Report on the

Professional Development Grant

A Study of University Mathematics Education in Japan

By

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The purpose of this study was to deliver a colloquium talk at Nihon University in Tokyo, Japan, investigate the pedagogical practices and mathematics curriculum at the university level in Japan, and bring forth recommendations for improving the mathematics program at Tech.

I am indebted to Dr. Jeanine Myers, Head of the Department of Mathematics, Dr. Jeff Robertson, Dean of the College of Natural and Health Sciences, and the Academic Affairs Office for their support of this endeavor. I also appreciate the Faculty Professional Development Grant Committee for recommending this project be partially funded as requested.

I arrived in Tokyo on Friday, June 2, 2017. My first official meeting was not until Saturday, June 10. I had intentionally arrived early to do some sightseeing (at my own expense). This actually turned out to be a benefit for my study because one of the places I visited was Sapporo, where I found that Hokkaido University was very near my hotel. This university was founded in 1876 as the Sapporo Agricultural College and is one of the top universities in Japan. It has been ranked as the 6th best research university in Japan and the 144th best university in the world. It has a very strong international component, both in terms of students and faculty. I was able to take a tour of the mathematics department where I found excellent facilities.

The Department of Mathematics has its own library as pictured above, including movable stacks (see below left)



The two pictures on the right above show a typical classroom, which is similarly equipped as those here at Arkansas Tech with the exception of having chalk boards instead of white boards.

The Department of Mathematics at Hokkaido University is very active in research as the following pictures show.

Due to the current financial and facilities constraints we have at Arkansas Tech, the following is not immediately possible, but perhaps we could work towards this goal.

Recommendation #1: **The health and vitality of our department could be improved if we could establish a Departmental Library within its physical location, in addition to the holdings in RPL, where faculty can meet and discuss issues of teaching and research.**

On Saturday, June 10, I met with Dr. Akira Saito, who had arranged for me to give an address at his campus of Nihon University. We discussed the logistics of the talk, including how to get to his campus by train.

On Monday and Tuesday, prior to my actual visit to Nihon University, I made a trial trip to ensure that I knew how to navigate the train system to his campus location, put the final touches on my talk based upon our conversation, and also had the privilege of taking a walking tour through Tokyo University, the number one university in Japan.

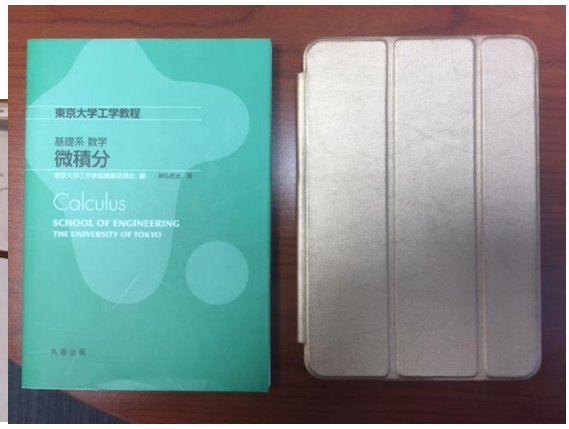
Tokyo University scene




The street from the train station to Nihon University.

Nihon University

Dr. Saito's teaching duties, although he is a member of the Information Technology Department at Nihon University, include calculus and linear algebra. The text in the picture on the left below is one he uses in calculus. The text in the picture on the right is one used at Tokyo University, which I purchased at its bookstore. Both texts are approximately the size of an iPad mini. Both texts contain about 185 pages. Both texts cover the usual topics in single ***and*** multivariable calculus! According to Dr. Saito there are approximately 100 calculus texts produced in Japan. All are approximately the same size. All cover the material that we would call calculus I, II, and III.

These findings are consistent with what I observed at the high school level in Japan. The textbooks are smaller than the ones generally used in the US, and the focus is on pedagogy and educational value rather than profits.

One might reasonably conclude that many topics must be omitted in order to package the material in a small book. In fact, the opposite is true. The text I purchased at Tokyo University has four chapters. The first chapter contains the typical pre-calculus topics but also the following: the ε-N_ε definition of the limit of a sequence, Cauchy sequences, complex numbers, Euler's formula for $e^{i\theta}$, Axiom of Archimedes, Bolzano-Weierstrass Theorem (they write Borzano), supremum, infimum, lim sup, lim inf, series, and even mentions abelian groups and rings. Then chapter 2 begins with the definition of a derivative.

Although the texts contain homework problems, instructors in Japan supplement the texts with their own problems. This is, in my opinion, better than the model in the US where problem sets often consist of 50 to 100, or more, problems. I want my textbooks to contain a few problems that cover the basics and leave it to me to provide additional advanced problems which I consider appropriate for the class.

Significant reform regarding calculus texts and their content would be very difficult in the US. Altering the content of our three semester calculus sequence in Arkansas would be even more difficult considering that we are part of the Arkansas Course Transfer System. However, I do have a recommendation, based upon my experience teaching the calculus sequence and after reflecting upon the Japanese system, which could be implemented immediately.

Recommendation #2: **(in three parts)**

a. **Give an introduction to partial derivatives after covering derivatives in calculus I.**
b. **Give an introduction to multiple integrals in calculus II.**
c. **Do a unit on partial derivatives and multiple integrals at the beginning of calculus III.**

On Wednesday, June 14, I gave my presentation to an audience of students and faculty. In preparation for that talk, and upon my review of the conversations I had with faculty and students at Nihon University, I have the following additional recommendations.

Recommendation #3: No course currently required for a mathematics degree at Tech covers complex numbers/functions. Although some students take Complex Variables as an elective, I recommend that it be added as a required course.

Recommendation #4: The curriculum at Tech for a mathematics degree requires introductory courses in linear algebra, abstract algebra, differential equations, statistics, analysis, and modeling. Students are not required to probe deeper into any area of mathematics. Therefore, I recommend that at least one 6-hour sequence be required. For example, Linear Algebra I and II.

Recommendation #5: Develop a sequel to Complex Variables, creating an additional 6-hour sequence from which our students could choose.

I am appreciative of all those who made this trip possible. It was beneficial to me professionally and, I believe, will benefit Tech students in the future.

I plan to continue making presentations about the Japanese education system to local civic groups, at the National Joint Mathematics meeting, and at the Oklahoma-Arkansas MAA Section. In particular, I will continue to promote textbook reform. My findings relative to the mathematics education system in Japan have influenced the writing (in progress) of my text for Math 1003 College Mathematics, which I hope will have a positive impact on student retention here at Arkansas Tech.