An Alternate Approach in the Application of the Thayer Concept of Teaching

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Abstract

The United Military Academy uses a teaching methodology coined “the Thayer Concept.” This method of instruction involves five tenets that focus on course structure and student learning. As a result, courses are designed to challenge students, but also provide students the means to succeed. The Thayer Concept does not use lecture as the primary vehicle of instruction. Rather, instructors use a variety of means to answer questions proposed during class. Although students do not self-teach, the Thayer Concept does require students to assume responsibility for their academics and uses instructors as tools to enhance the learning process. This study attempts to analyze the impact of teaching methodologies on students who struggle with general chemistry. Unlike the Thayer Concept, the altered approach followed the majority of Thayer’s principles but used lecture to teach concepts and calculations. By comparing quantitative and qualitative data, this study was able to determine qualitatively that students with weak science backgrounds learn better through lecture. Quantitatively, students earned similar grades on graded events.

Introduction

Regardless of the institution or course, teachers use a variety of teaching methods to motivate and educate their students. Inside the classroom, students bring their background knowledge of subjects, studying techniques, and personal motivation for learning. Each of these attributes influences a students’ performance academically to varying degrees.1 As a result, educators face multiple obstacles to overcome prior education gaps, preferred learning styles, and an unresponsive classroom environment by adjusting their teaching techniques.
Traditional teaching approaches use lecture as the primary vehicle of instruction. Depending on the author, the definition of lecture varies from a formal or oral presentation of instructional material provided by a subject matter expert. This method of instruction has many positive and negative aspects. One drawback includes the lack of interaction between instructor and student. According to Sullivan and McIntosh, effective lectures consist of several key characteristics. The table below summarizes their findings.

**Table 1.** Characteristics of the Effective and Ineffective lecture. Adapted from

<table>
<thead>
<tr>
<th>Characteristics of the Effective and Ineffective Lecture</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Effective</strong></td>
<td><strong>Ineffective</strong></td>
</tr>
<tr>
<td>Educator-student interaction</td>
<td>100% educator talk with limited interaction</td>
</tr>
<tr>
<td>Two-way communication</td>
<td>One-way communication</td>
</tr>
<tr>
<td>Educator-student questions</td>
<td>Few if any questions (educator or student)</td>
</tr>
<tr>
<td>Shared responsibility for active learning</td>
<td>Student depends on educator for all information</td>
</tr>
<tr>
<td>Small group, problem solving activities</td>
<td>No student activities</td>
</tr>
<tr>
<td>Variety of supporting media</td>
<td>No supporting media</td>
</tr>
<tr>
<td>Limited note taking required</td>
<td>Extensive note taking required</td>
</tr>
</tbody>
</table>

Beginning in the 1960's, Fred Keller introduced a novel teaching approach that involved instructors to carefully analyze their course content and break it into systematic units. For this revolutionary approach, Keller coined the term Personalized System of Instruction or PSI.
Key features of PSI. Adapted from 4,5

"(1) The go-at-your-own-pace feature, which permits a student to move through the course at speed commensurate with his ability and other demands upon his time.

"(2) The unit-perfection requirement for advance, which lets the student go ahead to new material only after demonstrating mastery of that which preceded.

"(3) The use of lectures and demonstrations as vehicles of motivation, rather than sources of critical information.

"(4) The related stress upon the written word in teacher-student communications; and, finally:

"(5) The use of proctors, which permits repeated testing, immediate scoring, almost unavoidable tutoring, and a marked enhancement of the personal-social aspect of the educational process." (Keller, 1968, p. 83; italics in the original).

Throughout the 1960-1970’s, institutions and instructors applied Keller’s teaching approach to twelve disciplines ranging from humanities to science and engineering.6 Upon further analysis, educators discovered “(a) PSI was more effective in raising final exam scores than other approaches; (b) PSI enhanced problem solving …more than traditional lecture-discussion format courses; (c) PSI has been shown to successfully yield higher achievement in complex courses than traditional lecture-discussion formatted courses.” 3

The United States Military Academy (USMA) incorporates the tenets of both lecture and PSI teaching methodologies. Developed by Colonel Sylvanus Thayer, Superintendent from 1817-337, the Thayer Method incorporates several key principles7,8

(1) Students receive detailed study objectives, a readable text, and supplementary study material at the beginning of the course.

(2) Learning is an incremental process that is best achieved in small units. Each lesson has specific performance objectives.
(3) Periodic reviews and quizzes allow students to consolidate material learned.
(4) A low instructor / student ratio enhancing learning.
(5) Segregation of high, mid, and low aptitude students enables instructors to maintain the best learning pace for the greatest number of students.

Over the course of four years, students attending the Academy undertake a rigorous academic schedule consisting of required or Corps Courses and courses specifically associated to their major or engineering sequence. During the first year of school, general chemistry is an example of a Corps Course that covers two semesters of instruction.

Application

In accordance with the Thayer Concept, the general chemistry course has low, medium and high sections, and traditionally has between four to eight low sections. During the Fall of 2009, I was responsible for instructing approximately 16 students assigned to a low section. After re-section, each of my new students came to my section with an average below 70 percent. Essentially, they were all failing general chemistry. Some of my students entered with a 56 percent after the first six weeks of classes and nine graded events. For the remainder of the semester, I used the assigned reading, homework, board problems, and lesson objectives. However, I altered my method of teaching. While other instructors followed the principles of the Thayer Method of teaching, I taught my section the material using a lecture style approach, and then required them to work on problems assigned to the lesson. During our next meeting, I checked homework from the previous lesson. In addition, the students were responsible for the reading and the vocabulary for the current lesson.
While this style of teaching followed many of the principles of the Thayer Method, I primarily used lecture supported by demonstrations, animations, and class work as the primary means of teaching. Unlike the Thayer Method, it uses lectures as a vehicle to address difficult concepts.\textsuperscript{7,8}

**Methods of Analysis**

Prior to entering their first day of general chemistry, students undergo an assessment using the standardized American Chemical Society (ACS) test. Students are then grouped based upon their scores into three categories – CH101 (general), CH151 (advanced) or validation. After approximately six weeks and the conclusion of the first major graded event, the introductory chemistry population undergoes further diversification. Using their current grades and teacher assessments, students fall into the same previous categories. However, the general chemistry population now contains low, average, and high sections. While low sections possess students with less than a 70 percent average in the course, a high section has students with a 90 or above percent average. The students remain in their new sections for the Fall semester. Students receive their Spring general chemistry instructors using the same procedure. However, the students’ Fall general chemistry grade was used as an assessment tool.

Since all general and advanced chemistry students take the same course quizzes and Written Partial Reviews (WPRs), these graded events served as a comparison between the traditional teaching style used by other general chemistry teachers and altered method used in one classroom. These graded events tested the students ability to recall and apply concepts taught throughout the semester.
Comprehension of core ideas were analyzed outside of graded events. Prior to a quiz or WPR, students conducted a self-assessment of their knowledge. They wrote down the concepts that they understood and ones they did not. Then, students wrote a study plan based upon their comprehension of the tested block of instruction. These plans were a modified form of lingering question papers or “muddiest point”. Finally, students voluntarily participated in a survey that assessed their understanding of the course material, their motivation for learning the course material, and method of teaching. Students in a low and average section completed the survey.

Results

In the Fall of 2009, 16 fourth class cadets were assigned to a low section of general chemistry based upon their average after the first six weeks of classes. Their grades ranged from a 56 percent to a 69 percent. Since general chemistry is a mandatory class for all students enrolled in the Academy and worth 3.5 credit hours, students possessed a degree of motivation to succeed in the course. Over the semester, three students left the class. Two permanently left the Academy, and the other chose to participate in First Year and Beyond program which allows a fourth class cadet to drop one course. The background of the students varied.

<table>
<thead>
<tr>
<th></th>
<th>High School Students</th>
<th>Prior Service</th>
<th>Preparatory School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>9</td>
<td>0</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 2. Diversity of students enrolled in Low Section Fall semester
A comparison of graded event scores would demonstrate the student’s comprehension and retention of the material. Graded events include End of Hour Quizzes (EOH Quiz) and laboratory work worth 60 point individually and Written Partial Reveiws (WPRs) worth 200 points. The material on quizzes and WPRs was taken directly from the lesson assignments, and the cadets did not know the problems prior to the test. However, the cadets were authorized use of external resources and possessed prior knowledge of the laboratory exercises.

**Graph 1.** Comparison between course average and Low Section on 9 graded events

An analysis of the lab grades showed that the Low Section earned close to the course average and averaged 53 points out of 60 or 88.39 percent. However on quizzes and WPRs, the low section did not perform well. For quizzes, the course averaged 79.53 percent and the Low Section earned a 67.32 percent. While on the remaining two WPRs in the course, the course earned 79.94 percent and the Low Section averaged a 67.41 percent respectively. Despite an approximately 10 percent
difference in grades, the Low Section steadily improved their performance. The same
trend occurred on the WPRs, and for many of the students, WPR III was their first
passing grade on an exam.

While comparing the Low Section to other sections in general chemistry provided
some insight in to the impact of altering the teaching method, further analysis amongst
the remaining five low sections proposed additional observations on teaching style.
Without analyzing the demographics of the five combined low sections, the results
showed a very close graded event average. For quizzes and WPRs, the combined
section earned 68.29 and 69.99 percent respectively. Only a difference of less than one
percent difference in quiz scores, approximately 0.98 percent and a 2.59 difference in
WPRs.

**Graph 2.** Comparison between low sections on 9 graded events
Although the analysis of the quantitative data failed to provide definitive proof that an altered method of teaching improved students’ comprehension and retention, twenty students from three different sections voluntarily participated in an 18 question survey that covered methods of instruction and comprehension. Graphs 3 and 4 centered on the students’ perception of the teaching methodology.

**Graph 3. Analysis of Effective Teaching Style**

**Method of Instruction**

- **Strongly Agree**
- **Agree**
- **Neutral**
- **Disagree**
- **Strongly Disagree**

**Effective Way of Teaching General Chemistry**

**Graph 4. Analysis of Memorization**

**Method of Instruction**

- **Strongly Agree**
- **Agree**
- **Neutral**
- **Disagree**
- **Strongly Disagree**

**General Chemistry Involves Mostly Memorization**
Sometime throughout the academic year, all students were taught by the same instructor. As mentioned previously, the instructor used only course materials but altered the teaching of the mathematical concepts. Both graphs show that students responded to the applied style of teaching and that they did not memorize facts and equations to pass. Rather, the students internalized some aspects of the course, a display of deep learning. Further interpretation of the survey suggests the students responded to the method of instruction based upon their academic strengths. For example, students with a strong background in chemistry and mathematics positively responded to the Thayer Concept of teaching. While students assigned to a low section, they also performed well and strengthened their science background from the modified Thayer Concept.

The next set of graphs focused on the students understanding of the material taught in general chemistry. One of the key principles of PSI and the Thayer Concept centers on self teaching and the use of the instructor as a facilitator. Graph 5 shows that most students felt responsible for their learning. Analysis of the data propose several interpretations. For instance, a sense of responsibility suggests the students possessed a motivation to learn and internalized the material. A different interpretation might imply the students felt the teacher failed to adequately teach the material. As a result, the students required assistance outside the classroom to understand the material.
Regardless of the interpretation of Graph 5’s results, the students believed they learned a lot from the material taught in the course. Graph 6 shows the majority of the students surveyed disagreed with the questions, and many of them surprised themselves on the amount of knowledge learned over the course of two semesters.

Graph 5. Sense of Responsibility

Graph 6. How much did I learn?
Discussion

Review of the quantitative and qualitative data reveals several interesting points. Overall, the students possessed a positive experience in their general chemistry course, and according to their responses, they learned a lot about science. However, the results are inconclusive on the impact of teaching style. Although the student’s assigned to the Low Section improved their performance on graded events, the analysis their scores failed to prove the basis of that change. In addition, the comparison between all six low sections during Academic Year 10-1 (AY10-1) did not show a large difference in grades, less than one percent for quizzes and 2.59 percent on WPRs.

Interview results discussed.

Conclusion

The altered application of the Thayer Concept resulted in mixed success. The students responded to the method of teaching. As a result, they showed a sense of motivation to learn and internalize the concepts of the course. For most teachers, they would claim a victory. However, the test scores did not show a significant improvement. Other low sections performed as well or better than the test low section. Yet, an underlying them became apparent through the interviews. Many students expressed that a slower paced and better explanation of concepts and calculations enhanced their comprehension of chemistry. Many of the students assigned to a low section did not possess a strong background in the science. As a result, they needed a different teaching approach.
Notes

1. (Felder & Silverman, 1988)
2. (Sullivan & McIntosh, 1996)
3. (Dunne )
4. (Gallup, Fred Keller and PSI Handout)
5. (Gallup & Allan, Concerns with some recent criticisms of the Personalized System of Instruction (PSI))
6. (Leo, 1973)
7. (Ertwine & Palladino, 1987)
8. (Palladino, 1979)
9. (Angelo & Cross, 1993)
10. (Silberman & Parker, 1974)
References


