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Evaluation of the Curricula of Emerging Technologies under DAE: Perceptions of Stakeholders

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Abstract

This article is a part of PhD dissertation. Diploma of associate engineering (DAE) is a three year program aimed at educating technicians in different technologies, present study was carried out to evaluate the curricula of three emerging technologies of DAE. Perceptions of the major stake holders i.e. 58 graduates & their 44 supervisors about the relevance of the competencies developed in the graduates through curriculum with the requirements of the job were elicited through questionnaires. Findings of the research indicated that curricula of food technology is relevant to the requirement of the job market, review / adjustment of the curricula of instrumentation technology is needed and minor adjustments in the subject petroleum refining of petroleum technology is required

Keywords: *DAE, Emerging technologies, Relevance of curricula, curriculum competencies*

1. Introduction

The technicians' education is not identified and defined uniformly in all the countries, but there is a general understanding that technicians constitute middle level manpower occupying positions in industry between engineers / technologists and skilled workers. They hold positions such as supervisors, foremen, technical assistants, technical instructors etc. In some countries the technician is closer to the engineers as "engineering aide" and the skilled worker may be performing repetitive operations. However in a developing economy the technician may have to exercise supervisory functions and also a good deal of manipulative skills on shop floor.

Technical education as an integral part of overall education system has also underwent remarkable changes both in size and quality. The magnitude of quantitative change can be seen from the fact that at the time of independence there was no separate institute for the training of supervisory personnel. The two engineering colleges, which existed in Karachi and Lahore, were also training supervisory personnel.

To bring about the quantitative changes in technician education infrastructure, sizeable resources had been allocated from time to time. Various measures were also taken to improve the quality of the system. Except few, no systematic studies have been conducted to relate the developmental inputs with the resulting outputs both in quality and quantity,

The quality of technical education depends on how effective the teaching and learning process is carried out in a given institution environment. This teaching learning environment depends on several elements of the system comprising the teacher, the learner, the curriculum, access to teaching learning resources, admission standards, policy and procedures, physical facilities, evaluation standards and examination.

Research and evaluation appeared to be one of the weakest areas of quality improvement in technician education. Some isolated studies were available but were focused more on the supply led issues pertaining to teaching learning processes, curriculum and physical facilities. The literature review revealed that these initiatives had wide range of aspects with low scope or with specific issues. Such as Anayat (1989) suggested that steps should be taken to introduce a system of liaison between industry and polytechnic. He also suggested that courses of physics and chemistry be included in the curriculum, and the course of mathematics be strengthened. Khawaja, et el. (1991) have also recommended that all manpower development institutions should increase their effectiveness. They also emphasized the need of industry-institution collaboration, with special recommendation that the curriculum and content of the polytechnic institutes should meet the needs of the job market.

The studies on demand led issues, management styles and performance of pass outs and such aspects which could help to determine the external efficiency of the system and its sensitivity to the industrial needs were never conducted before 1980's. The system also lacked evidence of manpower studies to predict the points at which curriculum revision exercises should be introduced to meet the fast changing requirement of the high tech era. However, in the light of the study conducted by Hawthorn Institute of Education (ADB, 1990) major changes in the curricula of Diploma of Associate Engineering (DAE) program were made and the revised curricula was introduced in 1996.

In a study conducted by Mirza & Khan (2001) comparison of the objectives of the curricula with the needs of the industry/employer was made. The results showed that generally the curricula were all right warranting few changes but its implementation and instruction keep it far below effectiveness.

The curriculum is the focal point of any education system. All the inputs to the system and the processes are geared to achieve the aims of curriculum that in turn serves as a vehicle for the required output

At the time of independence, Pakistan had meager educational facilities. The educational system inherited from the British was geared to create obedient clerks who could function in the English language. The curriculum was narrow, and teaching was by rote. Educational facilities had been distributed unequally in various parts of the country. The areas of Punjab and Sindh were relatively developed in comparison with NWFP and Baluchistan (Ghafoor, 1982).

In Pakistan the history of curriculum development for technician education dates back to 1954 when a Pakistani educators team visited USA to study the polytechnic system of education and develop a curriculum through an interactive exercise between the faculty of the Oklahoma State University. This exercise was to adapt existing models to suit the local needs. The first curriculum was introduced in 1955 in Civil, Electrical, Electronics, and Mechanical and power Technology. According to Ali (1998) this curriculum document hardly fulfill the definition of curriculum. It was basically a detail list of all the topics of theory and practical instructions for each of the period provided in the curriculum/ scheme of studies. This helps the teachers to determine the parameters of topics.

Punjab Government recast the curricula on annual pattern in early nineties and implemented from the session 1996. The main features of this new curriculum is that it is drafted in terms of behavioral objectives for each course and computer studies have also been included in the all technologies. The curriculum for new emerging technologies was developed under Second ADB technical education project. The coming years would be difficult because of ever accelerating globalization of trade in goods and services. While globalization will undoubtedly bring about certain benefits, it will also have significant costs. Specifically, it can have adverse effects on local industries if they are not prepared to compete with low priced, high quality imported goods and services. The globalization of the economy and rapid technological innovation challenge today's work force to prepare for continuous change. Due to technological innovation and the restructuring of the workplace, many workers have found that their current technical skills are obsolete. Furthermore, international corporate competitiveness has become

more dependent on the problem-solving abilities of the workers. To address these problems, members of the work force must commit themselves to lifelong learning to update their technical skills and develop their problem-solving skills (Inman and Vernon 1997; Payne 1997; Rowden 1996).

21st century will no longer be a post–agriculture or post industrial world. Rather it will be a new world of fast communications and information, rapid decision making, and intelligent social skills will be needed to deal with economic, technical, ecological, and ethical issues identified with complex problems facing every economic, social, or political system (Nijhof, 1998).

According to Carnevale (1991), this new economic world is vastly different from the agriculture/factory environment that ushered vocational education at the turn of 20th century. It is characterized today by international activity, cyberspace, ever-changing market demands and standards, rapid product life cycle, ever–increasingly sophisticated computers, and need for a more thorough knowledge of the holistic of the business environment rather than just specific skills or narrow job tasks. Therefore, today's workplaces are often in multi locations characterized by cultural diversity–almost mosaic, fragmented or "different" organizations and infrastructures, periodic economic restructuring, and constantly changing workers roles and duties.

2. Methodology

Present research aimed at the evaluation of the curricula of Diploma of associate engineering for emerging technologies. Out of emerging technologies the following three, generally considered high in demand were selected:

1. Instrumentation
2. Food
3. Petroleum

The study was delimited to the technical subjects (because they are directly related to the industrial needs), male institutions, the graduates of the session 1996-99 assuming that the maximum number of graduates would have been employed and the immediate supervisors might have got sufficient period to supervise and give feedback

Table 1 Number of Government and Private Institutes that offered the respective technology in the year 1996.

		Food	Instrumentation	Petroleum
Population	Govt.:	1	3	1
	Private	-	-	-
	Total	**1**	**3**	**1**
Sample	Govt.:	1	3	1
	Private	-	-	-
	Total	**1**	**3**	**1**

This study was aimed to evaluate the curricula of DAE for three of the emerging technologies as perceived by the stake holders .The major stake holders are the graduates and their immediate supervisors and they can evaluate the relevance of the competencies developed through the curriculum with reference to the requirements of the job. For this purpose the opinions of DAE graduates and their immediate supervisors were required. Therefore, separate questionnaires were developed for each technology. The questionnaires consisted of the list of competency statements derived from the instructional objectives of the curricula of the selected technologies. For developing the questionnaire the researcher primarily

prepared a list of all the concepts given in the syllabus of every technology separately. Each list of concepts and relevant curriculum was then given to a working experienced teacher of the related technology. The teachers were requested to help identify the duplication of the concepts and point out if any concept had been missed out. This procedure was adopted to ensure that every concept in the curriculum is included in the list. As the curricula of different technologies have different number of technical subjects and unequal number of concepts, therefore each questionnaire has different number of statements. Depending upon the nature of the subject and their concepts, one, two or more of the subjects were combined to form a cluster of competencies. The formation of clusters could also be helpful in making meaningful conclusions and better understanding of data.

Table 2 Cluster, Subject and Competency Wise Detail of Food Technology Questionnaire

Sr. No.	Name of Cluster	Subjects Included	Statement No.
1	Food and Applied Chemistry.	Applied Chemistry (Ch-113), Food Chemistry (FT- 213)	1, 2, 3, 4, 5, 6, 17, 18.
2	Food Science and Technology.	Introduction to Food Science and Technology (FT-113) Technology of Food I and II (FT-245, 325)	7, 8, 9, 41, 42.
3	Food Microbiology.	General and Food Microbiology (FT-124)	10, 11, 12, 13, 14, 15, 16.
4	Food Analysis and Instrumentation.	Food Analysis & Instrumentation (FT-224)	19, 20, 21, 22.
5	Food Nutrition.	Food and Nutrition (FT-312)	35, 36, 37, 38, 39, 40.
6	Food Engineering, Plant layout and handling.	Principles of Food Engineering (FT-233) Food plant layout and handling (FT-252)	23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34.
	Total Competencies		**42**

Table 3 Cluster, Subject and Competency Wise Detail of Instrumentation Technology Questionnaire

Sr. No.	Name of Cluster	Subjects Included	Statement No.
1	Basic and Advance Electronics	Principles of Electricity and Electronics, Digital Circuits, Microprocessor applications. (IT – 124,244)	1-8, 27, 28
2	Instrumentation and Control	Instrumentation workshop Practice, Instrumentation Drawing, Industrial Instrumentation and Controls (IT-133, 252, 314)	9-12, 29-31, 32-36.
3	Servicing and Calibration of Measuring Instrument.	Electrical and Electronic Measuring Instruments, Instrument Servicing and Calibration (IT – 234, 343)	24-26, 37-39,
4	Electronic Circuits and Devices	Semiconductor Devices and Electronic Circuits, Industrial Electronics (IT – 223, 323)	19-23
5	Process Variable	Process Variable Measurements (IT – 214)	13-18
	Total Competencies		**39**

Table 4 Cluster, Subject and Competency Wise Detail of Petroleum Technology Questionnaire

Sr. No.	Name of Cluster	Subjects Included	Statement No.
1	Industrial Stoichiometry	Petrochemicals and Industrial Stoichiometry. (Pet – 233) Applied Chemistry (Ch –123)	23-25, 1-7
2	Fundamentals of Petroleum & Geology.	Fundamental of Petroleum Technology, Petroleum Geology (Pet –113, 213)	8-12, 13-17
3	Mechanics and Thermodynamics	Fluid Mechanics and Thermodynamics, Instrumentation and Control (Pet – 223,363)	18-22, 57-60
4	Drilling & Well Logging	Drilling Technology, Well Logging and Testing, Petroleum Production Technology, Safety Practices and Procedures (Pet 243, 323, 343, 351)	26-30, 47-50, 54-56
5	Petroleum Production	Workshop Practice I & II (Pet – 123, 261)	35-40
6	Fuels & Combustions	Fuels and Combustions (Pet – 253)	31-34, 61-62
7	Refining and Gas Technology	Petroleum Refining, Gas Technology (Pet – 313, 333)	41-46, 51-53
		Total	**62**

The respondents were asked to rate the relevance of the competencies with the job performance. The respondents had to rate his response on a five point likert type scale ranging from 0% to 100%. In the instrument for graduates, name and address of the industry in which the graduates were working, the name and address of their immediate supervisor and detail of their previous history of employment and unemployment were also to be recorded

The heads of the sample institutes were approached to provide the requisite records of the graduates (name and addresses) of the session 1996-99. Questionnaires were sent to graduates by mail to solicit their responses As soon as the response of graduates was received, the graduates who were working in the industry and provided the name and addresses of their immediate supervisors the relevant questionnaire along with the covering letter was mailed to the supervisors.

Table 5 Detail of sample, respondent and data collection.

Name of Technology	Number of Graduates				Number of Supervisors	
	Total No. of Graduates to whom the questionnaire were sent.	**Total No. of respondent Graduates**	**Number of Graduates who had no work experience .**	**Effective Sample**	**Total No. of Supervisors to whom questionnaire were sent**	**Total No. of respondent supervisors**
Food	8	7	-	7	7	6
Instrumentation	45	37	5	32	32	22
Petroleum	25	20	1	19	19	16
Total	**78**	**64**	**6**	**58**	**58**	**44**

The data received from the DAE graduates and their immediate supervisors were analyzed by cluster (broad areas of competencies). Under each broad area relevant competencies were grouped together as clusters. The mean weight of each cluster was calculated for determining the degree of relevance of curricula. The criterion for interpreting the degree of relevance was set in consultation with – experts and is given below:

Range of Mean Score	Degree of relevance
≥ 4.0	Most Relevant
≥3.0 to<4.0	Relevant
≥ 2.0 to <3.0	Somewhat relevant
≥ 1.0 to < 2.0	Least relevant

3. Data Analysis

Food Technology

The Food Technology section was divided into six clusters. The following table shows the mean values for the clusters.

Table 6 Mean Weight of Food Technology Clusters

Sr. No.	Title of the Cluster	Group	N	Mean Wt:
1	Food and Applied Chemistry.	Gr.	7	3.92
		Sup.	6	4.04
2	Food Science and Technology.	Gr.	7	3.91
		Sup.	6	3.66
3	Food Microbiology.	Gr.	7	3.26
		Sup.	6	3.69
4	Food Analysis & Instrumentation.	Gr.	7	3.64
		Sup.	6	3.75
5	Food Nutrition.	Gr.	7	3.09
		Sup.	6	3.20
6	Food Engineering, Plant layout and handling.	Gr.	7	3.23
		Sup.	6	3.40

All the clusters were rated as **relevant** by the graduates and the supervisors except for one cluster namely **Food and Applied Chemistry** which is rated as **most relevant** by the supervisors to the requirements of the job market

Instrumentation Technology
The following table shows the mean value for the clusters. There are five clusters in this technology

Table 7 Mean Weights of Instrumentation Technology Cluster

Sr. No.	**Title of the Cluster**	**Group**	**N**	**Mean Wt.**
1	Basic and Advanced Electronics	Gr.	32	3.25
		Sup.	22	2.91
2	Instrumentation and Control	Gr.	32	3.34
		Sup.	22	2.62
3	Servicing and Calibration of Measuring Instrument.	Gr.	32	3.50
		Sup.	22	2.70
4	Electronic Circuits and Devices	Gr.	32	3.14
		Sup.	22	2.29
5	Process Variable	Gr.	32	3.80
		Sup.	22	3.03

None of the cluster received the highest rating of most relevant either by the graduates or supervisors. Of the five clusters the opinion of graduates and the supervisors is same for only one cluster namely Process Variable.

Mean values of the perceptions of **both** the graduates and their immediate supervisors indicate that the cluster of **Process Variable** was **relevant** to the requirement of the job market. Whereas difference of opinion was found for the following clusters:

1. **Basic and Advanced Electronics**
2. **Instrumentation and Control**
3. **Servicing and Calibration of Measuring Instrument.**
4. **Electronic Circuits and Devices**

The mean weight values categorized the above clusters as **relevant** by the graduates and **somewhat relevant** by the immediate supervisors.

Petroleum Technology
The following table shows the mean values for the Petroleum Technology clusters.

Table 8 Mean Weights of Petroleum Technology Clusters

Sr. No.	**Title of the Cluster**	**Group**	**N**	**Mean Wt:**
1	Industrial Stoichiometry	Gr.	19	3.81
		Sup.	16	3.93
2	Fundamentals of Petroleum & Geology.	Gr.	19	3.73
		Sup.	16	3.56
3	Mechanics and Thermodynamics	Gr.	19	3.77
		Sup.	16	3.29
4	Drilling & Well Logging Technology	Gr.	19	3.61
		Sup.	16	3.27
5	Petroleum Production	Gr.	19	3.72
		Sup.	16	3.38
6	Fuels & Combustions	Gr.	19	3.55
		Sup.	16	3.16
7	Refining and Gas Technology	Gr.	19	3.45
		Sup.	16	3.05

None of the clusters received the highest rating of **most relevant** rather all the clusters are rated as **relevant** to the needs of the job market.

4. Findings of the Study

Food Technology

- **Both** the graduates and their immediate supervisors perceived the following clusters as **relevant** to the needs of the job market.
    i. Food Science and Technology
    ii. Food Microbiology
    iii. Food Analysis and Instrumentation
    iv. Food Nutrition
    v. Food Engineering, Plant layout and handling
- The graduates perceived the cluster of Food and Applied Chemistry as **most relevant** by the immediate supervisors and **relevant** by the graduates.

Instrumentation Technology

- **Both** the graduates and their immediate supervisors perceived the cluster of Process Variable as **relevant** to the needs of the job market.
- There is a difference of opinion between the graduates and supervisors regarding the following clusters. The graduates perceived the clusters as **relevant** and their immediate supervisors perceived these as **somewhat relevant**.
    i. Basic and Advance Electronics
    ii. Instrumentation and Control
    iii. Servicing and Calibration of Measuring Instrument
    iv. Electronic Circuits and Devices

Petroleum Technology

- **Both** the graduates and their immediate supervisors perceived the following clusters as **relevant** to the needs of the job market.
    i. Industrial Stoichiometry
    ii. Fundamentals of petroleum and geology
    iii. Mechanics and Thermodynamics
    iv. Drilling & well logging technology
    v. Petroleum production
    vi. Fuels & combustions
    vii. Refining and Gas Technology

5. Conclusions and Discussion

Food Technology

In overall assessment of food technology curricula of DAE is relevant to the requirement of the job market. The graduates perceived the cluster of Food and Applied Chemistry as **most relevant** by the immediate supervisors and **relevant** by the graduates. The analysis shows a large variation in the perceptions. The subject was designed to enable the students to understand the food components and nutrition in relation to consumer health and food preservation. Whereas the subject Food Chemistry enables the students understand the food components in relation to food processing. It would, therefore, be appropriate to redefine the scope and sequence of the above-mentioned courses

Instrumentation Technology

The Instrumentation technology questionnaire consisted of thirty-nine competencies grouped under five competency clusters. Subjects Digital Circuits / Micro Processor Applications, Electrical and Electronic Measuring Instruments, and Instrument Servicing and Calibration were rated as somewhat relevant by the supervisors.

The detailed analysis of the curricula revealed that the nature of instrumentation technology is different from other technician education courses. It is designed to produce industrial technician rather engineering technician. The specialized nature of the instrumentation technology course demands the graduates to work closely with the modern, scientific and new technologies as demand for quality products are in increase. Old machinery is being replaced with new updated machinery. The industry especially sugar, synthetic yarn, pharmaceutical, food, ceramics and other are being computerized and automated. This entire scenario supports the view of immediate supervisors of instrumentation technology graduates who have rated most of the concepts of instrumentation technology as only somewhat relevant. This view of modernization and introduction of new technologies and equipment is also reported by Mirza and Khan (2001a). Therefore, a timely review / adjustment of the curricula of instrumentation technology are needed.

Petroleum Technology
Although, the curriculum of petroleum technology is relevant to the need of the job market, yet the subject petroleum refining requires minor adjustments.

Overall Conclusion
The perusal of all the three emerging technologies help us to conclude that the curricula of emerging technologies i.e. Food and Petroleum are very much satisfactorily relevant to the requirement of the job market. The Curriculum of Instrumentation technology is also found relevant but three of the ten technical subjects of Instrumentation technology require minor revisions and adjustments

6. Recommendations

The findings and Conclusions of the study led the researcher to make the following recommendations.

Specific Recommendations

- The minor adjustments and revision in the subject of Food and Nutrition of Food Technology should be carried out.
- The Instrumentation Technology course is designed to produce industrial technicians and therefore more emphasis is required on practical aspect. As new technology and modernization of production process is a key feature of quality products and market competitiveness. This can only be achieved with modern and updated curricula. Therefore, periodic review of instrumentation technology should be carried out.
- Following subjects of instrumentation technology require instant attention for revision.
    i. Digital Circuits / Micro Processor Applications
    ii. Electrical and Electronic Measuring Instruments
    iii. Instrument Servicing and Calibration
- Minor review and adjustment of Petroleum Refining subject of Petroleum Technology is suggested.

General Recommendations

- The policy maker and curriculum developers along with other stakeholders like industrialists should help develop industrial skill standards to facilitate the students to attain the excellence required, teachers to make objective assessments, and employers to help identify the right type of employee.
- Regular study visits to the industries be made to make graduates abreast with the new technologies and competencies being introduced with the establishment of new industries.

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