The Impact of Industry Exposure on Machine Shop Skills Development of Mechanical Engineering Students

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Abstract: ***This is a descriptive method of study aimed at finding the impact of the industry exposure program on machine shop skills development of mechanical engineering students from selected academic institutions in Davao Region, Philippines. Paired t-test was employed in treating the data to determine the significance of the level of machine shop knowledge, attitudes, skills and habits. Samples of the study were regular 4th year mechanical engineering students who were enrolled in the industry exposure or on-the-job training (OJT) and the computer software used in this study was the Statistical Package for the Social Sciences or SPSS. The analyses and interpretation of the data gathered in this study yielded the following findings: 1. Benchwork, lathe, shaper, drilling/boring machine operations, and blueprint reading and machine designing, and the over-all got Low level before the industry exposure. The percentage of their development is from 21% and 40%. The result of Low level was due to defective machines and lack of maintenance of equipment in the academe and the lack of training on the part of the faculty handling the particular course/subject. Milling and honing machine operations obtained Very Low Level. This is also due to the absence of some equipment in the machine shop laboratory of the academic institutions. There were institutions that have those machines but are non-functional due to defective spare parts. After the exposure, benchwork, lathe, milling, drilling/ boring, honing machine operations and the over-all level obtained Moderate level. Shaper and milling operations got high. This is because the student-trainees were more exposed in the area of shaper and milling machine operations. 2. There is a significant difference on the levels in all areas of knowledge and skills before and after the industry exposure. 3. Before the industry exposure, punctuality and attendance, productivity, behavior and attitudes towards work obtained High level. Compliance to 5S obtained the lowest mean score of 2.63 due to the fact that this particular area was neglected in the academe. After the industry exposure, the over-all mean was 4.87. This means that the student trainees were more attentive, more serious and very eager to learn while they were in the industry. 4. There is a significant difference on the levels in all areas of attitudes and habits before and after the industry exposure. 5. University of Southeastern Philippines requires its student-trainees to undergo 320-hour hands on training in machine shop, while the other institutions offer the course as an option in lieu of Fieldtrip or Plant visit subjects. Students who choose to undergo the hands on training spent only 200-hours in machine shop.***

Keywords: industry exposure, OJT, machine shop, machine shop skills, mechanical engineering, KASH

1. Introduction

Background of the Study

Our industrial progress always depends on the level of our technological ability. And such ability is not something bottled up in a laboratory. It is in every individual - the way they are trained and educated. Knowledge, attitudes, skills and habits (KASH) must be nurtured not only at home but in the academe and in the industry as well. Thus, there is a need to develop the basic skills in machining of mechanical engineering students. Industry exposure or on-the-job training (OJT) can provide what the academic institutions cannot provide such as training students to use equipment used in the industry.

Hence, industry exposure is important to provide exemplary technical training for student-trainees to become independent traders. It provides experience on a variety of machine tools particularly the different machine shop operations.

Since it is observed that not all engineering institutions offering mechanical engineering have industry exposure program in their curriculum, this study sought to compare the impact of the industry exposure program on the level of machine shop skills of mechanical engineering students.

The objectives of the study were to find out:

1. The level of development among mechanical engineering students before their industry exposure in terms of the following machine shop skills and knowledge: performing benchwork, lathe, shaper, milling, boring/drilling, honing machine operations, blueprint reading and machine designing.
2. The level of development among mechanical engineering students in terms of the machine shop skills and knowledge after their industry exposure.
3. If there is a significant difference between the level of machine shop skills and knowledge among mechanical engineering students before and after the industry exposure.
4. The level of development among mechanical engineering students before their industry exposure in terms of attitudes and habits.
5. The level of development among mechanical engineering students after their industry exposure in terms of attitudes and habits.
6. If there is a significant difference between the level of attitudes and habits among mechanical engineering students before and after the industry exposure; and

7. If the students were given hands-on training machine shop skills and knowledge and attitudes and habits during their industry exposure.

Null Hypothesis

Ho1: There is no significant difference between the level of machine shop skills and knowledge of mechanical engineering students before and after the industry exposure.

Ho2: There is no significant difference between the level of machine shop attitudes and habits of mechanical engineering students before and after the industry exposure.

Theory Base

This study is anchored on the claim of the President of the City University of Hong Kong Professor H K Chang (June 7, 2001) who hails the industrial exposure or on-the job training as an invaluable opportunity for students not only to gain hands-on industrial experience but also to immerse themselves in a different economic and cultural milieu, which is an integral part of university education.

The Conceptual Framework of the Study

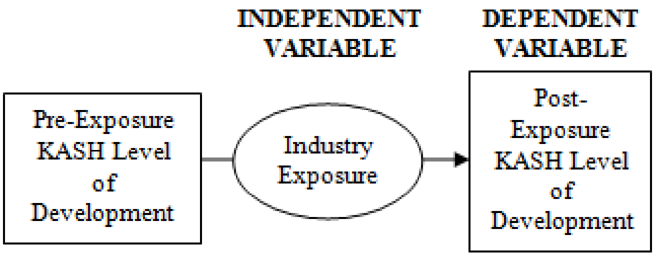

Figure 1: The conceptual framework of the study

Significance of the Study

The study helped improve the capability of the students in facing the practical aspects of the actual job operation and enhanced their knowledge in machine shop practices and the academic institution gained advantage by having a wider and more realistic laboratory and an opportunity to extend training programs to industry personnel.

Scope and Limitation of the Study

The machine shop skills and knowledge in this study are limited to benchwork, lathe, shaper, milling, drilling/boring, honing machine operations and blueprint reading and machine designing, and the critical attitudes and habits such as punctuality and attendance, productivity, compliance to 5S and behavior and attitudes towards work.

Definition of Terms Used

Impact. It is the term used to describe the difference in the level of development of students/trainees before and after the industry exposure.

Industry Exposure Program. It refers to the On-the-Job Training of the 4th year mechanical engineering students.

Machine Shop Skills and Knowledge. They refer to the ability to do something well, techniques and expertise. In this study, they are the skills and knowledge required by the mechanical engineering students in the academe and in the metal industry during industry exposure.

Attitudes and Habits. In this study, they refer to mental set that affects how a person will view something else, the feelings and beliefs that largely determine how a person perceive their environment and the manner in conducting oneself. In this study, it refers to the following: punctuality and attendance, productivity, compliance to 5S, and behavior and attitudes towards work.

2. Methodology

Research Method

This study made use of a descriptive method of research. Pertinent data were obtained through evaluation using an evaluation instrument to establish the baseline data on the level of skills and knowledge before and after the industry exposure program among the 4th year mechanical engineering students/trainees. In like manner, the level of development of attitudes and habits were also established.

Selection of respondents

The researcher selected the respondents of the study composed of regular 4th year mechanical engineering students of the four higher education institutions in Davao Region, Philippines. Sixteen were from University A, four from University B, four from University C and two from University D.

Procedure of the Study

The steps which were observed in conducting this investigation involved the following:

1) Permission to conduct the study
2) Facilitation of the industry exposure
3) Conduct of the evaluation
4) Collation of data gathered.

Data Tool

The researcher constructed a Knowledge, Attitudes, Skills, and Habits (KASH) evaluation instrument and had it validated by experts from the metals industry and from the academe. Before the students/trainees underwent the industry exposure, they were pre-tested by four evaluators, two were from the academe and two were from the industry using the said instrument. At the end of their industry exposure, they were post-tested by the same evaluators using the same instrument.

The data tool is composed of sixty-eight (68) items broken into two categories: Part I deals on skills and knowledge and part II deals on the attitudes and habits. The levels of development of skills are described below with their corresponding equivalent points or ratings.

Table 1: Level of Development

Level of Development	*Description*	*Ratings*
Poor	The student/trainee's machine shop skills and knowledge and attitudes and habits are developed approximately from 0-20%.	**1**
Fair	The student/trainee's machine shop skills and knowledge and attitudes and habits are developed approximately from 21-40%.	**2**
Satisfactory	The student/trainee's machine shop skills and knowledge and attitudes and habits are developed approximately from 41-60%.	**3**
Very Satisfactory	The student/trainee's machine shop skills and knowledge and attitudes and habits are developed approximately from 61-80%.	**4**
Outstanding	The student/trainee's machine shop skills and knowledge and Attitudes and habits are developed approximately from 81-100%.	**5**

Validation of Instrument

The evaluation instrument was shown to a group of experts from the metal industries and faculty members who were involved in the industry exposure program for their comments and suggestions. The instrument was validated thru the checklist of machine shop knowledge and skills (National Manpower and Youth Council- NMYC Brochure for Metals and Engineering Sector, 1990). A series of three revisions were done on the skill evaluation instrument before the same was finally reproduced upon certification of same group of experts.

3. Results and Discussion

Table 2: Level of Development on Knowledge and Skills among Mechanical Engineering Students before the Industry Exposure

Shop Knowledge and Skills	*Mean Score*	*SD Score*	*Verbal Description*
1. Benchwork Operation	1.52	0.26	Low
2. Lathe Machine Operation	1.77	0.42	Low
3. Shaper Machine Operation	1.57	0.2	Low
4. Milling Machine Operation	1.32	0.15	Very Low
5. Drilling/Boring Machine Operation	1.55	0.23	Low
6.Honing Machine Operation	1.42	0.12	Very Low
7. Blueprint Reading and Machine Designing	2.04	0.55	Low
Overall	**1.60**	**0.26**	**Low**

Table 2 shows the level of development among mechanical engineering students before their industry exposure in seven areas of shop knowledge and skills. The skills in blueprint reading and machine designing operations are as follows: interpretation of detailed and assembly drawing, identification of symbols, tolerance, fits, and limits, and designs and estimates. The milling and honing machine operations obtained Very Low level because these machines cannot be found in the academic institutions. Students got ratings of Low and Very Low in areas of skills and knowledge before exposure because of the following reasons: a) some of the machines in the laboratory were non-functional and defective; b) in adequate machine shop equipment c) some faculty handling the course have inadequate knowledge and were unskilled in metal technology; and d) some academic institutions are not complying with the minimum standard requirements of laboratory facilities are required and mandated by the CHED and TPEAME.

Table 3: Level of Development on Knowledge and Skills among Mechanical Engineering Students after the Industry Exposure

Shop Knowledge and Skills	*Mean Score*	*SD Score*	*Verbal Description*
1.Benchwork Operations	3.43	0.41	Moderate
2. Lathe Machine Operation	3.49	0.27	Moderate
3. Shaper Machine Operation	3.58	0.3	High
4. Milling Machine Operation	2.94	0.36	Moderate
5. Drilling/Boring Machine Operation	3.47	0.28	Moderate
6. Honing Machine Operation	2.81	0.41	Moderate
7. Blueprint Reading and Machine Designing	3.65	0.55	High
Overall	**3.34**	**0.25**	**Moderate**

It can be gleaned from table 3 that the mean scores of the seven areas vary from one operation to another. The benchwork, lathe, milling, drilling/boring and honing machine operations got Moderate rating. It is because all these equipment were found in the metal industry and the trainees really experienced how to operate the machines. However, since trainees were assigned from one machine to another for a short period of time, mastery and familiarization much still be given importance. The shaper operation and blueprint reading and machine designing obtained high level because trainees were more exposed in these particular areas. Student-trainees had already experienced the blueprint reading and machine designing while they were in the academe and more so when they were trained while having their exposure.

Generally, since the majority of the skills using all these equipment were found in the industry, trainees were trained on hands-on. More time allotment for every skill is still needed. Student-trainees obtained Moderate and High ratings after the industry exposure because: a) almost all the equipment, hand tools and all types of measuring devices are found in the metal industries; b) student-trainees spent more time on hands-on practice in the industries; c) all the industries gave them the opportunity to handle responsibilities; d) student-trainees got high sense of value for what they have learned, high competence in their ability to perform the task for which they were trained, and high levels of confidence in their ability to perform the trained skill. We have noticed also that the trend of development before and after the industry exposure is due to the effect of the industry immersion.

Table 4: Paired t-test on the Significance of the Difference between the Level of Development of Skills and Knowledge before and after the Industry Exposure.

	Knowledge and Skills	*Mean Before*	*Mean After*	*Computed t-value*	*df*	*Probability Level*
Pair 1	Benchwork Operations Pretest-posttest	1.5230	3.4356	-19.256*	26	.000
Pair 2	Lathe Machine Operation Pretest-posttest	1.7748	3.4933	-21.110*	26	.000
Pair 3	Shaper Machine Operation Pretest-posttest	1.5693	3.5789	-32.655*	26	.000
Pair 4	Milling Machine Operation Pretest-posttest	1.3222	2.9389	-26.873*	26	.000
Pair 5	Drilling/Boring Machine Operation Pretest-posttest	1.5526	3.4744	-29.207*	26	.000
Pair 6	Honing Machine Operation Pretest-posttest	1.4200	2.8122	-18.886*	26	.000
Pair 7	Blueprint Reading and Machine Designing Pretest-posttest	2.0367	3.6533	-19.929*	26	.000
Pair 8	Overall Pretest-posttest	2.1215	3.3407	-24.557*	26	.000

*significant at .05 level

Table 4 shows that Pairs 1-8 of knowledge and skill have negative computed t-values that are significant at a= .05. All the null hypotheses on the difference of the pretest and posttest mean scores in each of the eight pairs were rejected. This means that each skill and knowledge to be developed is significantly higher than their level of development before the industry exposure.

Table 5: Level of Development on Attitudes and Habits among Mechanical Engineering Students before the Industry Exposure

Attitudes and Habits	*Mean Score*	*SD*	*Verbal Description*
1. Punctuality and Attendance	3.99	0.39	High
2. Productivity	3.77	0.48	High
3. Compliance to 5S	2.63	1.16	Moderate
4. Behavior and Attitude Towards Work	4.48	0.31	High
Overall	**3.72**	**0.31**	**High**

Table 5 shows the result of the mean scores in 4 areas of attitudes and habits. Items on Punctuality and Attendance, Productivity, and Behavior and Attitude towards work got High level. This is because the students were already trained in school. Meanwhile, Compliance to 5S (Sort: Keeping and disposal of items, Systemize: Arrangement of necessary items, Self-Discipline: Spontaneity and initiative, sweep: Cleanliness in the workplace, and Sanitize: Maintenance and Housekeeping) obtained Moderate level because students were not given updates and lecture in this area. This could also be due to the non-inclusion of 5S in the course content of the subject.

Table 6: Level of Development on Attitudes and Habits among Mechanical Engineering Students after the Industry Exposure

Attitudes and Habits	*Mean Score*	*SD*	*Verbal Description*
1. Punctuality and Attendance	4.80	0.29	Very High
2. Productivity	4.58	0.39	Very High
3. Compliance to 5S	4.38	0.39	Very High
4. Behavior and Attitude Towards Work	4.91	0.2	Very High
Overall	**4.67**	**0.2**	**High**

Looking into the different areas after the industry exposure, all the areas obtained a Very High level. This means that trainees were more attentive and more mature during the actual operation. The rating of Very High in the overall operations means that all the areas were given more attention in the industry exposure.

Table 7: Paired t-test on the Significance of the Difference between the Level of Development on Attitudes and Habits after the Industry Exposure

	Knowledge and Skills	*Mean Before*	*Mean After*	*Computed t-value*	*df*	*Probability Level*
Pair 9	Punctuality and Attendance Pretest-posttest	3.9896	4.801	-11.622*	26	.000
Pair 10	Productivity Pretest-posttest	3.7730	4.5770	-9.516*	26	.000
Pair 11	Compliance to 5S Pretest-posttest	2.6307	4.3752	-9.092*	26	.000
Pair 12	Behavior and Attitude Towards Work Pretest-posttest	2.6307	4.3752	-9.092*	26	.000
Pair 13	Overall Pretest-posttest	3.77193	4.6678	-15.467*	26	.000

*significant at .05 level

It can be noted that all the computed t values on the areas on attitudes and habits are significant. Table 7 shows that Pair 9-13 has negative computed t- values that are significant at 8= .05. All the null hypotheses on the differences of the pretest and posttest mean scores in each of the four pairs were rejected. This implies that in each area on attitudes and habits to be developed after industry exposure is significantly higher than their level of development before the exposure.

4. Conclusions

1. The machine shop knowledge and skills among mechanical engineering students before the industry exposure were hardly developed in the academic institutions.
2. The levels of development on shop knowledge and skills among mechanical engineering students after the industry exposure increased in all areas.
3. The industry exposure has an impact in the development of a skills and knowledge and attitudes and habits among mechanical engineering students.
4. The student trainee's attitudes and habits were already formed in the academic institutions but were still improved especially in the area of compliance to 5S. The industry exposure still has an impact on their attitudes and habits.
5. The Level of development on attitudes and Habits among mechanical engineering students after the industry exposure also increase.
6. The impact of attitudes and habits of the student trainees was minimal because the same can be formed and learned in the academe. However, the level of their attitudes and habits were raised to the highest while they were in the industries.
7. Not all four academic institutions which were included in the study have the same number of hours in their Industry exposure or OJT. And not all four academic institutions offer Industry exposure or OJT as a requirement. However, regardless of number of hours, their knowledge and skills and attitudes and habits were still developed.

5. Recommendations

Taking the findings and conclusions into consideration, the following are recommended:

1. That the industry exposure or OJT must be continued among engineering schools in Davao City because the study found out that the industry exposure was able to improve the knowledge and skills of students and elevated their levels.
2. That the academic institutions should increase the number of hour's requirement of Industry Exposure Program. That the machine shop laboratory equipment in the academe should be upgraded.
3. That the academic institutions should strengthen the industry-exposure program to maximize the development of the skill, knowledge, attitudes and habits of mechanical engineering students and to implement the Faculty Return to Industry program for better immersion of faculty handling the course or subject.
4. That the way attitudes and habits are formed in the academic institutions be upheld. The culture of compliance to 5S and International Standardization for Organization or ISO be imbibed in the academic institutions and its inclusion in the syllabi must be considered.
5. That the skills other than machine shop skills being developed in the academe be also given attention to equip or prepare them for actual employment.
6. That the academic institutions should work hand in hand to make the Industry Exposure Program or on-the job training (OJT) be an effective tool in the development of knowledge, skills, attitudes and habits. That the academe should strengthen the linkage and collaboration between private agencies and government institutions (e.g. Mechanical Engineering Network (MEN), Philippine Society of Mechanical Engineers (PSME), Metalworking Industry Association of the Philippines (MIAP), Southern Mindanao Chamber of Metals Industries, Incorporated (SMCMII) , Technical Panel for Engineering, Architecture and Maritime Education (TPEAME), local government offices (GO) and non-government organizations (NGO), etc.) to assist the enhancement of industrial training.
7. That the industry exposure or on the-job training or OJT must be a requirement in the mechanical engineering curriculum to ensure the development of student-trainees' knowledge and skills and attitudes and habits. And that the academic institutions should improve the classroom instructions and delivery system and adopt curriculum development. Revisions of the mechanical engineering curricula must be always considered to answer the demands and needs of the industries.

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