Proposed use of Focus Topic Grids to measure Learning Outcomes

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Section One: Overview

The program we might propose to, over time, put into place would use specific pedagogical guidance, specific web based resources, some new low cost office equipment, and the current curriculum for each core mathematics course. The work is generalized to work within any university or college, and thus becomes that basis for service from Atlanta Metropolitan College to the University System of Georgia.

All courses taught at a two-year college, or during the first two years of an undergraduate program, may be categorized specifically as:

(1) The calculus series,
(2) Linear algebra and numerical analysis,
(3) Probability with statistics,
(4) The core liberal arts mathematics requirement
and
(5) Precollege curriculum given to under prepared freshman students.

Each program may have a focus topic grid that instruments measurement within the program's course work. For example, we take a specific catalog description from our work in the business department while at Norwich University.

	notation	theory	illustration
(1) set theory, basic			
(2) set theory, intermediate			
(3) real number system			
(4) fractions			
(5) fractions in bases other than ten			
(6) elements of abstract algebra			

Figure One: The beginning elements of a freshman Focus Topic Grid

This example of a focus topic grid is specified at a high level, and must be seen in that light. In Section 2 (unwritten as of Oct 18th) we will look at how a focus topic grid is being used in our teaching effort this year.

The grid in Figure One is focused on those elements from foundational algebra, set theory and arithmetic that a business major might find helpful in understanding linear equations and applied statistics. Each of the six focus topics maps to one or more additional focus topic grids where the high level topic is decomposed into subtopics. This decomposition is an essential element of our innovation. Measurement may occur at the subtopic level and then measurement aggregated to automate the use of the high level grid. Programs may be aggregated to general educational requirements and college learning objectives.

1.1: Generality of our measurement instrumentation

The proposed measurement strategy has specific guidance that may be communicated to members of the teaching staff, including adjunct instructors. However, it is noted that individual teaching styles are to be respected, and opportunities given for adjuncts and full time professors to make modifications to the pedagogy. Core principles, however, should be communicated and regular meetings held, particularly in regards to any precollege curriculum given to under prepared freshman students. Pre-college material and courses present a particularly difficult challenge. It is this fifth category of courses; e.g., precollege curriculum given to under prepared freshman students that we focus on.

From catalogue description and the assigned textbook, any faculty may develop a minimal list of focus topics. This year, our 0097 and Calculus I classes are now developing a focus topic listing, from direct student experience. The students are learning how to make this listing as part of their assuming greater responsibility for self-assessing learning outcomes. *Appendix One, Notation taught students to aid in self-evaluation*, shows the notation they have learned and are using. Given any homework or test problem, they are asked to indicate a focus topic, or set of focus topics, also to self-grade based on a three element learning taxonomy; use of notation, capacity to discuss theory, and illustration of a subject.

Self-grading brings an awareness, to the student. This awareness is different from that of typical developmental students who have well-established wrong ways of working algebra and arithmetic problems. As a general statement, no underlying coherence is found in these students' work. They often deny having any learning or behavioral problems. Steps made in solving a linear equation will have numbers that seem to appear out of nowhere; and for which there is no justification. Theory is rejected as un-

learnable.

The first learning objective is; therefore, to obtain agreements from the student that arithmetic and algebra may be preformed correctly so as to always obtain correct answers. First learning objective for developmental courses might be to bring awareness to the student that there is a foundation to arithmetic and algebra that may be cultivated. Self-grading may be the optimal means to achieve this objective. Traditional grading is often seen as a type of punishment, even if the answers are correct.

1.2: *Four Step Modified Method* ™

An important pedagogical element is captured in a *Four Step Modified Method* ™, developed this year, which ™ is a revision of the demand side learning methodology developed at Talladega College (2007-2008), Lane College (Fall of 2008) and Norwich University (2008-2010). The four steps are:

1) **Complete Exposition:** Complete fully the exposition of an exercise he or she has selected from some textbook.
2) **Focus Topic Selection:** Give the reason why the exercise is selected, using an identification of the "focus topic".
3) **Revision:** Revise the exercise by changing something, without altering the focus topic.
4) **Extension:** the deep understanding of the focus topic by using set or algebraic notation.

If implemented across the board in all entry-level developmental mathematics courses, 0097, we will be able to evaluate all students with a focus topic framework across the following learning taxonomy:

{ Notation, Theory, Illustration }.

One of the tools that might be used uniformly is the *Four Step Modified Method* ™ and self-evaluation. In addition to developing homework and test using the four steps, students might draw a box with four divisions. For example, one exposition might be about adding fractions, with the student self-assigning the following grades.

Adding fractions	70/100	40/100	100/100

Figure 2: Self evaluation instrument

The focus topic is self-identified. The student gives him or her self a grade on the use of

notation, description of underlying theory and illustration. Using the four-step method, students self select an exercise from the book. He or she uses proper notation and complete "sentences" while avoiding overwriting their work or making non-legible marks on the paper. A student revision of that exercise is followed by some attempt to discuss the underlying theory or to point out the use of laws of arithmetic.

1.3: Types of revisions

In many exercises from standard books, the exercises are selected to have overly simple answers; usually in the form of positive integer answers. Part of this practice may be seen as a business response to market forces. One consequence of this is the profound barrier that fractions and decimals now contribute to. Students should be encouraged to see that the real world is not often explained using only positive numerals. For example the exercise; 4 * x = 8, is preferred in textbooks over the exercise; 8 * x = 3. The exercise; 3 x = 7 would almost never be seen, as the answer, 7/3, is regarded as an "improper" fraction. By self selecting exercises and then modifying those in the book, the student comes to see that fractional and decimal arithmetic is essential. There is a deep internalization of the ownership over the selected problems. This ownership is reinforced by the grade self-assignment. The use of a calculator also has contributed to a dependence on easy problems solved using any thing other than one's own mind. Revisions open the door to self-exploration and ownership over the problems that the student works. Part of this task is to learn how to check the answer using one of several methods.

1.4: Core principles defining "demand pedagogy"

Core principles are more fully developed and illustrated in the book, "*The Education Bridge, a Bridge to the Future*", which is nearing its publication[1]. An unexpected conjecture frames a set of core principles, which is based on a review and application of first principles from theoretical immunology[2] and cognitive neuroscience[3] [4]. These first principles include:

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[1] Prueitt, Paul (2011, in review and editing). ***The Education Bridge, a Bridge to the Future*** is available for review at www.secondschool.net/bridge.pdf

[2] Eisenfeld, J. & Prueitt, P.S. (1988.) Systemic Approach to Modeling Immune Response. Proc. Santa Fe Institute on Theoretical Immunology. (A. Perelson, ed.) Addison-Wesley, Reading, Massachusetts.

[3] Levine, D. & Prueitt, P.S. (1989.) Modeling Some Effects of Frontal Lobe Damage - Novelty and Preservation, Neural Networks, 2, 103-116.

[4] Levine D; Parks, R.; & Prueitt, P. S. (1993.) Methodological and Theoretical Issues in Neural Network Models of Frontal Cognitive Functions. International Journal of Neuroscience 72 209-233.

1) As a supplement to the traditional curriculum, we use topical elements that have not been seen by the students, so as to establish a fresh look for the student,

2) We recognize that the student's capacity to learn and perform skillfully is strongly impacted by poor experiences in K-12 and,

3) We use a constructivist, participatory and Socratic method called "demand pedagogy" to replace or supplement traditional classroom practice.

The novel curriculum is seen as necessary, given that a resistance to learning the standard curriculum has been established. The mechanisms involved in establishing an acquired learning disability are understood as a response to under stimulation while experiencing poor instructional practice. Novelty assists us because this response system is quite different from the habituated response system. The mechanisms involved in creating a positive response use novelty so that existing habituated learning responses are by-passed.

1.5: Finding firm ground

A student finds a firm ground on which to base a new image of self. The critical recognition is that under stimulation and poor experiences have lead to problems with individual student self-image; e.g., self-efficacy. They are generally not motivated by any learning objective, and merely participate to the minimal degree possible. Across the nation, most developmental classes experience attendance that is often less than 60%. Poor participation by students leads to a habituation of two categories of institutional outcomes. The first is to fail students who do not attend. The second is to pass students regardless of test grades or attendance. In either case, enrollments are not impacted since society has created an over supply of new students.

Finding firm ground is essential for students who are under and poorly prepared. Students in the developmental arithmetic classes do not have a working model of what are called the laws of arithmetic, the concept of an equation, or any of the foundational notions in the construction of the real numbers with addition and multiplication. In our development of pedagogy we have documented five case histories[5] involving semester or year-long experiences in teaching developmental arithmetic. The first of these case histories was developed at Hampton University in 1988-1990. The sixth case history is

[5] Prueitt, Paul (2011, in review and editing). ***The Education Bridge, a Bridge to the Future, Section Seven, The Lifting Pedagogy.***

being developed as part of our work this academic year, 2010-2011.

The new element, this year, is a metaphor between what the students know of judicial review and adjudication and the use of the nine laws of arithmetic, the two laws of equality, the law or inequality and the construction of the real numbers with addition and multiplication. A comparison is made to Constitutional law and basic rights of man. How might a person judge whether something is lawful or not? Fourteen reasons are then available so that a solution to an algebraic expression might be made in a "lawful" fashion. These fourteen are the nine laws of arithmetic, the two laws of equality, the law of inequality and the two constructions for addition or multiplication of real numbers.

1.6: Extending the current work on Focus Topics

The two dimensional framework we propose follows the methodology developed by the National Council of Teacher of Mathematics (NCTM). Following this over one decade, old work by the NCTM, we may develop a broad-narrow taxonomy of focus topics for each of the courses being measured; e.g. calculus I II and III, linear algebra and numerical analysis, probability with statistics (pure mathematics with some applications), as well as the core liberal arts required courses.

The broad taxonomy is exemplified in Figure One. The narrow taxonomy is then used in primary measurement from student performance, and a score is then computed for the broad topical representation.

The key is, to minimally cover a broad topic with narrowly focused but foundational topics. A wonderful analogy is made to the axioms and postulates in geometry. These self-evident assertions serve as an axiomatic cover over all theorems in geometry. We realized then that the taxonomy must have a foundational set of learning objectives defined as narrow topics. The focus topic grid is then the cross product between a list from this set and a list from the quality of learning taxonomy. Properly specifying specific two-layer focus topic taxonomy has some significant challenges. The first of these is that the narrow themes must appear in more than one broad theme in much the same way as the theorems of geometry utilize more than one axiom/postulate.

1.7: What is a framework?

The focus topic framework creates a means to comply with state laws, while at the same time providing the flexibility required for self-directed study using demand pedagogy.

The student is allowed to select topics, categorize these as being comfortable with or not, and then study deeply that part of the entire curriculum which will benefit him or her the most. Self-selection serves to create individual ownership over this process.

1.8: Demand Side Learning

State law is complied with because the curriculum is fully identified and each day's class procedures are also clearly identified. Each day, students will "demand" clear expositions at depth of subjects that they have selected from the list that is posted on the web as the curriculum for that course. This is what "Demand Side Learning" means. Demand side learning may be contrasted with supply side learning, as we have done in the first chapters of *The Education Bridge*.

1.9: The Use of Topic Enumerations to Aid in Self-directed Learning

In our classes we ask each student to descriptively enumerate a topical cover over what he or she is studying. This is done each week, with a requirement that the students select and turn in sufficient exercises from the textbook, each being exposited using the *Four Step Modified Method* ™ written on one sheet of blank copy paper. We take up this work, use office equipment to drill three holes and place into a binder. This paper is then scanned with a high-speed scanner.

Scanning produces a permanent repository from which to measure individual progress over the course of his or her college career, as well as to create statistics on the program's performance. Placing incoming homework into a binder helps the very difficult task of managing student paper when students are not attending on a regular basis. The handwritten exercises create valuable discipline and uniform form.

For future teachers *Four Step Modified Method* ™ is useful as the enumeration activity itself creates an over view of the curriculum. We also perceive, and have extensive evidence of individuals demonstrating positive results from self-directed study. We measure evidence that learning occurs within the context of a specific part of the curriculum, and at the end of the semester, the entire prospectus.

Second Two: The Experience with Under-served Populations

The experiences over the past two and one half decades have been from teaching primarily in open access colleges having minority populations and minority administrations. We also have teaching experience at elite colleges. It is easy to show that the phenomenon we observe is only slightly pronounced when compared with Ivy League colleges. It is even easier to see the consequences of a wide variety of cultural phenomenon; including the over use of information technology, the impact from advertising, and negative cultural histories related to racism, egotism, nationalism, or self centeredness. We have talked, in *The Education Bridge*, about these issues in the context of the concept of ownership.

We have made the principled argument that the Bridge technology should be developed over an eighteen-month period using a budget of sixty million dollars from federal funds and used to create the future infrastructure for localized e-governance. We have proposed that the People create a public sector infrastructure for the use of a new public sector so that we may have control over our education and our private lives. This control is hotly contested from that 1% of people who have most of the effective ownership over natural resources. The private sector is seen as a servant of this 1% of humans.

We see a massive encroachment on the learning process. Damage to the learning process is seen in large and expensive textbooks, and in requirements that computer technology be used in even the most non-technology related subjects. For example, we saw the replacement of the chalkboard with the white board; a replacement that is in even way negative. The white boards are far more difficult to write clearly on. We see classrooms where small white boards are supposed to be used to teach mathematics, something that is virtually not possible to do. We see college administrations not providing classroom resources while also requiring the use of methods that are widely understood to be ineffective. We see the role of faculty reduced to that of a simple machine.

The proposed development of demand theory has a pedagogical, curriculum and a technology component; all of which are to be integrated. As we do this, the technology will become transparent, so that when used is not the distraction we now find in computer tutoring systems. It is also to be developed without proprietary ownership by corporations. The technology design is in fact illustrative of natural principles seen in

how nature is organized. This the pedagogy and the technology is mutually grounded in natural science, as we discuss in detail in *The Education Bridge*.

Demand theory requires a stratified view of natural processes, and with this view the placement of the individual human in an action perception cycle; e.g., a learning cycle. This cycle must have no advertising and no third party ownership, else the observed phenomenon related to control over population behavior will not be moderated.

Once the principles of pedagogy are well known and existing virtual world technology refactored so as to have a computing backplate, we will see the emergence of community intelligence as political forces. These emerging political forces will finally set aside the now dominate and growing capital driven instruments shaped by the 1% who believe that they should be in control of everything.

Section 2.1: The evolution of the demand pedagogy (to be written)

Appendix A: Notation taught to student to aid in self-evaluation

A notation is taught to class participants and then used by the students to talk, or write, about what they have learned.

Let

$$P = \{ \text{ notation, theory, illustration } \} = \{ a_i \mid i = 1, 2, 3 \},$$

and let

$$C = \{ \text{ topics in the standard curriculum in Chapter } \} = \{ t_i \mid i = 1, 2, \ldots n \}.$$

The cross product of C and P is called the focus topic framework.

$$C \times P = \{ (t_I \; a_i) \mid i = 1, 2, 3 ; \quad j = 1, \ldots n \}$$

A student composition is then a composition of a focus topic framework element

$\{(t_1 \; a_i) \mid i = 1, 2, 3)\}$ followed by a composition of

$\{(t_2 \; a_i) \mid i = 1, 2, 3)\}$, followed by a composition of

$\{(t_3 \; a_i) \mid i = 1, 2, 3)\}$

etc.

as seen in an illustration at the URL: http://www.secondschool.net/inSL/7.html, or in current student test taking in Calculus I or 0097.

Appendix B: The Problem of Subjectivity in Measurement

The measurement we propose taking is on a subjective evaluation by the student (with review by a professor) using a scale similar to a Likert scale; e.g., strongly disagree, disagree, no opinion, agree, strongly agree. [6]

Subjective measurement by students has a number of methodological issues. We are also interested in an assignment of an "oppositional scale" number between -10 and +10 based on professor grading of pre-college level courses given by universities or colleges.

These measurements must be gathered into a repository so as to build a portfolio for each student indicating, at depth the deep learning that is or is not occurring.

This measurement instrument might be used to develop a high-resolution description of the focus topics in a chapter, and then chapter by chapter develop a representation of curriculum as a set of focus topics.

[6] http://en.wikipedia.org/wiki/Likert_scale