

Licensure Examination Performance of Mechanical Engineering Graduates and Its Relationship with Academic Performance

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Abstract - *This study aims to investigate the Licensure Exam Performance of Mechanical Engineering graduates of one higher education institution in the Philippines from 2014-2018 and its relationship with academic performance. Descriptive type of research was utilized in the study with a total population of 30 examinees. Results showed that the examinees obtained a good rating result of licensure examination for mechanical engineers from 2014-2018 with an overall average of 81.33 percent. The graduates obtained a fair rating academic performance in Mathematics, Engineering Economics and Basic Engineering while just a passing rating for Machine Design and Industrial and Power Plant Engineering. Correlation exists between the Licensure Examination Performance result and the academic performance taken as a whole but not within per area or subject. The Final Grade of the graduates in Statics of Rigid Bodies is considered as the best predictor of the result of licensure exam performance in Mathematics, Engineering and Basic Engineering with 30.3 percent confidence on the strength of association. The Fuels and Heat Power as well as Combustion Engineering when combined the final grades are considered as best predictors of the result of Board Examination in Industrial and Power Plant Engineering with 44% confidence.*

Keywords: *Mechanical Engineering, Licensure Exam, Industrial and Power Plant, Machine Design*

INTRODUCTION

Continuous improvement should always be part of the culture of quality and excellence. Maintaining the status quo is not the name of the game for 21st century and in the midst of the fourth industrial revolution. Higher Education Institutions are in the forefront of innovations to strengthen the capacity and quality of the leaders and professionals from the products of convergence between academe and industry partnerships. Graduates of baccalaureate degree programs with board examinations are pressured after finishing four or more years in college to pass the licensure examination being administered by the Professional Regulation Commission in the Philippines.

The quality of instruction and training among students especially in engineering is very vital in maximizing the potential of the students and possibility of getting hired in national or multinational companies as licensed engineers to practice engineering profession. Feisel and Rosa [1] noted that engineering is a practical discipline and It is a hands-on profession where doing is key wherein, prior to the creation of engineering schools, engineering was taught in an apprenticeship program modeled in part after the British apprenticeship system.

Academic performance is one of the measures of student outcomes that determine how do the students learn from the instruction of any particular course. It is a significant issue in the university [2] and teachers as facilitators of science learning have a bigger share on the success of the teaching and learning process as they serve as the catalyst to transfer the knowledge and skills to the next generation of innovators [3]. How the students understand the subject and apply the principles into practices gives better comprehension of the intended learning outcomes. The student academic performances in the professional courses as well as in mathematics are considered important aspects that contribute to the result of the of their future undertaking especially the licensure examination.

Licensure Examination for Engineering programs is one way of measuring and ensuring the quality of engineers who would join the workforce of various manufacturing industries in the Philippines and abroad [4], [5]. Licensure examination to practice profession is a regulatory mechanism of a State [6]. The Professional Regulations Commission (PRC) has been consistently regulating the graduates from all board courses in granting the professional licenses to those graduate-examinees who will pass the board exam.

Determining the success factors involved in the licensure examination is the major concern of this study. Flores [7] mentioned that licensure examination performance provides an indication of the effectiveness of the curricular program to develop core competencies of students. This research intends to identify the best predictor of the possible results of the examination among the selected variables considered in the study. These variables include the computed average of Mathematics, Basic Engineering and ME Professional courses. Academic preparation of the students for board examination is a significant data that can be considered relevant as predictor of the result of the examination specifically the academic performance. Richardson, Abraham and Bond [8] noted that tertiary students' performance is usually expressed in terms of grade point average (GPA), that is, the mean of marks from weighted courses contributing to assessment of the final degree. This might be considered important factor in the success of the engineering graduates in taking licensure examination.

The results of this study will serve as a reference guide on how the graduate-examinees performed in the national board examination in comparison with their academic performance during college. It intends to produce an enhancement program in the curriculum and the delivery of instruction of the teachers in Mechanical Engineering based on the salient findings of this study.

The researchers hope to obtain an institutional passing rate which is consistent above national passing percentage or 100% to prove that LPU graduates really take the lead. The result of this study will be beneficial to the School Administrators especially to the College of Engineering for them to come up with implementing policies relative to the future licensure examinations of engineering graduates in terms of aligning and strengthening the Outcomes-Based curriculum to the board exam reviews. Faculty members will also be given substantial information regarding the performance of the students and their knowledge gained from general and professional courses with potential impact to the national board examination.

OBJECTIVES OF THE STUDY

This study aims to analyze the result of the Licensure Exam Performance of Mechanical Engineering graduates and its relationship to academic performance. Specifically, it aims to present the Board Examination Performance result of Mechanical Engineering graduates from 2014 – 2018; determine the academic achievement of the BSME examinees

with regards to their average academic performance in terms of Mathematics courses; basic engineering courses and ME Professional courses; test the significant relationship between Licensure Examination Performance results and the academic performance; determine which of the cited variables predicts the licensure examination performance of BSME examinees; and to propose an enhancement program relative to curriculum and instruction based from the findings of the study.

METHODS

The researcher utilized quantitative-descriptive method specifically co-relational research. Thirty (300) ME board examinees from 2014-2018 are the subjects of the study. Individual results of the licensure examination were taken from the Office of the College of Engineering that keeps the records from the PRC while the academic performance of the students were also taken from the same office as downloaded from the online records of the final grades. After obtaining all the needed data on the board examination and academic performance of the relevant courses, names of the examinees were deleted from the excel file as part of the data privacy implementation in the University. Mean, Pearson-product Moment Correlation, Analysis of Variance and Linear regression analysis are the statistical tools used for the study.

The given scale was used to interpret the academic performance of the mechanical engineering graduates from their scholastic records: 1.25-1.00: Outstanding; 1.75 - 1.26: Very Good; 2.25 - 1.76: Good; 2.75 - 2.26: Fair; 3.00 - 2.76: Passing; 3.01 - 5.00: Poor. The given grades were inversely coded for the purpose of correlation and testing of hypothesis as predictor. The given scale was used to interpret the result of the licensure examination for mechanical engineers: 96-100: Excellent; 91-95: Outstanding; 86-90: Very Good; 81-85: Good; 76-80: Fair; 75: Passing; Below 75: Failed.

RESULTS AND DISCUSSION

Table 1 presents the Licensure Examination Performance Results of Mechanical Engineering Examinees from 2014-2018. Results showed that the examinees obtained better results in the areas of mathematics, engineering economics and basic engineering with 83.70 than industrial and Power Plant engineering with 81.07 percent while they obtained the least mean score of 80.77 percent in Machine Design, Materials and Shop Practice.

Table 1. Licensure Examination Performance Results of Mechanical Engineering Examinees from 2014-2018 (N=30)

	2014	2015	2016	2017	2018	Mean	Remarks	Std. Deviation
Math, Engineering Economics and Basic Engineering	87.00	83.00	85.00	83.00	79.33	83.70	Good	6.27062
Machine Design, Materials and Shop Practice	89.67	78.13	83.40	76.83	78.00	80.77	Good	5.08333
Industrial and Powerplant Engineering	73.00	80.63	82.60	80.33	86.67	81.07	Good	5.13899
Overall Average	83.22	80.58	83.67	80.06	81.33	81.87	Good	3.46185

The finding can be attributed to the complexity of professional courses compared to basic engineering and mathematics subjects where most these courses were taken during early college years. Meanwhile, the professional courses like machine design, materials and shop practice require the students to produce outcomes as application of knowledge and theories into practice.

This finding is contrary to the result of Board Examination performance from 2006 to 2011 [4] where examinees from the same University under study obtained highest average score in Machine design (78.27%) subject seconded by Math subjects (76.94) while Power Plant Design (PPD)/ Industrial Plant Design (IPD) obtained the lowest rating of 73.03 percent.

Meanwhile, the batch of examinees with the better result of licensure exam came from 2016 with 83.67 percent followed by 2014 (83.22%) and 2018 (81.33%) while 2015 (80.58) and 2017 (80.06%) obtained the least overall average. The mean scores of the three subjects are considered good with standard deviation ranging between 5.08 and 6.27 where the scores are considered diverse.

From the result of study of Mohammed and Mohammed [5] in 2017 revealed that the performance comparison among the licensure examination results of the mechanical engineer candidates revealed that there is no significant difference among their performances in the four year period. This means that the performances of the mechanical engineer candidates were comparable per examination year. The average performance of the candidate engineers in the field of mechanical engineering is above the passing mark of 70 percent. This can be attributed to the low number of students enrolled in the program. Less than 20 students are in their fourth and fifth year. With the limited number of students, faculty members can coach the students properly in their respective specialized classes or major subjects

Academic Performance of Mechanical Engineering Examinees in Mathematics, Engineering Economics and Basic Engineering Courses

The examinees during their academic years in college obtained very good average rating in Physics (1.6523) followed by Chemistry (1.6769) when they took these courses during first and second year levels. Students were given background knowledge on the application of chemistry and physics in the practice of engineering profession.

These courses were followed by Analytic Geometry (1.8276), Plane and Spherical Trigonometry (1.8750) and College Algebra (2.0446) as top five (5) courses from Mathematics and Basic Engineering. These allied sciences are considered foundation courses for higher level of science and mathematics where the students learned the basics. This is also the year level where the students will be observed their study habits and their attitude towards engineering.

Meanwhile, they obtained good rating in Engineering Economics (2.3417) and majority of the Basic Engineering Courses obtained Fair rating in Statics of Rigid bodies (2.7667), Mechanics of Deformable Bodies (3.0000), Dynamics of Rigid bodies (3.0333) and Fluid Mechanics (3.0458). The overall average of 2.3967 implies that the graduates obtained Fair rating in the areas of mathematics, engineering economics and basic engineering. The students could not able to get high grades on these courses because they cannot really get at first the concept of the problem to be solved. They find it hard to analyze the situation of the problem as well as what appropriate formula they will use for specific given statement.

Mechanics of Deformable Bodies obtained a standard deviation of zero (0) because all final grades of the students is 3.00. It covers topics on kinematics, statics, and dynamics of deformable bodies; the vortex theory; as well as the theory of waves. This can be attributed according to the students due to heavy workloads, they cannot really concentrate on specific

course because they have to comply with requirements of all other subjects simultaneously. Choi, Grebsk and Dudeck [9] emphasized that the exposure of the mechanical engineering students to the application of different mathematical concepts adds another dimension to the body of knowledge that they are gaining in their math courses.

Academic Performance of Mechanical Engineering Examinees in Machine Design, Materials and Shop Practice

The graduates obtained Fair rating in Machine Shop Theory (2.5750) followed by Materials Engineering (2.5917) and Workshop Theory and Practice (2.6034). Meanwhile, they obtained almost passing rating in Thermodynamics 2 (2.9815) and considered poor rating in Machine Elements (3.0805) and Machine Design (3.1667). The academic performance of 2.8356 implies a passing mark which is considered a normal academic rating for engineering students. Most of the students believed that their grades are not true measure of their intellectual capacity and what they can actually do and perform as students because major examinations especially paper-pen exams only measure the knowledge which is only a small portion of the total ability to become future professional engineers. They also considered the elements and design aspects of machines as one of the hardest courses in the mechanical engineering program. Schilling Jr. [10] noted that the teaching of design skills to engineering students is paramount to their success as an engineering professional. Booth et al. [11] emphasized that engineering design projects are an important learning tool for first-year university students who are taking their first big step into the world of engineering. These projects provide a structured approach to the design process, giving students a solid understanding of how to move from a mere concept to a working model of a system.

Workshop theory and practice deals with the basic principles of machine shop practices and it includes workshop safety and organization; simple workshop measuring instruments, hand tools, fitting bench work, bench drill and bench grinder, sheet metal working; principles of welding processes, welding metallurgy, joining processes; testing and inspection of welds, foundry and metal casting. These workshop processes and practices are significant motor skills for mechanical engineering profession [12] where the students obtained fair academic performance rating.

Academic Performance of Mechanical Engineering Examinees in Industrial and Power Plant Engineering

The graduates obtained good rating in Power Plant Operation and Maintenance (2.2167) while Fair rating in Instrumentation and Control Engineering Lab (2.2667) and Lec (2.5086), Environmental Engineering (2.3793). They have academic passing rating in terms of Airconditioning and Ventilation System Lab (2.7667), Power Plant Engineering Lab (2.9000) and Lec (2.9667), Industrial Processes (2.9417), Fluid Machinery (2.9750) and Thermodynamics (2.9833). However, they obtained poor rating in Industrial Plant Engineering (3.0333), Aircon and Ventilation Systems Lec (3.0708), Fuels and Heat Power (3.0750), Combustion Engineering (3.0917), Heat and Mass Transfer (3.1208) and Refrigeration Systems (3.2125).

Those professional courses with higher than 3.00 final grades mean that the students obtained failing grades and repeated the subject twice. They have an overall average academic passing rate of 2.8634 which implies that the students are struggling to get better grades in the following courses where majority of the ratings are poor and almost passing.

Table 2. Relationship between Licensure Exam Performance and Academic Performance

Licensure Exam Performance and Academic Performance	r-value	p-value
Overall Average	0.438(*)	.016
Math, Engineering Economics and Basic Engineering	0.257	.171
Machine Design, Materials and Shop Practice	0.313	.093
Industrial and Powerplant Engineering	0.252	.178

*Significant at $p\text{-value} < 0.05$

Table 2 reveals the relationship between Licensure Exam Performance and Academic Performance. There is a significant relationship between the results of Licensure examination and the academic performance when taken as a whole as denoted by the computed r-value of 0.438 which implies moderate positive correlation and p-value of 0.016 which is less than 0.05 alpha level. This signifies that the higher the overall academic performance rating of the graduates, there is a possibility of obtaining higher results in board performance.

In which this study proves the importance of academic performance in the life of students under board degree programs. However, there is no significant relationship in the results of board

examination when correlated per subject area. This signifies that their performance in particular set of courses like Math, engineering economics and basic engineering does not provide absolute result for board performance which is the same with Machine design and Industrial and Power Plant Engineering.

Table 3. Relationship between the Board Examination Performance and Academic Performance in Math, Engineering Economics and Basic Engineering

	r-value	p-value
Engineering Economics	-0.156	.411
Advanced Engineering Mathematics for ME	-0.025	.896
Plane and Spherical Trigonometry	0.203	.301
Differential Calculus	0.086	.658
Differential Equations	0.403(*)	.046
College Algebra	0.265	.173
Advanced Algebra	0.220	.253
Solid Mensuration	0.454(*)	.015
Engineering Statistics and Probability	0.284	.128
Analytic Geometry	0.276	.147
Integral Calculus	0.303	.111
Fluid Mechanics	0.114	.548
Statics of Rigid Bodies	0.571(**)	.001
Dynamics of Rigid Bodies	-0.099	.601
Chemistry	0.148	.442
Physics	0.153	.429

**Significant at p-value<0.01; *Significant at p-value<0.05

Table 3 reveals the relationship between the Board Examination Performance and Academic Performance in Math, Engineering Economics and Basic Engineering. Results showed that the final grades of the graduates in Differential Equations, Solid Mensuration and Statics of Rigid Bodies are closely related to the result of their board examination in the areas of Math, EEco and Basic Engineering subject.

This signifies that those students with higher scores in Licensure Exam in Subject 2 which is composed of Math, Engineering Economics and Basic Engineering are also those students with higher grades in Differential Equations, Solid Mensuration and Statics of Rigid Bodies. This signifies that the final grades of the students can be considered as factors in determining their scores on this subject area of the licensure exam.

These subjects can also be considered as interrelated according to the study of Choi et al. [9], the authors noted that the most important subject among the solid part is statics. After introducing the concept and need of statics, the students will be exposed to the advance applications of mechanics of materials, design of

mechanical components, and material science. Motion part deals with dynamics, vibration, and controls of systems. Since these Basic Engineering and Math courses are considered significant, faculty members assigned to these courses will observe how the students perform in this subject to make the result of the future investigation on these courses more valid and reliable.

Other Basic Engineering and Math Courses have no significant relationship with the result of licensure examination which means that these students have diverse final grades on these courses without correlation.

Table 4. Correlation between the Board Examination Performance and Academic Performance in Machine Design, Materials and Shop Practice

	r-value	p-value
Machine Design	-.210	.266
Materials Engineering	-.151	.426
Workshop Theory and Practice	-.308	.104
Thermodynamics 2	.034	.865
Machine Elements	-.231	.219
Machine Shop Theory	-.189	.316
Machine Design	-.313	.093

*Significant at p-value<0.05

Table 4 presents the correlation between the Board Examination Performance and Academic Performance in Machine Design, Materials and Shop Practice which also reveals that no significant correlation exists between the result of board examination in this area and the academic performance of the graduates in the following courses: Machine Design, Materials Engineering, Workshop Theory and Practice, Thermodynamics, Machine Elements, Machine Shop Theory and Machine Design. The courses with the closest final grades and slight correlation are the Machine Design (r=3.13) and Workshop Theory and Practice (0.308) but not considered significant due to insufficient variation on the final grades of the students which sometimes fall within 3.00 and 2.75 only which cannot really determine the magnitude of their academic performance in the following courses.

Table 5 presents the relationship between the Board Examination Performance and Academic Performance in Industrial and Power Plant Engineering. Only the final grade in Fuels and Heat Power has significant positive correlation with the result of board examination in Industrial and Power Plant Engineering as denoted by the computed r-value of 0.562 which is considered with moderate correlation and p-value of .001 which is less than 0.01 alpha level.

Table 5. Relationship between the Board Examination Performance and Academic Performance in Industrial and Power Plant Engineering

	r-value	p-value
Industrial Processes	0.180	.341
Industrial Plant Engineering	0.055	.774
Power Plant Engineering Lab	0.151	.426
Power Plant Engineering Lec	0.110	.563
Fuels and Heat Power	0.562(**)	.001
Combustion Engineering	0.112	.557
Thermodynamics	0.235	.212
Heat and Mass Transfer	0.097	.611
Refrigeration Systems	-0.116	.541
Environmental Engineering	0.122	.528
Airconditioning & Ventilation Systems Lab	-0.167	.378
Airconditioning & Ventilation Systems Lec	0.054	.779
Fluid Machinery	0.062	.747
Power Plant Operation and Maintenance	-0.244	.194
Instrumentation & Control Engg Lab	-0.161	.395
Instrumentation & Control Engg Lec	-0.072	.709

**Significant at p-value<0.01; *Significant at p-value<0.05

This signifies that those students with higher result of licensure examination in Industrial and Power Plant Engineering are also those students with higher academic performance in the Fuels and Heat Power. This relationship can also be attributed to the behavior of the data. Even though, the students had a Poor performance rating on this course but it has the highest standard deviation of 0.60226, which signifies with the largest dispersion of grades compared to other professional courses. This has the closest scores similar to the result of licensure examination on this subject area.

Table 6. Determinant of Mathematics, Engineering Economics and Basic Engineering (Model Summary)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Static	.550(a)	.303	.271	4.97170

a Predictors: (Constant), Static; F-value = 99.556; p-value = 0.005

Considering the academic performance of the graduates under Mathematics, Engineering Economics and Basic Engineering, only the final grade in Statics of Rigid bodies is considered determinant of the score

in Licensure Examination in the Subject 1 with 30.3 percent confidence on the strength of association. According to the CMO 97 series of 2017, Policies, Standards and Guidelines [12] for BS Mechanical Engineering that this course deals with the forces acting on non-moving bodies. It covers concurrent and non-concurrent forces, operation with the free body concepts, equilibrium and coplanar systems, friction forces, centroids and moments of inertia. This subject is considered foundation courses of engineering that will be applied in various fields of engineering.

$$Y = 110.90 + (-9.741)(\text{Final Grade in Statics of Rigid Bodies})$$

The result of licensure examination in Subject 01 (Y) for Mathematics, Engineering Economics and Basic Engineering is explained by the given regression when taken into consideration the final grade in Statics of Rigid Bodies.

Table 7. Determinant of Industrial and Power Plant Engineering Subject in the Licensure Examination (Model Summary)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Fuels & Heat Power (a)	.584	.341	.315	4.37901
Fuels Heat & Combustion Engineering (b)	.664	.440	.395	4.11446

a Predictors: (Constant), Fuels_Heat; f-value=13.430; p-value=.001

b Predictors: (Constant), Fuels_Heat, Comb_Engg; f-value=9.832; p-value =.001

$$Y = 117.374 + (-6.404)(\text{Final Grade in Fuels \& Heat}) + (-5.463)(\text{Final Grade in Comb_Engg})$$

The model summary reveals the information on the professional courses as predictors of the results in Subject 3 for Industrial and Power Plant Engineering when combined the final grades in Fuels and Heat Power and Combustion Engineering with 44.0 percent confidence on the strength of association.

The result of licensure examination in Subject 03 (Y) for Industrial and Power Plant Engineering can be explained by the given regression when taken into consideration the combined final grades in Fuels and Heat Power and Combustion Engineering. Some of the

mechanical engineering students obtained failing grades on these subjects and retake the course to obtain passing mark. The High standard deviation on these professional courses contributed to become determinants on the result of licensure examination in Subject 03.

Table 8. Determinant of the Overall Average Result of Licensure Examination (Model Summary)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Math	.494	.244	.217	3.06344
	(a)			

a Predictors: (Constant), Math Average; f -value = 9.034; p -value=.006

$$Y = 99.711 + (-7.443) (\text{Math Average})$$

The model summary reveals the information on the subject area as predictor of the overall average result of the Licensure Examination when considered the overall average on each academic performance with 24.4 percent confidence on Mathematics, Engineering Economy and Basic Engineering and regarded as low in terms of its strength of association.

It is crucial to stress the importance of studying math by showing the use of math skills currently used in Engineering Technology and how they are applied. If students can appreciate why they learn math and how they apply the math skills to solve engineering-oriented problems, it can increase their motivation and desire to study math while deepening their mathematical comprehension [9].

The result of licensure examination (Y) can be explained by the given regression when taken into consideration the overall academic performance of the students in Mathematics.

CONCLUSION

The examinees obtained a good rating result of licensure examination for mechanical engineers from 2014-2018 with an overall average of 81.33 percent. The graduates obtained a fair rating academic performance in Mathematics, Engineering Economics and Basic Engineering while just a passing rate for Machine Design and IPD/PPD. Correlation exists between the Board Examination Performance result and the academic performance taken as a whole/overall but not within per area or subject. The Final Grade of the graduates in Statics of Rigid Bodies is considered as the determinant of the result of board performance in Mathematics, Engineering and Basic Engineering with

30.3 percent confidence on the strength of association. The Fuels and Heat Power as well as Combustion Engineering when combined the final grades are considered as determinant of the result of Licensure Examination in Industrial and Power Plant Engineering with 44 percent strength of association. The Average Academic Performance in Mathematics, Engineering Economy and Basic Engineering is considered determinant of the Overall Result of the Licensure Examination for Mechanical Engineers with 24.4 percent confidence on the strength of association though considered low.

RECOMMENDATION

The College of Engineering may continue to strengthen the selection and retention policy to screen the students who have the capability academically and emotionally to pursue and finish the BS Mechanical Engineering program. The Faculty members may prepare major examinations similar to the nature of licensure examination most especially to the professional courses and mathematics courses starting in the first year level. The University may develop programs to strengthen the self-discipline, confidence and study habits of the students through co-curricular activities from recognized student organizations and during college days. The University may facilitate discussion on sharing of best practices of colleges with licensure examination. The College of Engineering may prepare an action plan on how to improve the academic performance of the students gearing towards higher performance rating with board notcher. The study is limited to 30 examinees from only one private university in the Philippines and the result cannot be generalized to the wider population and the variable included is limited to academic performance. Future studies may consider in examining the relevance of entrance examination and other intelligence and psychological test results of the students as well as the academic attitude and behavior in the result of their licensure examination.

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