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FACTORS AFFECTING THE QUALITY OF DOCTORAL THESSES

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Abstract

An investigation of the quality of twenty-five doctoral theses in M.I.T.'s Metallurgy Department. Quality evaluations of the theses by the department's professors were related to the responses of the students (now alumni) on a questionnaire. A strong correlation is found between high quality doctoral research and the single fact that the student had carried out a Masters thesis in Metallurgy at M.I.T. In addition, the better theses are written by students who settle early on a thesis topic after exploration of only a few topics, and by those who take doctoral exams earlier and spend fewer years in graduate school. There is no relation between thesis performance and total college grades and only a weak relation with grades in graduate metallurgy courses.
Every year American universities award Ph.D. degrees to more than 10,000 men and women in the sciences and engineering. Each doctoral candidate submits a thesis "in partial fulfillment of the requirements ...." Some theses are superior in quality to others. The factors which contribute to high quality doctoral dissertations are the subject of many myths, much debate, and no systematic investigation. Some educators argue that the thesis should be a test of independent scholarly contribution; others, that it should be guided practice in preparation for a career involving scholarly research. Some argue that the value of a thesis is a linear function of its length in double-spaced pages; others believe that a thesis should be in a form suitable for publication as an article or book. Most university catalogs imply that study for the Ph.D. degree is expected to require four years; several surveys indicate that it occupies an average of 5 to 10 years in different areas. (Note that half of the students exceed the average.) During this period the student is maintained in a continuous state of desperate anxiety and dependency -- an experience presumed to prepare him for a career of independent creative achievement.

But what are the facts? The study reported here investigates a number of factors potentially related to the quality of 25 doctoral theses accepted in the M.I.T. Metallurgy Department during 1965 and 1966.

**RESEARCH METHODS**

**Faculty Ratings of Thesis Quality**

Questionnaire responses were requested from faculty experts in the field who were familiar with each thesis. The respondent was asked to rate the thesis in comparison to other theses on (1) originality and creativeness, (2) thoroughness and accuracy, (3) degree of advance in the state of the art, (4)
value to future research work at M.I.T., and (5) overall excellence. Questionnaires were sent to all faculty members in the Department, who were asked to complete as many as they felt qualified to evaluate. There were four ratings of one thesis, three of two theses, two of nine theses, and one of each of the 19 remaining theses. Comparison of the multiple ratings showed that the faculty were consistent in their opinion of the thesis quality, or no more than one point different on a scale of seven.

The ratings of theses on the five scales were highly intercorrelated, and the rating of overall excellence is used in most of the analyses.

**Student Questionnaire**

A questionnaire was sent to graduates to obtain information on variables potentially affecting quality of theses. Questions were included to cover:
(1) time spent and types of employment before graduate school, (2) type of support in school, (3) length of time in graduate study, (4) length of time in school before taking doctoral exams, (5) marital and family status, (6) time spent on the thesis, (7) time spent in other school work, (8) number of thesis topics explored, (9) sources of ideas and guidelines for the thesis, (10) time spent in consultation with the adviser, (11) student opinion of laboratory facilities, (12) student enjoyment in working with his adviser, (13) and time spent on construction of any apparatus used in the work.

**Student and Laboratory Data Sources**

Student personnel records supplied data on (1) time in graduate school, (2) location of undergraduate schooling, (3) whether or not an S.M. thesis was completed and the grade obtained, (4) number of hours of course work in and out of the Metallurgy Department, (5) cumulative grade average for all courses.
and individual course grades, and (6) time spent completing various degree requirements (i.e., exams and languages).

Information on the several laboratories and staff members of the Department was obtained from the M.I.T. General Catalogue, the directories of the Center for Materials Science, and the Industrial Liaison Office Directory of Current Research, and included: (1) size and staff of laboratories, (2) areas of research interest of faculty, (3) number of research contracts, (4) status of faculty members, (5) teaching responsibilities, (6) number of publications of the laboratories, (7) number of degrees granted in each laboratory, and (8) number of technicians and assistants in each laboratory.

Sample Size and Analysis

The potential sample size was 67, the number of doctoral degrees awarded by the Department in the years 1965 and 1966. Forty-eight of the 67 students returned questionnaires. Faculty responses covered 31 of the 67 students. The final sample size is 25; these had both faculty rating(s) and student questionnaire returns.

RESULTS

One of the most interesting findings of this study is that students whose theses received the highest ratings on all five scales were more likely to have done a Masters thesis at M.I.T., and to have done a superior job on it (Table I). Although it seems reasonable to assume the Masters thesis would provide excellent training and background for doctoral thesis research, these results show the most substantial relationship of any variable in the study. Of the 14 who did not write an S.M. thesis at M.I.T., six did S.M. theses elsewhere, but doctoral quality ratings on the six were as poor as the remaining eight who did no
Table I

Number of Students with Theses Rated on Overall Excellence

<table>
<thead>
<tr>
<th></th>
<th>1 High</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6 Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carried out an S.M. Thesis</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1*</td>
</tr>
<tr>
<td>at M.I.T.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not carry out an S.M.</td>
<td>1**</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>thesis at M.I.T.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Received a grade of "B" on his S.M. thesis, all others received "A".

**Received a grade of "A" on his S.M. thesis at Carnegie Tech.

S.M. thesis anywhere. From these results, it would appear that for superior doctoral research there is a definite need for previous thesis research work by the student at M.I.T.

Students whose theses were rated higher were more likely to be married at the time they finished their graduate work, but no significant correlations were found either with having children when in school, or with getting married while in school.

Significant correlations are found between higher thesis quality and fewer thesis topics attempted before settling on the final topic. Moreover, the greater the number of topics which were investigated before finding the final topic, the poorer were the student grades in Metallurgy coursework, the less the student liked working with his adviser, the more experimentally oriented was the thesis, and the less was the time spent on the final topic. Of special interest is that students who did not carry out a Masters thesis at M.I.T. considered more topics before finally settling on a doctoral thesis topic, but they
did not spend more years in graduate school; in fact, they spent even less than average time in graduate school.

Grades and Thesis Quality

Student grades show surprising relationships to thesis quality ratings. Overall cumulative course grade averages show no correlation with any of the thesis quality ratings. However, when grade averages for Metallurgy courses are separated from grade averages for non-Metallurgy courses, some relations appear. Better grades in Metallurgy courses correlate moderately particularly with better originality and with better overall thesis performance. But grades in non-Metallurgy courses are correlated in the reverse direction; the poorer the grades the higher the rating on thoroughness, advance in the state of the art, and overall quality of the thesis research. It may perhaps be that better students tend to take the more difficult non-department courses that other Metallurgy students are not willing to risk taking. In any case, the correlation of grades with thesis quality is very weak for all ratings.

The overall grade averages, and the Metallurgy course averages, do correlate with years spent in graduate school before taking the doctoral exams. The better the grades, the sooner were the exams (particularly the second exam) passed. Also interesting to note in Table III is the correlation of grades with the amount of time spent in consultation with the adviser concerning the thesis. Poorer grades correlate with greater consulting time.

The number of years spent before taking doctoral exams shows a similar trend. The sooner the first exam was taken, and the sooner the second exam was taken, the better is the thesis. The greater the total years in graduate school also relates to poorer thesis quality.
Thesis quality is also related to the enjoyment reported by the students in working with their adviser.

Laboratory Variables and Thesis Quality

No laboratory variables studied show any correlation with thesis quality. Variables were size of laboratory staff, number of contracts, research areas, number of publications from the laboratory, number of degrees granted, number of technicians in the laboratory, and teaching load of the faculty members. However, there are very great differences in the quality ratings of theses from various laboratories. In laboratories where several students were in the sample, they tended to have similar ratings. This seems to indicate a thesis process that is adviser-dependent, but dependent on some personal characteristics, and not on the measured laboratory variables.

CONCLUSIONS

The quality of twenty-five doctoral theses in Metallurgy was evaluated on five dimensions, by from one to four professors who were thoroughly familiar with the research reported. The five dimensions were highly intercorrelated with the rating of overall thesis quality.

Questionnaire responses were obtained by mail from the same twenty-five graduates. Questions dealt with all aspects of the students' background, from time spent on the thesis to enjoyment in working with the adviser.

The most important finding was that higher quality doctoral research was performed by students who had done an S.M. thesis in Metallurgy at M.I.T. Apparently, for high quality doctoral research, there is a definite need for previous thesis research work.
Higher quality doctoral research is also performed by students who investigate fewer topics before settling on a final topic. With less searching about for a topic, and having done a Masters thesis, the student's experience provides the combination necessary to choose a valid thesis topic with the least topic exploration. In addition, higher thesis quality is achieved by students who take doctoral exams earlier and spend fewer years in graduate school.

No relation is found between thesis quality and the total cumulative grade point average. The lack of correlation is the resultant of a weak positive correlation with grades in non-Metallurgy graduate courses.
Table II

List of variables whose intercorrelations are presented in Table III

1. Professors' rating of the thesis on originality and creativeness
2. Professors' rating of the thesis on thoroughness and accuracy
3. Professors' rating of the thesis on "degree of advance in the state of the art"
4. Professors' rating of the thesis on its value for future research work at MIT
5. Professors' rating of the overall excellence of the thesis
6. Student cumulative graduate course grade average
7. Student Masters thesis rating (grade if a thesis was written)
8. Student grades in Metallurgy graduate courses
9. Student grades in non-Metallurgy graduate courses
10. Number of years spent in graduate school
11. Number of years spent on final thesis topic
12. Number of hours spent on final thesis topic
13. Experimental orientation of doctoral thesis
14. Student's reported enjoyment in working with adviser
15. Years in graduate school before passing first doctoral exam
16. Years in graduate school before passing second doctoral exam
17. Student undergraduate school (MIT or non-MIT)
18. Number of years of related work experience before entering doctoral program
19. Number of jobs held during the previous work experience
20. Number of thesis topics investigated during the doctoral research process
21. Percentage of time spent on theoretical work for final thesis topic
22. Student evaluation of the quality of the laboratory facilities
23. Hours spent in constructing equipment
24. Hours spent in consultation with adviser concerning the thesis
25. Married or unmarried when student left graduate school
26. Number of children born while in graduate school
27. Did student marry while in graduate school
28. Number of course hours taken in graduate school
29. Number of course hours taken in the Department of Metallurgy in graduate school
Table III

Intercorrelation of all Variables Listed in Table II
(Kendall-Tau Corrected Values)