# Work sampling of university academics in STEM departments with and without a graduate programme

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ABSTRACT: As part of planning for the addition of a mechanical engineering graduate programme, the current time allocation used for engineering academics was compared to that used for academics in biology, which has an established graduate programme. A work sampling study was conducted over 23 consecutive weeks, covering portions of two semesters. Results showed some field-specific differences, yet the per cent time devoted to teaching, research and service were similar between departments. The results obtained further indicated that each academic in engineering would need to dedicate an additional 12.5 per cent to their current effort to accommodate graduate students, which would necessitate the addition of one position to the department. This study demonstrates the utility of work sampling studies in providing valuable information that can inform programme development decisions.

## INTRODUCTION

Academics at institutions of higher education are charged with simultaneously balancing the three fundamental functions of academia: a) teaching; b) scholarship in the form of research and other creative activities; and c) service to the community, university and discipline. Determination of the overall value of an academic - how well an individual performs the three functions above - is traditionally assessed in several ways. Personnel evaluation reports, whether produced through self-evaluation or performed by a supervisor, are often used to improve performance and may direct resource allocation [1]. Tenure and promotion portfolios, which document the cumulative contributions of teaching, research and service, are very important in the career of most academics. Student evaluations, which use a standardised instructor evaluation form, are commonly used to assess instructional performance and to provide a means of addressing instructor accountability [2].

In some instances, knowing how much time is spent in each function is more informative than what was done. Workload surveys, an important industrial tool for quantifying workplace efficiency, can be used to provide this information. These include traditional time studies, which make direct observations using a stopwatch to help subdivide a job into observable components and work sampling, which measures a random portion of a work activity, and is more suitable to non-repetitive tasks [3][4]. Work sampling has been used to analyse work effort/efficiency in health care settings [5][6] and in university libraries [7]. Work sampling has been demonstrated to have several advantages over assigning a dedicated individual to track time allocation. In this study, the participating individuals are self-reporting and, therefore, the mechanics of the study are less time- and manpower-intensive. Ultimately, the data provide significant insight into where university academics spend their time [4][8]. The latter information can directly inform departmental decisions, such as regarding the potential expansion of programmes.

In this study, two academics from a department of mechanical engineering and two academics from a department of biology investigated their usage of time in their respective disciplines. The McCoy School of Engineering is considering expansion of their programme to include an MSc degree. Among the questions that arose from consideration of adding a graduate programme to mechanical engineering included: What extra activities are associated with addition of graduate students to a programme? How will the addition of a graduate programme affect the time academics devote to each of their responsibilities? Will the addition of a graduate programme require the hiring of additional academics to maintain current and future teaching effort? The purpose of this study was to see what differences exist in academic staff effort when comparing a programme that offers a BSc alone (mechanical engineering) with one that offers both BSc and MSc degrees (biology). Thorough documentation of the typical daily duties of engineering academics, juxtaposed with those of biology academics, will illuminate from where time and resources must be supplied and/or diverted to develop and implement a feasible and robust MSc in mechanical engineering.

## METHODOLOGY

The participants in this study are the authors of this article, and members of the faculty at Midwestern State University, a regional state university of approximately 6,000 students located in north central Texas, United States. Academic semesters at Midwestern State University include typical 15-week fall and spring terms. The study ran from 2 November 2011 to 10 April 2012, allowing for portions of both fall and spring semesters to be included. This is important, because the teaching schedules for the consecutive terms were quite different for the academics, and using portions of two semesters yields a more meaningful representative sample of typical duties than would data collected during a single semester. Weekends were included in the study, but Thanksgiving, Christmas and New Year's Day were not. The methods follow two previous studies [4][8], and are adapted from Jacobs et al [9].

The study included five major categories of effort, each with several subcategories. The major categories were: a) teaching related activities; b) research activities; c) service; d) personal time; and e) other. Personal time includes both physically at and outside of the university. It was decided that the *other* category would include only commuting to and from the university and attending professional conferences (including travel time).

A table from Jacobs et al [9] was used to determine the required number of observations with a 95 per cent confidence level and an absolute error of ± 2.5 per cent. It was determined from this table that the academics would require an average of 1,536 observations each. The study was planned for an actual 158 days of observations, so it was, therefore, decided to use 10 observations per day for each of the four academics.

Specific sampling times were determined using a random number generator to provide 10 unique numbers in the range of 420 to 1,200. This range represents minutes after midnight and corresponds to the inclusive hours of the survey (7:00 am to 8:00 pm). None of the participants had a class scheduled later than 7:00 pm during the period of the study. Any university related work occurring outside of these times was not included in the study. Each participant was presented with a spreadsheet of their sampling times before each day began, but were asked to proceed with each day, while not allowing the study to influence their activities. The activity being performed for each sample time was logged as soon as feasible to the actual time to prevent having to rely on memory.

## RESULTS

A total of 1,580 observations by each participant were made during the duration of the study. Table 1 shows that teaching (18.8 per cent to 52.5 per cent; a range of 33.7 per cent) and research (2.6 per cent to 26.5 per cent; a range of 23.9 per cent) efforts show a large variation among the participants. The service effort is more uniform (6.5 per cent to 9.1 per cent; a range of 2.6 per cent), while the personal time (34.6 per cent to 51.1 per cent; a range of 16.5 per cent) and *other* categories (1.3 per cent to 5.1 per cent; a range of 3.8 per cent) have moderate variation.

Table 1: Percentage of overall duty allocation for two mechanical engineering (MENG) and two biology (BIOL) university academics (Data from 1,580 observations per individual).

| | MENG #1 | MENG #2 | MENG AVG | BIOL #1 | BIOL #2 | BIOL AVG | Overall Average |
|---|---|---|---|---|---|---|---|
| Teaching | 18.8 | 52.5 | 35.6 | 28.8 | 41.6 | 35.2 | 35.4 |
| Research | 26.5 | 2.6 | 14.5 | 9.6 | 7.2 | 8.4 | 11.5 |
| Service | 6.5 | 9.1 | 7.8 | 8.4 | 8.3 | 8.4 | 8.1 |
| Personal | 44.4 | 34.6 | 39.5 | 51.1 | 37.9 | 44.5 | 42.0 |
| Other | 3.9 | 1.3 | 2.6 | 2.1 | 5.1 | 3.6 | 3.1 |

An important aspect of this study was to examine differences in the biology graduate programme compared to the undergraduate programme. Table 2 breaks down the three major duties to the per cent of overall effort dedicated to each duty for the BIOL programme. Biology academics dedicate a large proportion (45 per cent) of their research efforts to their graduate programme, while graduate teaching and service are less than 10 per cent. When the overall effort is analysed, biology academics dedicate 12.5 per cent of their time to graduate programme activities vs. 87.5 per cent to the undergraduate programme.

Table 2: Comparison of undergraduate vs. graduate duties for biology university academics.

| | Undergraduate | Graduate | % Graduate |
|---|---|---|---|
| Teaching | 32.7 | 2.5 | 7.1 |
| Research | 4.6 | 3.8 | 45.2 |
| Service | 8.0 | 0.4 | 4.8 |

All sampling categories were broken down into subcategories among the participants for their undergraduate duties (not shown in any table). Of the teaching duties, the most time was spent on lecture preparation (an overall average of 12.7 per cent), with substantial variation seen among the participants (4.6 to 25.2 per cent; a range of 20.6 per cent). The time spent lecturing in class was the next highest, with an overall average of 6.6 per cent. Grading of course material (5.2 per cent), laboratory preparation (2.9 per cent), and laboratory supervision (2.7 per cent) were other subcategories with fairly high effort. From the graduate programme analysis (biology only), supervision of graduate students was the highest subcategory with an average of 1.6 per cent, while assisting with degree plans was next at 0.4 per cent. Lecturing in graduate courses was an average of 0.2 per cent.

The greatest amount of research effort represented active basic research, with a large variation once again seen among the academics (0.1 to 26.3 per cent; a range of 26.2 per cent) with an overall average of 8.4 per cent. Active research involving undergraduate students was the other subcategory with instances reported by all participants. BIOL #1 reported 19 instances of active research with undergraduate and high school students, representing 1.2 per cent of their overall effort. The results from the breakdown of graduate research effort for the biology academics reveal that research with graduate students was the highest subcategory with an average of 2.3 per cent, while active basic research on graduate projects was next at 0.8 per cent.

Of the service related duties, the most time was spent on service to the university (an overall average of 5.3 per cent), with a more uniform distribution (2.5 to 7.8 per cent; a range of 5.3 per cent). This was followed by service to the community (0.8 per cent) and service to the profession (0.13 per cent). The major components of graduate service effort for the participants from the Department of Biology included academic service to the University involving graduate projects (0.1 per cent), and academic and graduate student service to the University (0.2 per cent). The breakdown of personal time among the participants show that personal time spent away from the University had a fairly close range of 34.2 per cent to 42.3 per cent and an overall average of 37.7 per cent, with personal time spent physically at the University more variable (range = 0.4 to 9.0 per cent; average = 4.4 per cent). In the *other* activities category, commuting to/from the University saw an overall average of 1.5 per cent, while travel to/from professional conferences has an average of 1.6 per cent (data not shown).

## DISCUSSION

Workload surveys have been used extensively in industry to evaluate work effort and time allocation [10]. In academic settings, work sampling studies have been used to compare time allocation differences across institution types [11][12], and by personal attributes, such as race and gender [13][14].

This study differed from many of these in two respects. First, the authors utilised a self-reporting method where each participant recorded their activities at randomly selected times throughout each day of the study period. Yuker [10] describes two similar studies by Ritchey [15] and Lorents [16]. In the Ritchey study, participants were personally contacted by phone. In the Lorents study, an electronic device was programmed to beep at random times, which signalled a data collection point. A similar device was used in the study of librarian time allocation carried out by Divilbiss and Self [7]. The authors felt that such devices would be disruptive in the classroom and other situations and decided against their use. One alternative to self-reporting is observational data collection by a third-party. Colbeck compared time allocation differences between two departments, English and Physics, within one institution [17]. In this study, the researcher observed participants and recorded, which activities were being performed.

The second way in which this study differed from others was the continuous collection of data over the majority of two semesters and the inclusion of *after hours*, weekend and intersession time. Work sampling studies in clinical settings have included greater portions of the day, but over a shorter overall period of time. The study conducted by Williams et al recorded data from 6:00 am to 11:55 pm over a period of two weeks [6]. The study of library time allocation by Divilbiss and Self collected data only during a standard nine-hour workday [7].

In some studies, times outside of regular hours were sampled [7]. Ritchey selected 20 days outside of regular school days and had the participants report on their activities [15]. Colbeck observed each study participant for five non-consecutive work days scattered throughout more than one term [17]. Each participant was also interviewed and asked to report on activities outside of regular working hours and off-campus. With this study, the authors decided to incorporate continuous data collection over the majority of each day during the study period. Although the authors anticipated inclusion of a greater percentage of non-academic activity, this design would allow one to capture those activities, such as grading and class preparation that they knew anecdotally and personally are performed outside of the standard academic class day.

Despite these differences in study design, and despite the small sample size, these results were comparable to previous studies. The average time dedicated to teaching duties for all four academics in this study was 35.4 per cent (Table 1). This is comparable to a survey of physics professors from Cosmopolitan State, a pseudonymous public Master's level university, which scored teaching-only duties at 38.0 per cent [1][17]. Both are slightly higher than the 31.7 per cent

reported by Link et al [14]; however, that study focused specifically on an extensive doctoral/research university. All are lower than the 57 per cent teaching only effort at comprehensive universities reported by Allen [18] and the 57.9 per cent reported by Bellas and Toutkoushian [13]. Since this analysis used data from the National Study of Postsecondary Faculty, this may, in part, be explained by differences in study design. The lower numbers in teaching and in research in this study, described below, are a reflection of the inclusion of weekends and intersession weeks in the study. This conclusion is supported in that MENG #2 was involved in two previous work sampling studies, including one during a fall semester where 74.3 per cent of time was spent on teaching duties [8], compared to 52.5 per cent in the current study (Table 1).

The average effort of 11.5 per cent for active research is comparable to results from the broad surveys of Allen [18], and Bellas and Toutkoushian [13], which showed time in research at 14 per cent and 15.5 per cent, respectively. Link et al reported a research effort of 35.7 per cent [14]. This higher per cent effort would be expected at an extensive doctoral institution with its greater emphasis on research. Somewhat unexpectedly, Colbeck [1][17] reported 26.2 per cent research effort in the Physics Department at Cosmopolitan State. This may reflect some difference in study design or a discipline-specific difference.

One additional explanation between this research effort results and those of Colbeck may be in the per cent service effort. Table 1 shows that an average of 8.1 per cent of total effort was spent on service activities. The physics academics at Cosmopolitan State spent 2.9 per cent of their time in service-only activities [1][17]. The present results are more comparable to the time in service of 6.3 per cent from the 1993 survey [13]. Allen [18] and Link et al [14] reported service as 20 per cent and 24.4 per cent, respectively. It is more difficult to make a 1:1 comparison with these studies; however, because of differences in the specific categories defined by these authors.

In addition to these comparisons with previous studies, the authors were able to make some general observations based on the obtained results. Although there is variability between academics within a department and between individuals across both departments, the average time allocation when comparing the two departments is very similar (Table 1). When personal time and other activities are not considered (teaching, research and service only), academics in this study are spending approximately two-thirds of their time teaching (data not shown). Research follows at around 20 per cent, with service at around 15 per cent. This is indicative of a small public liberal arts university, such as Midwestern State University, which has an emphasis on teaching, but where research and service are required for promotion and tenure.

Looking at specific activities, both disciplines spent a near identical percentage of their effort on teaching duties (Table 1). Research was higher for MENG than BIOL (14.6 per cent to 8.4 per cent). This directly results from the research effort of MENG #1, but also may result from differences in the way research is performed by academics from the two fields. Outside of literature searches, data analysis and manuscript preparation, biological research is constrained by being carried out in the laboratory or in the field. Furthermore, experiments often require extensive blocks of time for set up and execution and, thus, are more susceptible to interruption by class time, committee work and meetings with students. In contrast, although some engineering research efforts require laboratory facilities for testing, much of their research is mathematical and theoretical in nature. In these cases, it is clear that the time devoted to research by the engineers may be higher due to the convenience of needing only computer hardware and software to perform the research.

More generally, the results demonstrate that academics at Midwestern State University, as with most academics and other professionals, greatly exceed the standard US 40 hour workweek. The 13 hour daily data collection period gives 91 hours per week included in the study. Of these 91 hours, 58 per cent is devoted to academic-related activities. This results in a 52.8 hour workweek, which is what has been reported in the national surveys performed in the US. The results obtained by the authors, thus, provide empirical support for the workload estimates that make up these surveys. Furthermore, when the weekends-only data were analysed (data not shown), personal time was an average of 74.1 per cent for the three academics investigated. Thus, academics spend about 26 per cent of their weekend time occupied with university-related activities.

The primary goal of this study was to determine how much time biology academics spend on the graduate programme as compared to the undergraduate programme. The McCoy School of Engineering is currently contemplating adding a graduate programme and the results of this study will suggest if it is feasible to do so with the current number of academics in the Department. Table 2 shows that, during the course of the study, approximately 7 per cent of BIOL teaching effort, 45 per cent of research effort and 5 per cent of service time was spent on the graduate programme.

The relative time allocated to graduate level teaching was due, in part, to the specific study timeframe and the low number of graduate-only courses offered in the Biology Department at this University. During the duration of this study, a single one-hour course was taught by BIOL #1 during the fall semester (with BIOL #2 sitting in on this course), and neither BIOL #1 nor BIOL #2 taught graduate courses in the spring. Graduate teaching workload, with respect to both number of courses and course-hours per class, vary from year-to-year. Certainly, during semesters when a 3 or

4-hour graduate course is taught, the numbers for teaching duties would be higher. However, in keeping with Midwestern State University's mission as a primarily undergraduate institution, graduate teaching effort will continue to be much smaller, proportionally, than undergraduate teaching effort.

Both biology academics were guiding multiple graduate students toward their MSc degree during the duration of the sampling study. As a result, nearly half of the research effort was spent on the graduate programme. The fundamental reason to compare MENG #1 with both biology academics was a function of research effort. For the two biology academics, research effort with graduate students was 45.2 per cent of their total research activities. For MENG #1, 32.5 per cent of all time allocated to research activities was, by definition, in the absence of interaction with graduate students. Therefore, a significant point is that, if the biology academics are used as indicators, it is reasonable to assume that a graduate programme will greatly affect the research trajectory of MENG #1. At a primarily undergraduate institution with several active undergraduate research programmes, this presents a potential dilemma for academics and administration. Constraints that may limit resources (time, talent, available development funds) may force choices by academics and the students with which they collaborate on research endeavours.

Overall, 12.5 per cent of the effort for the academics in biology was spent on the graduate programme. It can be inferred that MENG must be able to cover an approximate 12.5 per cent increase in effort required by the addition of a graduate programme. This aspect should be intently studied to determine the effects of extra load, given that undergraduate enrolment and class size have been increasing in the McCoy School of Engineering. The authors conclude that at least one additional department member would be needed by MENG to provide the time for current engineering academics to work with their graduate students. In addition to working with graduate students directly in teaching and research mentoring, addition of a graduate programme will require the engineering academics to supervise graduate teaching assistants. While only 1.6 per cent of the overall effort for the biology academics, supervision of graduate students was the highest subcategory (50 instances during the sampling period), which represents approximately 4.8 per cent of all teaching effort and 26.1 per cent of all graduate duties.

## CONCLUSIONS

Academic work at institutions of higher education involves a complicated integration of teaching, research and service. Results of this study, provided over portions of two semesters, offer a reliable window into the efforts of science and engineering academics at a liberal arts state institution. Self-reporting work sampling as used in this study remains an inexpensive yet effective means to understand allocation of academic time and effort, and ultimately to provide insight into the development and sustainability of a graduate programme.

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