GC 2012-5618: TIME-ON-TASK: A PEDAGOGICAL MEASURE TO ASSESSES DIFFERENCES IN U.S. AND INDIAN ENGINEERING CURRICULA AND OUTCOMES

Dr. Roman Taraban, Texas Tech University

Roman Taraban is Professor in the Department of Psychology at Texas Tech University. He received his Ph.D. in cognitive psychology from Carnegie Mellon University. His interests are in how undergraduate students learn, and especially, how they draw meaningful connections in traditional college content materials. This research was supported by a Fulbright-Nehru Research Award.

Time-on-Task: A Pedagogical Measure To Assesses Differences in U.S. and Indian Engineering Curricula and Outcomes

A recent niche movie in the mass media, *Two Million Minutes* (Broken Pencil Productions, 2007), poignantly conveyed what is generally believed, that the U.S. is falling behind India and China in science and math. The message was cleverly conveyed by following two high-school seniors, a male and female, in the U.S., India, and China, in their day-to-day lives. Time-on-task was one major factor that distinguished the students. At the high-school level, Indian students invested about 1.5 times more study time than U.S. students, and Chinese students spend about twice the time of U.S. students. Correlated with these figures are international test scores in science and math: e.g., in a recent international test of mathematics, U.S. students placed 24th out of 29 developed countries. This informal glimpse into the lives of U.S., Indian, and Chinese students implied that the amount of time students invest in academics makes a difference in achievement.

Time-On-Task

In the educational literature, time-on-task has typically been applied as a measure of the time students engage in academic activities. There are several reasons to believe that time-on-task could be an important indicator of academic growth and development. Chickering and Gamsom[1] list time-on-task as one of the seven principles of effective teaching and learning. In research involving learning, it has been shown that increasing the number of practice trials results in greater learning. At a neurological level, a chemically-based process of long-term potentiation is responsible for changing synaptic connections in the brain due to persistent chemical and electrical stimulation over time arising from the experience of the individual. Long-term potentiation is associated with learning. There is ample evidence for the importance of time-on-task to college learning.[1,2,3]

How students spend their time has been of interest to educators in the U.S. since the early 1900s. College educators of the time wondered: "Are they [students] overworked or is college a country club where young people may find rest and pleasant relaxation between social engagements?"[4] In one of the earliest studies[5], questionnaires were distributed to 1,715 students in 56 different college courses. Often, students were asked to keep a careful record of all their activities for a week—to record the distribution of their time in study, extra-curricular activities, leisure, and sleep, but in other cases they were asked to simply indicate how much time they spent in various activities, including study, for the entire week. Variations of the activity log method continue to be used today.[6,7,8]

Monitoring students' allocation of time for academic work has also been applied to engineering. Ressler and Lenox[8] described a time survey that was used extensively in civil engineering courses at the United States Military Academy. For each of the 40 lessons in the course, students anonymously indicated the number of minutes they spent outside of class to prepare for the lesson. The faculty used the survey results for course management, evaluation, and change. The survey allowed faculty to ask whether students were spending an appropriate amount of time preparing for class, and to monitor, evaluate, and modify course demands as deemed appropriate to the goals of the course and program.

The Golden Rule

A longstanding expectation among college instructors in the U.S. is that students will devote at least twice as much time to independent study as to class attendance. This is known as the *Golden Rule*.[9] In an extensive analysis of national databases, Babcock and Marks[2] found that U.S. students were close to the mark in 1961, averaging about 24 hours of study time per week (the Golden Rule would require 15 * 2 = 30 hours, on average, based on a 15 credit course load). By 2003, average weekly study time had fallen to an alarmingly low 14 hours per week. In terms of the production of knowledge and skilled workers, Babcock and Marks regard this decline as a matter of grave concern.

Time-on-Task in Undergraduate Engineering Programs

The goal of this research was to assess differences across U.S. and Indian engineering programs in the allocation of time to academic activities and to relate time allocation to students' academic achievement.

Case Study 1

The first study addressed the following questions:

- How much time did engineering students in the U.S. and India allocate to specific learning activities?
- How did time allocation change from freshman through senior years?
- To what extent did engagement in specific activities correlate with grade-point average (GPA), which is an overall indicator of achievement?

The rationale for addressing these questions was based on previous research[10] that had shown that U.S. students allocated the majority of their study time to solving textbook problems with little attention given to writing papers and working on projects. In the present study, students reported times spent doing homework, reading textbooks, reading other printed materials (e.g. novels, handouts), answering assigned questions from the textbook, writing papers, and working on projects for classes. Relatively equal numbers were sampled from freshman to senior years. Based on the current position in the mass media (e.g., *Two Million Minutes,* Broken Pencil Productions, 2007) that Indian students dedicate significant time to academics, we predicted that Indian students would spend more time than U.S. students on homework, reading textbooks and other printed materials, and solving textbook problems, and that Indian students would follow the Golden Rule for study time, which is two hours of study outside of class for every hour in class. We also predicted that both groups would spend less time on textbook problems from freshman to senior years and transition to working on independent projects.

Participants and Procedures

The U.S. data for this study were part of a larger project[11] involving two large public research universities, Texas Tech University and the University of Wyoming, which are in the southwest and west regions of the U.S., respectively. Both institutions have well-established engineering programs. The combined U.S. sample consisted of 410 engineering majors that included 108

freshman, 93 sophomores, 102 juniors, and 107 seniors. The Indian sample consisted of 313 students from the Indian Institute of Technology in Kharagpur (IIT-KGP) and included 106 freshman, 86 sophomores, 50 juniors, and 71 seniors. Indian Institutes of Technology are known for their rigorous admission standards. They are also considered to have the best engineering programs in India.

Participants in the U.S. and India were recruited through undergraduate engineering courses with the prior permission of the instructor. Students completed a consent form and were assured that their responses were confidential and would not affect their course grades. Questions and responses were presented in a paper-and-pencil format.

Results and Discussion

The data revealed that U.S. students significantly exceeded Indian students in homework time and time solving textbook problems, contrary to predictions. Indian students significantly exceeded U.S. students in reading textbooks and reading other printed materials, consistent with predictions. The two groups did not differ in time writing papers and working on projects. (See Table 1.) Given that U.S. students spend about 15 hours per week in lecture and Indian students spend about 23 hours in lecture, U.S. students were closer to following the Golden Rule than Indian students, but neither group appeared to be following the rule.

Table 1. Mean Times for Academic Activities for U.S. (N = 410) and Indian (N = 313) Engineering Students

On average, each day I spend an average of ___ minutes	U.S.[a]	Indian	*p*-value[b]
Doing homework	122.48	44.14	**.001**
Reading textbooks for my classes	36.68	42.28	**.029**
Reading other printed materials for my classes (e.g., novels, handouts)	19.86	32.26	**.001**
Answering assigned questions from the textbook	68.13	22.44	**.001**
Writing papers for my classes	16.89	14.26	.079
Working on projects for my classes	31.81	32.28	.284

[a]U.S. data adapted from previous study.[11] [b] *p*-values (two-sided) based on Mann-Whitney *U* test for differences between mean ranks. Significant values are bolded.

The data were further examined for changes in use of time from freshman through senior years (FR-SR) and associations with cumulative grade-point averages (GPA) (See Table 2). U.S. students spent significantly more time on homework and solving textbook problems from freshman through senior years, as indicated by significant positive correlation values (r), as shown in Table 2. That outcome is contrary to predictions. Indian students spent significantly less time, as indicated by significant negative correlation values (r), which is consistent with predictions. Indian students spent significantly less time reading textbooks and other printed materials; U.S. students did not change. The prediction that both groups would spend more time

on projects as they advanced from freshman to senior years was fulfilled, but there was a significant decline in writing for both groups across that time period. Doing homework and solving textbook problems were positively associated with GPA for U.S. students. Working on projects was positively associated with GPA for Indian students but negatively associated for U.S. students.

Table 2. Means (in minutes) for Daily Study-Time Questions by Academic Level, Spearman Correlation Coefficient (*r*), and *p*-Value (shown as superscript).

Activity	Country	FR	SO	JU	SE	*r*-credits	*r*-GPA
Doing homework	US	112	121	133	124	$.128^{.010}$	$.111^{.026}$
	INDIA	48	51	34	37	$-.142^{.012}$	-.019
Reading textbooks	US	38	29	43	36	.028	.038
	INDIA	51	43	36	33	$-.153^{.007}$	-.065
Reading other printed materials	US	22	17	18	22	-.044	-.066
	INDIA	38	27	35	27	$-.113^{.046}$	.021
Answering textbook questions	US	46	72	84	72	$.212^{.001}$	$.103^{.039}$
	INDIA	32	23	13	15	$-.359^{.001}$	.042
Writing papers	US	28	14	10	16	$-.135^{.006}$	-.05
	INDIA	17	14	11	12	$-.173^{.002}$	-.015
Working on projects	US	28	22	33	43	$.238^{.001}$	$-.107^{.031}$
	INDIA	18	20	51	54	$.350^{.001}$	$.254^{.001}$

Notes. FR: Freshman, SO: Sophomore, JU: Junior, SE: Senior. **r-credits** is the correlation of completed college credits with the amount of time spent in the related activity. **r-GPA** is the correlation of cumulative grade-point average with the amount of time spent in the related activity. When the correlations are significantly different from zero, the *p*-value appears as a superscript.

In conclusion, the data showed significant differences in how U.S. and Indian students allocated their time as they progressed through their respective programs. The differences in study time and the patterns of correlations with GPA signal significant differences in the training programs for U.S. and Indian students and the effects that those curricula have on the skills that these students ultimately gain through their education, as indicated here by GPA. Overall, there was no clear evidence that Indian students exceeded U.S. students in time-on-task.

Case Study 2

The previous case study compared students on specific activities. It is possible that a focus on specific academic activities distorted the description of U.S. and Indian academic habits. Further, because Indian students tend to carry higher course loads and therefore spend considerably more time in lecture than U.S. students, the present study also included questions about time spent in lecture. The purpose of this study was to compare lecture times and study time for a cohort of U.S. students and two cohorts of Indian students, i.e., a cohort from IIT-KGP

used in the previous case study and a cohort from a well-respected institute of technology in Manipal (MIT) but not of the same rank as the IIT-KGP. These data provided a more comprehensive measure of time-on-task and broadened the Indian sample.

Participants and Procedures

U.S. participants were recruited from Texas Tech University and the University of Wyoming, as in the previous case study, for a combined sample of 211 participants. Indian students were recruited from IIT-KGP (N = 32) and MIT (N = 47). At the time of data collection, students were enrolled in introductory thermodynamics and participated on a voluntary basis. Introductory thermodynamics is typically taken in the freshman or sophomore year in an engineering curriculum.

Lecture and study time data for introductory thermodynamics were collected using an activity log, which consisted of an instruction page detailing how participants were to use the log and a set of labels and definitions for the students to use to code their study-related activities. The labels, which were developed in earlier pilot studies, were mutually exclusive and covered all possible student study behaviors. The log provided space for students to record times for all activities in the thermodynamics course for one week. A student completed the log only once during the semester. Two additional questions were included that asked students to estimate the total time spent in lecture for all classes in the past week and the total time studying for all classes in the past week.

Results and Discussion

The mean total times that thermodynamics students spent attending lectures and studying for the thermodynamics course for one week are summarized in Table 3. A statistical analysis of the combined lecture and study times for the U.S. and Indian schools showed no reliable difference [$F(2, 287) = 0.14$, $p = .87$].

Table 3. Lecture Times and Study Times for One Week of Thermodynamics Class, in Hours

School	Total Lecture Time	Total Study Time	Combined Times
U.S.	2.07	6.91	8.98
India IIT-KGP	2.53	6.60	9.13
India MIT	3.70	4.97	8.66

The mean total times that thermodynamics students spent attending lectures and studying for all their courses for one week are summarized in Table 4. A statistical analysis of the combined lecture and study times for the U.S. and Indian schools again showed no reliable difference [$F(2, 260) = 2.14$, $p = .12$]. In summary, when considering total time-on-task for either the individual thermodynamics course or for students' full course load, students in the U.S. and India apply themselves nearly equally. It is especially remarkable that there are no differences between the

elite IIT-KGP and the U.S. schools nor between the IIT-KGP and MIT, the latter a less renowned Indian engineering institute.

Table 4. Lecture Times and Study Times for One Week for All Classes, in Hours

School	Total Lecture Time	Total Study Time	Combined Times
U.S.	15.62	23.15	38.82
India IIT-KGP	20.02	19.16	39.18
India MIT	24.12	20.36	44.48

Conclusions

Compelling arguments can be made for the relevance to time-on-task to the acquisition of knowledge and skills. At a cognitive, behavioral, and neural level, the evidence shows that time-on-task is associated with learning.[2,3] Babcock and Marks[2] note the decline in time-on-task in the U.S. in terms that clearly acknowledge the individual and social risks of lowering academic demands:

> We have argued that academic effort is an important input to the production of skills and human capital, but whether or not student effort matters, the pattern in the data is clear. Postsecondary institutions in the United States are falling short of their self-stated standard for academic time investment, and the amount they fall short by has quadrupled over time. We submit that if academic effort is, in fact, a crucial input to the production of knowledge, and eliciting such effort is an important part of the university's mission, then this widespread deterioration of the standard for student effort demands attention and considered action from all who have a stake in the quality of higher education in the United States.

The data here suggest that U.S. engineering students study at about the level as the national U.S. norm in 1961 and close to the level recommended by the Golden Rule. Indian students study somewhat less, but the difference can be explained in terms of the greater demands on these students in terms of course loads (22-25 credits compared to 12-15 in the U.S.) and concomitant increased time in lectures. Combined lecture and study times showed no reliable differences between U.S. and Indian students, regardless of the renown of the Indian institution.

These data surely do not nullify the associations of time-on-task with learning. Given sensitive data measures, we would expect to find that individual effort mattered in knowledge acquisition and skill development.[3] Case Study 1 further suggests that there are institutional and cultural differences in curricula that complicate the question of exactly how time-on-task contributes to an individual student's development. However, the major question addressed in this paper was whether, on average, Indian engineering students invested significantly more time in their academic work than U.S. students. The data suggests that there are no significant differences overall.

Bibliography

1. Chickering, A. W., & Gamson, Z. F. (1987). Seven principles for good practice in undergraduate education. *AAHE Bulletin*, *39*(7), 3-7.
2. Babcock, P., & Marks, M. (2010). Leisure college, USA: The decline in student study time. *American Enterprise Institute for Public Policy Research*, No. 7, 1-7.
3. Taraban, R., Rynearson, K., & Stalcup, K. (2001). Time as a variable in learning on the World Wide Web. *Behavior Research Methods, Instruments & Computers*, *33*, 217-225.
4. Hutchinson, R. G., & Connard, M. H. (1926). What's in a college week? *School and Society*, *24*(625), 768-772.
5. King, I. (1915). An inquiry into certain aspects of the study habits of university students. *School and Society*, *2*(49), 824-828.
6. Bailey, M., Floersheim, R. B., & Ressler, S. J. (2002). Course assessment plan: A tool for integrated curriculum management. *Journal of Engineering Education*, *91*(4), 425-434.
7. Hayes, R., Kotovsky, K., Kozbelt, A., & Weissman, A. (1999). Where does students' time go? *Center for Innovation in Learning at Carnegie Mellon, Research Brief*, *1*(2), 1-4.
8. Ressler, S. J., & Lenox, T. A. (1996). The time survey: A course development tool that works! *Proceedings of the 1996 American Society for Engineering Education Annual Conference and Exposition*, Washington, D.C.
9. Rohwer Jr., W. (1984). An invitation to a developmental psychology of studying. In *Applied developmental psychology*, *1*, 75-113.
10. Taraban, R., Hayes, M. W., Anderson, E. E., & Sharma, M. P. (2004). Giving students time for the academic resources that work. *Journal of Engineering Education*, *93*(3), 205-210.
11. Taraban, R. (2011). Information fluency growth through engineering curricula: Analysis of students' text-processing skills and beliefs. *Journal of Engineering Education*, *100*(2), 397-416.