

**'The Seven Laws of Teaching'
As Applied to Engineering Education**

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Abstract

Each decade seems to bring new methods of pedagogy, with recent years witnessing personalized systems of instruction (PSI), audio tutorial (AT) methods, and computer assisted instruction (CAI), and the present time and technologies prompting interests in distance learning and multimedia. Expressing concern that a good foundation be the base of any "modern" pedagogy, the author of this paper reviews a book written in the mid 1800's by Dr. John Milton Gregory,¹ a well known educator. Entitled *The Seven Laws of Teaching*, the objective of the book was "to set forth, in a certain systematic order, the principles of the art of teaching."

First published in 1884, Dr. Gregory's book was subsequently revised and reissued in 1917 by W.C. Bagley and W.K. Layton of the University of Illinois. In the book, Dr. Gregory sets forth the following "laws": (1) **The Law of the Teacher** - A teacher must be one who *knows* the lesson or truth or art to be taught; (2) **The Law of the Learner** - A learner is one who *attends with interest* to the lesson; (3) **The Law of the Language** - The language used as a *medium* between teacher and learner must be *common* to both; (4) **The Law of the Lesson** - The lesson to be mastered must be explicable in the terms of truth already known by the learner -- the *unknown* must be explained by means of the *known*; (5) **The Law of the Teaching Process** - Teaching is *arousing* and *using* the pupil's mind to grasp the desired thought or to master the desired art; (6) **The Law of the Learning Process** - Learning is *thinking* into one's own *understanding* a new idea or truth or working into *habit* a new art or skill; (7) **The Law of Review and Application** - The test and proof of teaching done -- the finishing and fastening process -- must be a *reviewing*, *rethinking*, *reknowing*, *reproducing*, and *applying* of the material that has been taught, the knowledge and ideals and arts that have been communicated.

Drawing from over twenty five years of experience in engineering education, the author discusses each law, making application of each to engineering education in the present time. A set of "rules" is defined associated with each law to make clear its proper application, and common violations of each are discussed.

This paper, which is based upon Dr. Gregory's book, should be of interest to all engineering educators, but particularly to young faculty, as it describes with clarity and simplicity the fundamentals of teaching. To quote from the introduction to Dr. Gregory's book, "The first object of teaching, then, is to stimulate in the pupil the love of learning, and to form in him habits and ideals of independent study." He concludes with "The study of these laws may not make of every reader a perfect teacher; but the laws themselves, when fully observed in use, will produce their effects with .. certainty .." No matter what technology or method of pedagogy, all seven of the "laws of teaching" must be observed to assure success. Simple in their statement, they are key to success in managing the complex process of learning.



I. Introduction

Engineering education is one of few professions for which its practitioners have little or no training. I'm not saying we are uneducated! It's just that teachers of engineering normally have no special training in principles and practices of teaching and learning. Even so, as teachers we have done quite well, I believe, learning by experience what works and what does not.

Interestingly, we require our students, whom we are training to become practicing engineers, to learn the basics of engineering, whether it be basic electric circuits, mechanics of materials, or whatever. As teachers it would seem that we should know the basic "laws" of teaching. It seems particularly appropriate at a time when so many new and innovative schemes of delivery and technology-based tools are being proposed and implemented, e.g., the Internet, multimedia and distance learning. It is sometimes too easy to become enamored by the tool, with its flashy graphics, impressive video, and high fidelity sound, perhaps overlooking the fundamentals of teaching and learning.

In the late 1800's, Dr. John Milton Gregory wrote a book entitled "The Seven Laws of Teaching," first published in 1884, and subsequently edited and reissued in 1917 by William C. Bagley and Warren K. Layton, of the University of Illinois School of Education. In his book Dr. Gregory presents "A clear and simple statement of the important factors governing the art of teaching, .." An eminent educator, Dr. Gregory was instrumental in the establishment of the University of Illinois and was the first regent of the University.

In the introduction to his book, Dr. Gregory states "Knowledge of the laws of electric currents has made it possible to send messages through the ocean; and he that masters the laws of teaching may convey to the minds of others the experience of the race." He goes on to summarize his view of teaching as follows: "Teaching, in its simplest sense, is the communication of experience. .. It is painting in the mind of another the picture in one's own -- shaping of the thought and understanding of the comprehension of some truth which the teacher knows and wishes to communicate." Here he uses the word "communicate" in the sense of "helping another to reproduce the same experience and thus to make it common to the two." In the introduction to his book, Dr Gregory also suggests that there are seven distinct elements, or factors, involved in the teaching/learning process: Two personal factors, a teacher and a learner; two mental factors, a common language or medium of communication, and a lesson or truth or art to be communicated; and three functional acts or processes, that of the teacher, that of the learner and a final or finishing process to test and fix the result. He goes on to suggest that none of these elements can be omitted, and no others need be added. He then defines seven "laws of teaching" as follows:

The Seven Laws of Teaching

1. A teacher must be one who **knows** the *lesson or truth or art to be taught*.
2. A learner is one who **attends with interest** to the *lesson*.
3. The language used as a **medium** between teacher and learner must be *common* to both.
4. The lesson to be mastered must be explicable in the terms of truth already known by the learner .. the **unknown** must be explained by means of the *known*.
5. Teaching is **arousing** and using the *pupil's mind* to grasp the desired thought or to master the desired art.
6. Learning is **thinking** into one's own *understanding* a new idea or truth or working into habit a new art or skill.
7. The test and proof of **teaching done** .. the finishing and fastening process .. must be a *reviewing, rethinking, reknowing, reproducing, and applying* of the material that has been taught, the knowledge and ideals and arts that have been communicated.



Each "law" seems obvious at first hearing, yet in practice, whether in engineering education or other fields of study, there are many ways in which one or more of these laws is broken. Our first responsibility as teachers is to know and understand each law. We must also consider the consequences of the breaking of any of the laws. At the end of his book, Dr. Gregory states "The study of these laws may not make of every reader a perfect teacher; but the laws themselves, when fully observed in use, will produce their effects with the same certainty that chemical laws generate the compounds of chemical elements, .." As we seek to make use of new technologies and to alter our teaching styles to reflect student motivation and interests, we will do well to keep the seven laws in mind. In the following we present each law and make application of each to engineering education.

II. The Law of the Teacher

"The teacher must know that which he would teach." Sounds simple; but think about it. Have you ever had a teacher who didn't seem to know what he or she was supposed to be teaching? Have you ever been that teacher? On many occasions we are called upon to teach a course which is outside of our area of "specialty," with the result that we sometimes find ourselves lacking full understanding of a lesson. Even for courses within our area of expertise we sometimes get caught short on lecture preparation time and rely on being able to "wing it," after reminding ourselves that we clearly know more about the subject than the students in the class.

Dr. Gregory suggests that there are several levels of "knowledge," beginning with (1) Faint recognition, then (2) ability to recall and describe in a general way, (3) the power readily to explain, prove, illustrate and apply; and, finally, (4) "such knowledge and appreciation of the truth in its deeper significance and wider relations, that by the force of its importance we act upon it, .. our conduct is modified by it." For good teaching, clearly the teacher must attain a high level of knowledge of the subject material. Only then can he/she gain an excitement for the subject and only then will he/she be enabled to excite the students to acceptable levels of interest and concentration. Without a good understanding the teacher cannot light the fire of enthusiasm within the students to inspire them and to keep their attention.

Also, having prepared well for a lesson, the teacher will be more relaxed and better able to observe the students during the class period to detect obstacles to their learning, expressions of confusion, etc.

Hence, Dr. Gregory suggests the following "rules" for teachers: (1) Prepare each lesson by fresh study; (2) find in the lesson its analogies to more familiar facts and principles; (3) study the lesson until it takes shape in familiar language; (4) find the natural order of the several steps of the lesson; (5) find the relation of the lesson to the lives of the learners; (6) use freely all legitimate aids, but never rest until the real understanding is clearly before you; (7) bear in mind that complete mastery of a few things is better than an ineffective smattering of many; (8) have a definite time for the study of each lesson, in advance of the teaching; (9) have a plan of study, but do not hesitate, when necessary, to study beyond the plan. .. Ask what? How? Why? (10) Do not deny yourself the help of good books on the subject or your lessons.

Common violations of the law of the teacher include an attempt by the teacher to bluff his/her lesson, assuming the students are "ignorant" of the material; assuming that it is the students, alone, who must study the material, and not the teacher; to scan the lesson in preparation for the class, then assume that even though not thoroughly mastered enough is known to "fill the period," perhaps supplementing with random talk about a pet research project; and failing to find personal stimulation in the lesson.

III. The Law of the Learner

"The learner must attend with interest the material to be learned." Good luck! With a class of 10 students, perhaps, but let's be real!



Dr. Gregory defines attention as “.. the direction of the mind upon some object .. the act of bringing the object into the ‘focus’ of consciousness.” He describes three different kinds of attention as: (a) passive attention, involving no effort of will; (b) active attention, evidenced by a willful attempt to do what should be done in spite of distractions; and (c) absorbed attention, in which the student is fascinated by the lesson, almost to the point of another form of passive attention, that is, the interest is so high that little effort is involved to remain attentive, termed “secondary passive” attention by Dr. Gregory. The challenge for the teacher is to develop this secondary passive level of attention on the part of the students. Perhaps this is one place where new, high tech tools of delivery will be helpful; the audio and video modes of presentation afforded by multimedia can serve to capture the students attention, but it is important to attach that attention to the subject of study.

It is important to realize that “Knowledge cannot be passed like a material substance from one mind to another, for thoughts are not objects which may be held and handled. Ideas can be communicated only by inducing in the receiving mind processes corresponding to those by which these ideas were first conceived.” Certainly unaware of the technology which we enjoy today, Dr. Gregory states “Ideas must be rethought, experience must be reexperienced .. the pupil must think.” A high tech means of delivery must not get in the way of, or take the place of, active learning experiences.

Rules of teaching relating to the law of the learner include: (1) Never begin class without the attention of the students, (2) arouse and hold attention by variety in your presentation, (3) kindle and maintain the highest possible interest in the subject, (4) appeal to the interests of the students wherever possible, (5) reduce distractions to a minimum, (6) prepare thought-provoking questions beforehand, (7) make your presentations as attractive as possible, and (8) maintain and exhibit in yourself genuine interest in the lesson, for true enthusiasm is contagious.

Violations of the law of the learner include: (1) Beginning the lesson before the students’ attention has been gained, (2) class is too long, extending beyond the students’ ability to remain attentive, (3) not connecting the subject to students’ interests or stimulating new interest in the subject, and (4) failure of the teacher to utilize fresh inquiries into the subject to stimulate interest.

IV. The Law of the Language

“The language used in teaching must be common to teacher and learner .. it must be understood by each, with the same meaning to both.” Again, this seems so obvious, but many subject areas in engineering are filled with new and unusual terms; they have vocabularies of their own. “No one has more language than he has learned,” states Dr. Gregory. It is incumbent upon the teacher to “come within the sphere of” the students’ language power if the subject material is to be understood. It is “not what the speaker expresses from his own mind, but what the hearer understands and reproduces in his mind {that} measures the communicating power of the language used.” The teacher must learn by interacting with the students what needs they have regarding vocabulary.

Dr. Gregory goes on to say that one of the clear functions of teaching is to help the student “to gain a full and clear expression of what he/she already knows imperfectly .. We master truth by expressing it .. The pupil must do much of the talking.” By encouraging the students to communicate, to talk through the ideas and concepts being studied, we help them to learn, for “ideas must precede words in all but parrot speech .. Thoughts disentangle passing o’er the lip.” “ .. a too talkative teacher is rarely a good teacher.” Dr. Gregory declares.

Rules of teachers derived from the law of language include: (1) Study carefully the language of the students, (2) secure from the students as full a statement as possible of their knowledge of the subject, to learn both their ideas and their modes of expressing them, and to help them to correct their knowledge, (3) express



yourself as far as possible in the language of the students, (4) use the simplest and fewest words that will express your meaning, (5) repeat misunderstood statements in other language, (6) try to increase the students' vocabulary, (7) do not require long periods of silence on the part of the students, encourage them to talk freely; (8) test frequently the students' understanding of the words he/she uses.

Violations and mistakes of the law of teaching are: (1) Being fooled, by students' facial expressions, to think that they have understood .. the students may unknowingly have misunderstood the meaning of an statement; (2) misuse of the language is one of the common faults in teaching; (3) a break in the connection caused by a single unusual or misunderstood term, and failure to detect the break and restore the connection; (4) failure to secure from the students clear statements to test their success in understanding; and (6) failure of the teacher to have proper appreciation of the wonderful character and complexity of language.

V. The Law of the Lesson

“The truth to be taught must be learned through truth already known.” This is perhaps one of the most significant in engineering education, in view of the fact that most engineering courses have prerequisites. Not only that, but we permit students to progress from course to course without full comprehension of the course material. When a student earns a ‘C’ in Calculus I, for example, is he/she prepared to continue on to Calculus II? Yet common practice permits this progression.

Students “learn the new by the aid of the old and familiar. The new and unknown can be explained only by the familiar and the known,” states Dr. Gregory in introducing the law of the lesson. “If the subject is wholly new, then a known point must be sought by showing some likeness of the new to something known and familiar.” Learning must proceed in graded steps, with each new step linked to a previous step. “Each new idea mastered becomes a part of the knowledge .. and serves as a starting point for a fresh advance .. Each step must be fully mastered before the next is taken ..” How can the unknown be used to explain the unknown?

Of all the laws discussed herein, this is perhaps the most difficult simply because it relies on a structure which is generally beyond the control of the teacher. There are a few steps we can take, however, as Dr. Gregory points out in his rules for teachers. They are: (1) Find out what your students know of the subject you wish to teach to them; (2) make the most of the students' knowledge and experience; (3) encourage the students to clear up and “freshen” their knowledge by whatever means; (4) begin your lecture/study with facts or ideas that lie near your students; (5) relate every lesson/subject as much as possible to former lessons and with the students' knowledge and experience; (6) arrange course topics so that each step leads easily and naturally to the next; (7) find illustrations in the most familiar objects suitable to the purpose; (8) make every new fact or principle familiar to your students so that it forms a good foundation for the next; (9) encourage the students to make use of their own knowledge and attainments in every way that is practicable (much easier these days with the availability of computer tools such as Matlab, Spice, etc.); and (10) remember that your students are learning to think, and that to think properly they must learn to face intelligently and reflectively the problems that arise in connection with their studies.

Common mistakes and violations of the law of the lesson are: (1) To set students to studying new subjects for which they are inadequately prepared or not prepared at all; (2) to neglect to ascertain carefully the students' background; (3) to fail to connect the new topic to previous studies; (4) to consider past acquisitions as “goods stored away,” rather than instruments for further use; (5) every step is not thoroughly understood before moving on to the next step; (6) to make assignments of unreasonable length and time, making mastery of the principles impossible; (7) to fail to instill in the students an attitude of discoverers; and (8) to fail to show the connections between parts of the subject that have been taught and those that are yet to come.



VI. The Law of the Teaching Process

“Excite and direct the self-activities of the student, and as a rule tell him nothing that he can learn himself.” The law of the teacher spoke to the qualifications of the teacher. This law is directed toward function. It suggests that the teacher is “transmitting experience” to his students. Dr. Gregory suggests that teaching should be conditioned by that aim. “The actual work of the teacher consists of the awakening and setting in action the mind of the pupil, the arousing of his self-activities .. knowledge cannot be passed from mind to mind like objects from one receptacle to another, but must in every case be recognized and rethought and relived by the receiving mind.”

We all learn best by experience. Teaching is not defined by the knowledge we *give* too the students, but rather teaching is that which stimulates students to gain knowledge. “The eye must do its own seeing, the ear its own hearing, and the mind its own thinking, ..” states Dr. Gregory. Not an easy thing to do with a large room full of students, but still a worthy and necessary goal. The laboratory orientation of most engineering curricula serves well to aid in meeting this “law.”

Rules for teachers, as prescribed by Dr. Gregory, include: (1) Excite the students’ interest in the subject .. attempt to awaken inquiry; (2) place yourself frequently in the position of a student among your students, and join in the search for some fact or principle; (3) repress your impatience .. wait for the student to explain himself/herself; (4) observe the students to catch wandering minds; (5) give the students time to think, and encourage questions; and (6) don’t exhaust a subject .. leave additional work to stimulate the thought and the efforts of the students.

Common violations and mistakes are: (1) The attempt to force lessons by simply “telling;” and (2) to refuse students time to think when questions are asked in class.

VII. The Law of the Learning Process

“The pupil must reproduce in his own mind the truth to be learned.” Dr. Gregory presents five phases of the learning process, which can be summarized as: (1) Simple memorization; (2) understanding of the thought; (3) translation into the student’s own words; (4) ability to give reason for the things he/she believes; and, finally, (5) ability to make connections and applications of the knowledge.

Practical rules for teachers and learners include: (1) Help the student to form a clear idea of the work to be done; (2) ask the student to express, in his/her own words, the meaning of the lesson as he/she understands it, and to persist until he/she has the whole thought; (3) cause the student to expect to have to give reason for his/her opinions/statements; (4) aim to make the student an independent investigator; and (5) assist the student to test his/her conceptions.

Violations and mistakes, suggested by Dr. Gregory to be the most common and most fatal, are: (1) Leaving the student “in the twilight of an imperfect and fragmentary mastery by a failure to think it into clearness;” (2) failure to insist upon original thinking by the students; (3) insisting upon the language of the textbook and not encouraging the students to try their own power of expression; (4) not questioning the statements of the lesson; and (5) neglect of practical applications.

VIII. The Law of Application

“The completion, test and confirmation of the work of teaching must be made by review and application.” The chief aim here is to perfect and confirm the knowledge gained and to render it ready and useful. Review and rethinking of the subject is critical lest the study be left half done. Making application of the knowledge, as through laboratory projects, serves to fix it into memory and build understanding.



Practical rules for teachers in this regard are: (1) Reviews should always be considered to be in order; (2) have set times for review, e.g., at the beginning of each period; (3) close each class period with a summary; (4) following several weeks of study, stop for a review from the beginning; (5) make reference (review) to a former, related, topic whenever appropriate; (6) when beginning a new topic, review related previous lessons; (7) the final review should be “searching, comprehensive, and masterful,” (8) find as many applications as possible; (9) do not neglect hands on work as part of the review; and (10) encourage the students to ask questions on the material of previous lessons.

Violations and mistakes in application of the law of review and application include: (1) Total neglect of review; (2) wholly inadequate review; (3) postponing review until the end of the term; and (4) offering a “lifeless and colorless repetition of questions and answers” as review.

IX. Summary

Basic? Yes. Do we break these “laws?” Yes. Do our infractions impact student learning? Yes.

Our challenge, as we move toward the next century and as we attempt to absorb and make use of new technologies, is to obey these laws of teaching and learning, whether we are lecturing to a class of 50 students, developing and applying lessons employing multimedia, or implementing “distance learning,” in whatever format.

At the end of his book, Dr. Gregory states "The study of these laws may not make of every reader a perfect teacher; but the laws themselves, when fully observed in use, will produce their effects with .. certainty.."

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1. John Milton Gregory, *The Seven Laws of Teaching*, The Pilgrim Press, 1917, as revised by William C. Bagley and Warren K. Layton.

Biographical Information

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