	I would like to attend more classes about the curriculum of quality management	3.45	0.99
9	I will give the curriculum positive feedback	3.57	0.95
10	I think I am energetic and active when attending the classes	3.36	0.88
11	The curriculum content fits in with my expectations and interests	3.23	1.07
12	After learning, I become more confident and professional	3.17	1.09
13	After learning, I gain a sense of achievement	3.28	1.10
14	The curriculum carries out concepts of quality management	3.55	0.91
15	After learning, I have the ability of quality management	2.91	0.99
16	I can tell the difference between the terms of quality management and methods for the right situation	3.36	0.96
17	I can apply the concepts or methods of quality management in daily life	3.36	0.92
18	I will actively collect information on quality management	3.11	0.97
19	I would like to talk to other people about questions on quality management	3.47	0.99
20	I intend to be involved in a job related to quality management	3.38	0.90
	Total Average	3.38	

The subject of *quality management* in the fundamental industrial technology curriculum includes 10 items on the introduction of quality management. The subject of *the design and making of finished products* contains *recognising and making pictures*. The subject of *quality management* gained positive feedback from students.

The teaching and learning of the curriculum of fundamental industrial technology emphasises fitting in with the needs of students and places emphasis on flexible communication. The teaching and learning of the curriculum of fundamental industrial technology emphasises balance between the quality and quantity of the process of assessment. The teaching and learning systematic models of fundamental industrial technology include analysis, design, development, performance and assessment. They are shown in Figure 2.

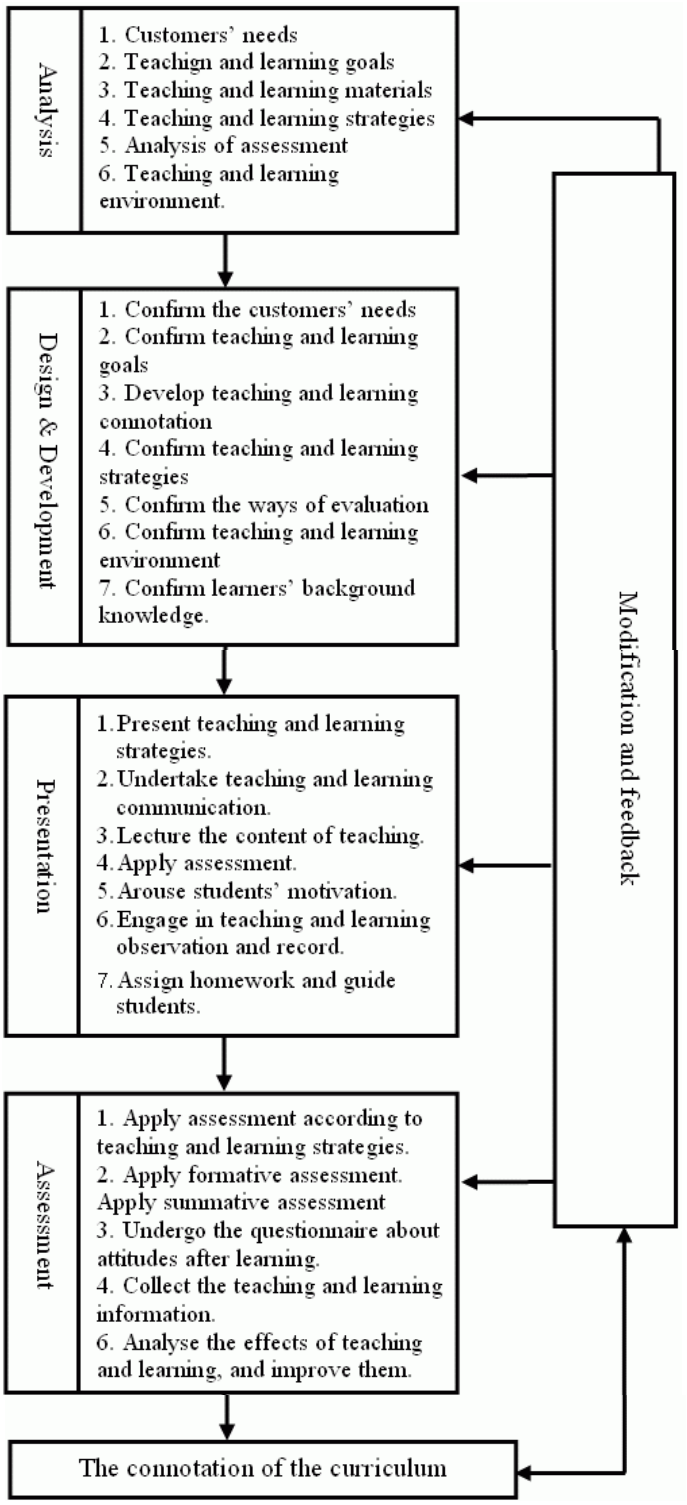

Figure 2: The teaching and learning systematic models of fundamental industrial technology including analysis, design, development, performance and assessment.

SUGGESTIONS

According to the above-mentioned conclusions, some suggestions are offered, as follows:

- The objectives and connotation of a baccalaureate curriculum of fundamental industrial technology should be used as a reference point for teaching and learning, as well as for strategic assessment;
- The teaching and learning application of a baccalaureate curriculum of fundamental industrial technology should fit in with students' demands;
- The application of complete quality theories should be undertaken so as to carry out flexible teaching and learning communication;
- Assessment should keep pace with the construction of the abilities and development of students;
- The application of ideas of systematic models of teaching and learning should be conducted to enhance the quality of the curriculum of fundamental industrial technology;
- Other related fields of the curriculum should be constructed according to the flow of the project.

FURTHER RESEARCH

The research has verified teaching and learning systematic models of a baccalaureate curriculum of fundamental industrial technology.

In the future, the third research objective will be verified again through experiments. Moreover, applying project assessment towards the whole research process and assessment should improve the efficiency of the curriculum of fundamental industrial technology.

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