Learning Outcomes using Focus Topics and Virtual Worlds

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Executive Summary, for the Georgia Virtual Education Bridge proposal

How might learning outcomes be measured and improved? What structural changes have been made in the Learning Support program at many colleges? One example is found in the form of modularization of developmental program into parts of semester. A second example of such a change is a procedure to accelerate successful AMC students from 0097 to 1111[1]. The results are easily shown to be marginal. Such marginal results reflect the difficulty, and the complexity, of the learning-support task. The proposed Center of Excellence will fully acknowledge the difficulty that all mathematics departments, across all fifty states, have found. Scholarship on remediation strategies will be supported.

Over the past two decades university and college faculty have seen a constant decrease in demonstrated skills and knowledge. Students are not demonstrating deep understanding of focus topics selected from developmental mathematics and freshman liberal arts major mathematics courses. This absence of demonstrated mastery over curricular elements extends to undergraduate programs.

It is conjectured that difficulties are "acquired" by most children during a formative period while in K-12 education. The difficulties are seen in all segments of the entering college population and are supported by practices related to social consumerism. For example, last year only 21 out of 952 and 18 out of 825 enrolled 0097 students were able to move from 0097 to 1111. This is 2%.

One benefit of our current active and well-supported learning support program is that 1111 classes have better prepared students. Might this be measured? The success rate for students who pass 0097 and move into 0099 reflect a qualitative difference between 0097 students advancing to 0099 and incoming students placed into 0099 using standard COMPASS placement exams[2]. Outcome measurements might be derived from a departmental test measuring the retention of curriculum focus topics, by AMC students, at three levels; skill, knowledge of, and understanding of the theory underlying 0097 curriculum.

[1] Mathematics 0097 is the first semester of a two-semester developmental mathematics program. Mathematics 0099 is the second semester. Mathematics 1111 is the AMC college algebra course.

[2] This statistical work has not been developed. Longitudinal studies are needed to know if any of these 35 students enrolled in and passed 1111 the following semester.

Section One: Proposed use of Focus Topic Grids to measure Learning Outcomes

The Center, if funded, would proto-type a specific set of remediation strategies. These strategies are based on a theory that purports to explain the causes of and manifestation of a category of learning difficulties.

A discussion paper is advanced as a first step in creating a department consensus. Once this consensus is reached, we may seek sufficient external funding so as to develop a Center of Excellence within the University System of Georgia (USG). This Center would advance the use of web based and virtual world social networks for the purpose of transitioning Georgia's high school population from high school curriculum and behaviors to college curriculum and behaviors.

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 to be generalized to work within any university or college, and thus becomes a basis for service 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. An example of a focus topic grid is given in *Section 1.2.* This measurement may be assisted using a hand held device with a dedicated database, or with paper based data repository; e.g., with no computer technology at all. In a distance learning setting, the measurement may be served using the professor's computer. The marketplace has not supported the easy availability of these technologies for reasons

that are discussed in *The Education Bridge*[3]. The Bridge is a proposed public sector infrastructure that would be dedicated to supporting the transition from high school to college, nation wide.

The design of policies and procedures using deep measurement of student learning status has been advanced in *Chapter Seven: The Lifting Pedagogy*, in *The Education Bridge*. As discussed in the *Bridge*, the entirety of our work up to 2008, was without any use of digital technology. We focused on pedagogy and on understanding policies and procedures within colleges and universities. During the academic year 2009-2010, we began to use web-based technology to teach computer science using focus topics. We also positioned ourselves for participation in the leading edge of dedicated educational use of virtual worlds; e.g., 3-D simulation environments. We can now see how easily digital devices, such as paper scanners, computer databases with well-designed interfaces, and virtual world components might be used as an inexpensive aid for developmental mathematics.

The work advanced in *The Education Bridge* is a reflection on a specific social observation. Our society accepts a common negative orientation to college mathematics. The argument is made that our technology marketplace cannot be responsive to a critical need, due to a specific cultural entrenchment. This entrenchment has its causal origins, we conjecture, in well-established cultural histories, such as nationalism, sexism and racism. The intent of the entrenchment, as conjectured in the *Bridge*, is to restrict deep knowledge of science and mathematics. Aligned with this intended restriction is confusion about the nature of ownership and human communication. This confusion has produced a poor information theory, including the mythology of Artificial Intelligence and related viewpoints, as well as has bogged down the "free market" development of open source software and infrastructure.

The above argument may be seen to justify the use of federal funding designed to develop open source software, and both data and process standards, so that an optimal software code base might be available to the iPad and similar digital devices. How might methods exposited in the *Bridge* apply to the immediate needs of departments of mathematics? One answer is in regards to the measurement of learning. Longitudinal studies are needed to know if any of students enrolled in and passing 0099 also enrolls

[3] 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

in and passes 1111 the following semester. The open source software, proposed in the *Bridge*, is specifically designed to make these measurements and to persist the data in an informationally secure way.

The measurement is made through a process that shifts responsibility for learning for the system to the learner. The measurement of student progress using a focus topic grid may allow the individual to have more control over when evidence is given that material has been mastered. This additional freedom is allows individual students to create one-to-one learning contracts while assisting the professor in managing individualized learning programs. The need for individualized learning programs may be obvious given the average failures rates in developmental studies of 70% across all colleges and universities in the United States. This failure rate is now all to often justified by faculty and administrations. Again, some deep-seated cultural problems are responsible for this entrenchment.

The use of a computer based focus topic database for each student is also consistent with pedagogy such as the *Modified Four Step Method* ™, discussed in *Section 1.3*.

1.1: The Problem is a Failure to Communicate

Our funding argument is that the use of a four-step method; introduced in *Section 1.3*, and focus topic frameworks; see *Section 1.2*, increases the ease at which each student and the professor are able to communicate about the individual learning process. In upper level mathematics courses the maturity of the student and the generally small class size may increase communication between professor and student. However, in the developmental and college level non-major courses, communication about course content is held to a minimum. A number of factors are involved.

Core to most of these is the student's past training and to a cultural disregard for the value of underlying abstract theory, as seen in the preliminaries to the algebra. These factors are not uniformly affecting students in a standard developmental class. There is; however, a hard core to cultural disrespect for the learning process in college mathematics classes. A significant percentage of students will slow down the rest of the class. These individuals are just as important as anyone else and often the behavior is one that has been learned during the K-12 years. A uniform set of procedures is needed to identify individuals that need specific consulting regarding this behavior. The expression of the behavior in class has to be limited.

Faculty members also need to have a common understanding. The *Bridge* proposes a theory involving a deep and thus difficult shift in personality traits. We suggest that the student must undergo a type of radical transformation similar to a religious re-birth. The natural science underlying Acquire Learning Disability theory is essential. A social justification to the necessary interventions must be made, if the individual is to ever have a "normal" view about arithmetic and algebra. Recognition that a specific type of learning disability is present and may be remediated is often thought of as a necessary first step.

Using the COMPASS test, the 0097 class is measured and constituted as homogeneous using standardized multiple choice college entrance exams. However, as soon as some students begin to advance, the homogeneity is lost. Classroom management becomes a limiting factor leading to the observed failures rates. So what are the solutions? At some point students need to be able to join in small groups and assist the professor in managing this diversity. In Prueitt's class in the fall of 2010, there are four or five exceptionally responsive students in each section, each section having an attendance of around 20. In each case, each of these individuals has been allowed to develop a small peer-to-peer study group using class time. This is enormously helpful. However, we need to take some additional steps, one of these is in the use of social network software. Social networking might be seen as ideal for any small group formation, but tools are not in place to make this work seamlessly. So an early focus of our work has been to develop virtual worlds and cell phone social networks that students may access 7-24. This is far easier than one would think, given the current state of virtual world use as dedicated education infrastructure.

So the problem we are resolving is in response to student behaviors and expectations. Student immaturity is often a classroom management problem. In the typical developmental class some students exercise a great deal of control over class time. Often this control is intended to slow down presentation of material or to conform the professor to the expectations of what is often a majority of students. The behavior is understandable and from one point of view justified. Students are avoiding being challenged. The conjectured acquired learning disability explains why. Attempts to change this avoidance behavior meet specific and well-defined resistance due to acquired and deeply held personal behaviors.

Prueitt's conjecture regarding acquired learning disability is presented in *The Education*

Bridge. In summary, under stimulation during the long and formative period while a student is in K-12 education is conjectured to lead, over time, to a biologically reinforced inhibition of the capacity to do fractional arithmetic. Let us look at specifics. The average developmental mathematics student is not able to retain the ability to solve the general problem of the type:

$$2/3 * x = - (4/5)$$

even if this capacity was demonstrated one week earlier.

Case studies could be reported here, where it not for regulations regarding human subject research. However, the general nature of the commonly observed learning difficulties may be discussed, and as approvals are sought for clinical-type studies we will be able to fill in the details. In very general terms we may make some remarks about our experiences this semester. In around seven to eight individual instances in each section, the student is stuck with the belief that actual understanding is beyond his or her self. So if actual understanding does occur, this "learning" is felt as being at odds with the well established self-efficacy; e.g., the image of self. So the learning is challenged and quickly the new capability is lost again.

This inability to retain understanding is also noted across the board in all fields of study. Retention may in fact be the epicenter of the crisis in American education. Retention requires internalization of content, something that did not occur in K-12. In my classes this semester, several individuals have developed a faith that there can be a shift in actual ability. This developed faith is very carefully encouraged in the class, and requires a lot of one to one discussion.

We are not merely attempting to create a type of philosophical conversion. Our remediation of acquired learning disability requires the student to develop an appreciation of the laws of arithmetic and the construction of the set of real numbers. The theory underlying how the above algebra-in-one-unknown problem is solved opens the student's mind to higher mathematics, but most developmental students regard this theory as unlearnable. Much of the class behavior arises from this opinion, and is thus justified unless strong evidence is provided to the individual. This provision of evidence is time intensive.

1.2: 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 should be communicated and regular meetings held, particularly in regards to any precollege curriculum offered 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. The Center will have responsibility for looking across the board in Georgia so that what is working can be communicated.

Focus topics are a natural means to evaluate program success. From catalogue description and the assigned textbook, any faculty member 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.

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.

The grid in Figure One is focused on those elements from foundational algebra, set theory and arithmetic that a business major might find helpful to his or her learning task: such as 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. Program learning objectives may be aggregated to general educational requirements and college learning objectives.

We encourage self-assessment. Self-grading brings an awareness to the student. This awareness is different from that of typical developmental students. The use of the Modified Four Step Method ™ creates the scaffolding that supports a shift from passive non-participation to active demanding of clear explanations. In each class, a core of around four to six students religiously develops self-selected homework problems using the Method. As a general statement, an underlying coherence is found in these students' work. Steps made in solving a linear equation will have full justification. Theory is seen as 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. The individual acknowledgement that learning can occur is a learning objective. This learning objective brings awareness to the student that there is a foundation to arithmetic and algebra and that this foundation 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 but particularly when most answers are not correct.

1.3: 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 by the department's faculty 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 instruction become very student centered, while also being centered in the actual curriculum. A focus topic is self-identified. The Four Step method is used. The student gives him or her self a grade on (1) the use of notation, (2) description of underlying theory and (3) 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.

1.4: 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. The demand is deemed to be for simpler and simpler problems, while a sense of selection is imposed. Students get selected out of the group who will be comfortable in a mathematics class in college. They participate in this selection. 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, 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 test grade self-assignment. Students sometimes will not give themselves a grade of A unless there is actual learning. In other cases, the student demands an A while maintaining that learning is not possible. 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. Checking procedures in the pedagogy we developed in 2006-2007 at Talladega College allowed students to learn and study arithmetic without any need for a book as discussed in *Chapter Seven: The Lifting Pedagogy*; in *The Education Bridge*.

1.5: 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[4]. An unexpected conjecture frames a set of core principles, which is based on a review and application of first principles from theoretical immunology[5] and cognitive neuroscience[6] [7]. These first principles include:

1) **Novelty Principle:** 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) **Recognition of Damage from K-12:** We recognize that the student's capacity to learn and perform skillfully is strongly impacted by poor experiences in K-12 and,

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

A novel curriculum is seen as necessary, given that a resistance to learning the standard curriculum has been well established culturally as well as within the individual student's self efficacy. 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.

1.6: Finding Firm Learning 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., sense of self-efficacy. The enrolled students 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% each class period. Failure rates are between 60 and 80%.

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[4] 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

[5] 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.

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

[7] 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.

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. This observation is a critical one if we are to understand that virtually no feedback stimulus is directed at actually improving outcomes radically. Small gains are also rare.

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[8] 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 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.

1.7: 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

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

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 learning 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 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. We address this concern with formal knowledge management type methods.

1.8: What is a Framework?

The focus topic framework creates a means to comply with state laws, while at the same time providing flexibility as required by 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. The framework guides the individual as well as provides objective evidence for mastery of focus topic areas.

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.

The handwritten exercises create valuable discipline and uniform form. 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. We are also able to accept homework via email or uploaded images in a virtual world. When the handwriting is original, there is no longer an issue about whose work it is.

For future teachers *Four Step Modified Method* ™ is useful. 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.

Section Two: A hybrid regular classroom - distance learning environment

This second section will outline our thinking on a hybrid classroom – distance-learning environment.

A team of computer scientists, under the direction of Professor John Rogate at Champlain College in Vermont, will provide technical support during the deployment of a new virtual world system, similar to Reaction Grid or 3rdRock. This functional 3-D simulation will serve to familiarize faculty at Atlanta Metropolitan College with virtual world capacities, and as a means to allow faculty to participate in virtual conferences held as part of educational uses of Second Life, 3rdRock, Reaction Grid, Quest Atlantis, Blue Mars, and any other virtual world hyper grid. Faculty will be assisted in developing in-world avatars and learning how to build simulations. The URL, www.educationWorlds.com, will be used as a communications page where all members of our team will be able to find up to date information on virtual events of interest to educators.

2.1: Adherence to Ethical Standards

AMC's virtual world presence will exhibit high standards as exemplified in the Mission Statement of the University System of Georgia (USG). The active participation by Atlanta area faculty in educationWorlds events will bring all participants high quality knowledge about cutting edge virtual world use in education. A trust is established. This trust is meet by responsible use of the educationWorlds sim. The sim will be 100% monitored, following the example of several university joint projects with K-12 institutions. As part of our prototype work, FERPA policies[9] will be developed and adhered to.

A hybrid distance learning classroom program could be proto-typed starting in January 2011, if approved by AMC Academic Vice President. The program will be a supplement to the first of two semesters of developmental mathematics, Mathematics 0097. All 0097 sections, approximately 30 sections enrolling over 1400 students, will qualify for participation during the spring semester 2011. Professor Prueitt is scheduled to teach two sections of 0097 in the spring term 2011 and is currently teaching three sections of 0097 students. His work with students selected from these two sections will be viewed

[9]The Family Educational Rights and Privacy Act (FERPA) text and annotations may be reviewed at the web site: http://www2.ed.gov/policy/gen/guid/fpco/ferpa/index.html

by other faculty participants, and is thus subject to FERPA policies. These policies will be spelled out in a work product to be produced by two of our Principle Investigators (PIs), Choi and Prueitt.

The instructional media to be revealed to 0097 students in the eW sim during the spring 2011 semester at AMC will produce focus topic specific measurements of learning, with specific measurements taken over time. Measurement will be developed using a topical cover over the existing curriculum, as discussed in *Section One*. The eW sim will specifically target assistance to enrolled 0097 students. This focus topic framework for the measurement of learning in 0097 has been discussed within the Department of Mathematics.

To be allowed into the eW sim, an individual student must demonstrate purposeful in-class advancement in their understanding of a specific set of focus topics. Each student must earn the right to be in educationWorlds, by demonstrating that he or she understands the Four Step Modified Moore Method ™, as discussed in *1.2: Four Step Modified Method* ™, in *Section One*. The student must show advancement as well as that he or she is taking the course material for Mathematics 0097 ***seriously***. An individually constructed contract must be written and signed by Professor Prueitt and the 0097 student. This contract will amend and extend the existing and approved course syllabus governing the student and class expectations, and professor responsibilities, in the AMC Mathematics 0097 course.

2.2: eW Participation is a Temporary and Inferred Right

Providing evidence about the Acquired Learning Disability (ALD) conjecture is critical to our responsibility to achieve measured full-remediation, even for adult and non-traditional 0097 students. However, the ALD conjecture claims that students have inhibited capacity. This inhibition is overcome by novel stimulus[10] [11] [12]. Student motivation and participation is essential to an engagement phase. To continue to be in eW, students must show interest in spending extra time as well as be able to ask questions about specific focus topics.

[10] Prueitt, Paul (1988) PhD Thesis, The University of Texas at Arlington; "*Mathematical Models of Learning in Biological Systems".*

[11] 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.

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

As a principle, students will be tested only on topics that they have indicated an interest in. Individuals will be supported in developing an avatar presence as well as to learn how to build simulations in any of the virtual world sims, such as Second Life. Nany Kayo, Director of Virtual Native lands in Second Life[13] is part of our team, and will help individual students create avatar personas. We will also use lessons learned from the Indiana University project with Australian schools, since 2005 working with groups of teachers and students in the Australian educational system[14].

This earned right is important. To continue to participate, individual students must demonstrate that they are advancing; otherwise the individual support for the eW sim will be withdrawn. The presence of support for learning is to be represented as an inferred right of temporary "citizenship" in educationWorlds. The team of computer scientists will attempt to develop means to support this inferred right within FERPA compliant measurement of student progress.

Demand theory requires an extensive scientific and technology background to understand fully. This requirement is discussed in great detail in the four hundred and fifty-plus page "The Education Bridge, pdf"[15]. For purpose of brevity, we summarize this proposal to the White House in four pages: "National Bridge from High School to College", in a pdf file available on the web[16]. Four technical papers discuss the grounding of our understanding, about the natural science regarding human learning, in a computable architecture for next generation virtual worlds. The grounding of demand theory in science literatures may uniquely characterize our proposals.

2.3: New measurement and analytic methods

Student disinterest in learning college mathematics is easily observed and may be quantified statistically. Given necessary support, professors Choi and Prueitt will organize some basic research on the statistical measurement of "Acquired Learning Disability", or ALD. This work will include clinical studies. The proposed studies involve measurement tools such as galvanic response, EGG or PET scans and are designed to give evidence that remediation strategies have success, or not.

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[13] The Virtual Native Lands sim in Second Life may be accessed via the web postal www.virtualNativeLands.org

[14] The Quest Atlantis project may be reviewed via the web site: http://en.wikipedia.org/wiki/Quest_Atlantis

[15] Prueitt, Paul (2010, published on the Web) Accessed October 2010 at www.secondSchool.net/bridge.pdf

[16] Prueitt, Paul (2010, published on the Web) Accessed October 2010 at www.educationworlds.com/pdf/nationalBridge.pdf

The development of proper pedagogy is the key. Being able to reveal this pedagogy in a hybrid regular classroom - distance-learning environment is what we might be able to do easily and soon. This hybrid approach is discussed in Section Three. What we are looking for is an understanding of a commonly used code base, so that a new architecture might be placed under the set of standards currently in use. The underlying architecture will run on a virtual machine having C-code expressions of a derivative of the Core Talk machine[17]. The derivative will have BIM services based on Prueitt's work [18].

In some cases, there will be lessons learned and data structures that have been shown to work. We are seeking some start up funding so that we can get the code base that Professor Rotate has running at Champlain College some of the faculty in computer science departments around Atlanta might do some basis work on key issues that have already been identified in discussions between the principle investigators.

2.4: Refactoring of Open Sim

Demand theory, as developed by Prueitt in *The Education Bridge*, is not merely about a new pedagogy. The theory also brings a technology and a new curriculum. Each of these three contributions is interrelated and has common elements. The technology reveals itself as a open source, non-proprietary, information science with high levels of information assurance and functional performance. The advanced curriculum is associated with simulation of physical systems using 3D simulation environments, common to 3D multiple user game environments. Part of the justification made for federal funding of the new public sector infrastructure is that our work has been seen as a pathway to a next generation virtual world hypermesh.

Educators have not been satisfied with realXtend; e.g., Open Sim, performance of the current system and no one is seeing the development of proper pedagogy in any of the virtual worlds. Part of the concern is about performance. We MUST be able to run at current Second Life performance WITH BIM. "BIM" standards for Building Information Model and was coined by Professor Charles Eastman at Georgia Tech. Prueitt's architecture promises a proof that BIM files may be accessed locally instantly using a

[17] Prueitt worked with CoreTalk founder Sandy Klausner from 1997-2009. For some of the architectural detail see the position papers at www.coreTalk.net

[18] Prueitt, Paul S (2009) Articulating SOA in the cloud, SOA Magazine http://www.soamag.com/I34/1109-4.php

referential information base (or "Rib"[19]). He coined the term, and developed the technology supporting, the Rib after work on the Hilbert Engine patent (1994-1999). The technical requirement is to run BIM equipped 3-D simulations, 3-D game data files and process ontology[20].

Part of the concern is that new developing “in-world” pedagogy continues to be supply side; e.g., the system supplies what the student must then learn. Demand pedagogy turned the tables and requires that the student take primarily responsibility for learning, and that learning focus not only on how exercises are to be completed, but why the exercises are completed the way they are.

Linking pedagogy with technology is not an end into itself, but rather the skills required of a knowledge age are precisely those that are developed under demand pedagogy. The modern student may see these skills as relevant, whereas a program based on supply side pedagogy may be seen as more of the same.

[19] Prueitt, Paul S (2010) Systems Science and Service Computing, submitted (Sept 8, 2010) to http://www.soamag.com

[20] Prueitt, Paul S (2010) Stratified Model over Transaction Services, (Oct 12, 2010) submitted to http://www.soamag.com

Section Three: Preliminaries to the first statewide Education Bridge program

This section will look at all aspects of typical college learning support courses: including recruitment, failure rates, and retention of knowledge when measured longitudinally. So as to create specific information, our work focuses on the two semester learning support program at Atlanta Metropolitan College, with a first semester "0097" course and a second semester "0099" course. Students are placed into these courses depending solely on that student's COMPASS test scores[21].

3.1: Developing a Generic Model

A generic model of placement tests and learning support programs is to be developed. As part of this model, a methodology is being used in finding root causes to failures rates. These failure rates are seen uniformly within the University System of Georgia. Depending on the type of assessment used, Georgia ranks 47th to 50th in statewide measures of high school outcomes in mathematics. We are reminded that national learning support type programs have only slightly higher success rates. The comparison from one state to another state is an important activity that we will undertake. We also understand that the surface of the crisis in education may change in appearance from one state to the next, but that the underlying causes are common to all states.

We start at one USG institution. We propose to develop a complete set of measurement statistics for that one institution and then develop various models that might address the failure rate concern. Each model is developed to support a complete transition-funding instrument. The funding instrument is conceived as primary support for a five-year program. There are also requirements that current practice be modified. How and why is to be addressed in the model.

We may make the following observation. Less than 75% of all students enrolling in 0097 at AMC pass the course. Of those passing and moving into 0099 there are additional failures. The truth is that the learning support process is fully preparing only a small number of students for college algebra. The models that we propose to develop will require dollars to make a transition. Measurement of the AS-IS nature and status is

[21] On this test, a maximum score of 100 is possible. Student making a 32 or below are placed into mathematics 0097. Students making between 32 and 39 are placed into 0099, and student scoring over 40 are placed into the college credit "college algebra" course.
For additional detail see: http://academics.georgiasouthern.edu/testing/compass.htm

required to justify these dollars. The goal will be to reduce the social cost of failure, while also increasing the social value of success.

This observation of a 75% failure rate may not be precisely correct. Institutional information will be used to tighten up the data. Significant changes in measurement are consistently envisioned across each of the remediation programs. These changes would create, in each instance, a student profile that is maintained consistent with FERPA policies over a five-year period. The profile includes detailed focus topic based self-assessment before, during and after completion of any mathematics course at the college.

At Atlanta Metropolitan College, we have structured an exemplary Learning Support program, but the failure rates suggest that some additional work might be under taken. This one college exists within larger systems of systems. We find that almost any effort to improve is meet with only marginal success. For example, changing the textbook or using a different set of web based tutorial systems will help a few individuals. However the failure rates remain constant. This suggests that the underlying cause is resilient.

As suggested in *Section 1* and *Section 2*, we start with the assertion that learning difficulties are imposed on the individual by experiences in K-12 as well as are re-enforced culturally. So the observed failure rates are reasonable because the task is difficult. The foundational concept justifying state supported *Education Bridges* is that the system is so broken that a solution to the crisis in education cannot come from within the educational system itself. To work within the system, and yet also create real transitions is a very difficult task.

The initial work on a specific model started in the fall 2010 in classes taught by Dr Prueitt. In his 0097 classes he faced, as all learning support professors have faced, an extreme form of resistance by individual students to being challenged by the 0097 curriculum. Direct challenges to teaching often dominated classroom time.

Even if students face in-class disciplinary actions the resistive behavior never completely recedes. This challenge is from a core of about 20% of attending students who express a right to not change study habits, or orientation. “This is not the way we have been taught to do math!” There are other subgroups including those who have responded very well (40%) and those who do not attend on a regular basis (50%).

The conjecture developed in *Section 1* and *Section 2* is that learning expectations have habituated in a state similar to various classical learning disorders. This conjecture leads to different remediation programs depending on which subgroup the students are in. In addition to the conjecture on acquire learning disability, we see the following factors"

- **Non-homogeneity:** The 0097 class is NOT homogeneous in nature.
- **Attendance:** Around 50% of the students are attempting to attend class, but are often not able to get to class.
- **Intention:** Significance percentages, perhaps 30%, of students do enroll primarily to receive federal support in the form of grants or loans, and then do not attend class.

These four factors are to be addressed separately. How the acquired learning disability might be addressed is the subject of *The Education Bridge*.

3.2: Non-homogeneity of student status

A one semester developmental course, such as Mathematics 0097 and 0099, takes too long. Many students need to be accelerated through the eight chapters of their textbook. They need to be in the real mathematics class, and yet they are enrolled in 0097. They feel this need early in the semester. So they stop attending class.

We can develop and examine several other examples where class homogeneity is not found. As discussed in previous sections, *One* and *Two*; several students may use well-established methods to slow down the instruction in class. They do this for, as suggested, several reasons. Often, they are afraid that their own individual weakness will be shown if the material is developed in class. They may believe strongly that they as an individual are not capable of learning even the material in 0097. This belief is strong and profound in almost all cases. In a solid 60%, the belief is found to be unshakable using traditional learning methods. An awaking process may also be occurring within another group. The first group can damage this awakening process.

Observed fact is justification for a modular decomposition of the curriculum. I propose an instrumentation of department common measurement over eight modules, and that this measurement instrumentation is made available to all 0097 and 0099 students. We envision that these instructional units be the only basis for the Learning Support program at AMC.

This instrumentation will require an almost doubling of the full time faculty, as well as the

integration of all adjunct teaching into a common virtual world. Funds to achieve this growth in full time faculty are to be sought as a core part of the first request for external funds. The funding sought is for a five-year program, developing a virtual learning platform dedicated to a 100% monitored 3D simulation environment.

This instrumentation is to be supplemented with a cell phone communication system – one that extends the GeorgeView classroom management system. A web based system is similar to the one developed by Prueitt in 2008-2010 while teaching computer science and statistics at Norwich University. If funding is received, this work will be extended also via the use of a high-speed scanner and some simple office equipment. Dedicated classes are to be sought so that students may turn in hand written homework into a scanner, in the classroom.

The learning by the entire student population of the Four Step Modified Method ™ will be a central task of student freshman orientation and our AMC AMIR (institutional graduation requirement course). A scanning facility could be added to the AMC Test Center, and all dedicated classes be held in the Academy Building at AMC. Students would turn in hand written paper that may be scanned rapidly and placed into a relational database.

Homework must be turned in using individual handwriting, on copy paper that must be stacked and rapidly scanned by a scanning machine. Copy paper is usually provided to Prueitt's students during each class, and all common departmental exams are hand written in pencil by the student. Again we use the standard 8 ½ by 11-inch copy-paper so that there is a blank sheet of paper that the student starts with. Demand theory explains why this use of blank paper testing is essential to shifting the teaching and learning paradigms.

Our Mathematics 0097 classes already have four compositions of focus topics, aligned with a textbook and a common departmental exam. The exam is given every four weeks. However, there is no acceleration policy to bring 0097 students forward in the series of four modules. There seems to be a departmental agreement; however, this policy will have an expensive implementation.

We are not without research literatures. Some use-cases are available from other colleges and universities. There are more than several colleges where developmental students matriculate through eight modules. These modules do correspond to the

current measurement by the common departmental exam. These external programs help establish the justification for modular course work at the developmental mathematics level. The department becomes a unit. The student studies from the entire faculty, and thus there is some degree of allowing student selection. Student may earn the right to select; only when evidence is given that continuing advancement is being made. This right is considered an inferred right.

Re-constituting classes periodically addresses non-homogeneity. This requires that the traditional class be set aside. If the full time faculty in the department of mathematics are willing to consider this then we build a new possibility. This possibility is that all but one part of the possible categories of students moves to a different classroom and is taught by a different mathematician.

Enrollment is a very difficulty problem. The re-constitution of all 0097 and 0099 classes require a software accounting system that will interface with and aggregate to the one semester course enrollment. While Chair of the Department of Mathematics at Talladega College (2007-2008); Prueitt envisioned a software program that would manage this interface. The software tracks the student through eight sections of a developmental program. The program uses a focus topic framework, as discussed in *Section 1 and 2*.

However, the permission to conduct mathematics classes of this type was not received in 2008. There are; however, institutionally adopted modular programs as part of current practice in learning support programs. The department of mathematics will continue to review these programs. We also, propose to, add virtual and cell-phone learning-environments. These environments may in fact be the sole platform for communication between student and the department. Most students will see selection for honors modules as attractive and appealing. Thus, the use of virtual worlds may transition some individual student into computer science, natural science, or pure mathematics.

This concept simplifies from the point of view of the student. The student pays for four units. If he or she can go from the first part of 0097 to the last part of 0099 in four periods, then this is wonderful. The purpose of the Learning Center has been fulfilled in that particular case. Remember that now there are less than 4% of enrolling 0097 students who are measured to enroll in and pass the required course, Mathematics 1111. This rate may be changed to a very high percentage, even to a majority measure where most students find success. The work is expensive and difficult and this

challenge is reflected on our arguments for doubling the size of the full time mathematics faculty.

One last issue related to interfacing the Registrars Office with student advancement records as measured through eight, rather than two, learning units. Those students who do not pass all eight learning units must enroll in a 0099 course so as to complete all eight units. This does not mean that the department could not give honors types modules in set theory or probability; for example. These honors units would always be given in the virtual learning environment.

In all cases, all unit testing will also test to see if previous topics, measured in previous tests, are still understood and for which there are demonstrated skills. Prueitt's demand theory suggests that self-assessment is a more powerful motivational force than are common departmental exams. This difference of opinion has found balance in his classes, where blank paper tests and handwritten homework is one form of measurement. The common departmental exams are given every four weeks.

3.3: Attendance

In about 50% of instances of an enrolled student not being in class, the student is being impacted by difficulties arising from life situations. A child is ill and has to be taken to the doctor, or the Metro system has cut service. However, some of the attendance is simply due to poor management of time.

The use of some web-based tools might help students who do not attend a specific session. In fact, the use of virtual worlds, by some forward seeking K-12 systems, is showing an increase in student participation. The availability of free mathematics tutoring aids has increased in the last few years. One marginal effort might be made in using these aids more commonly across all classes. However, as observed by several professors, those students who become motivated already have many such tools.

If any increase in web based tutoring tools is to be capitalized on, then the program must be carefully managed. Students with specific behavioral problems might need reinforcement within a small group where the focus of assistance is not merely tutoring in mathematics, but is behavioral in nature.

3.4: Intention

Almost 20% of enrolled students have attended just enough to avoid being dropped by a "no show" policy. The origins of this behavior are complex, but are often similar to underlying reasons why students feel unable to learn.

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. [22]

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.

In some cases, there will be lessons learned and data structures that work. We are seeking some start-up funding so that the core team members, Professors Prueitt, Rogate and Choi, might get the code base that Professor Rogate has running. The sim called eW for "education Worlds" will be opened to faculty in computer science departments around Atlanta whose assistance on key issues are needed.

The implementation of a BIM (Building Information Model) standard coincides regarding the need for demand theory based pedagogy expressed in Second Life type sim environments.

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