Title: Assessing the Effectiveness of an On-line Math Review and Practice Tool in Foundational Mathematics.

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Preliminary Research Report

Abstract: 150 words

Preliminary results of research into the effectiveness of an innovative on-line mathematics review and practice tool (www.mathessentials.ca) will be reported (data collection completion in Dec. 2010). The goal of the web-site is to provide students with the opportunity to review and practice developmental math skills (fractions, percents, etc.), thus filling in gaps in their knowledge. The development of the web-site begat the development of an innovative evaluation model, which can be used to evaluate online educational technologies. Key to the model is not simply evaluating improvement with pre/post test scores, or with anecdotal reports, but through tracking built into the site, which has the potential to provide a multidimensional view of improvement, usage and engagement (usability score). We believe that the web-site itself (support of student success) and the evaluation model ('gold standard' for evaluation of educational technologies) have implications for both teaching and research.

Keywords: online practice, developmental math, educational technology, introductory statistics

Introduction and Background

This research project arose out of a need for stronger basic math skills in developmental mathematics needed by students in Health Sciences, who were preparing for courses in introductory statistics. The initial focus was on two groups of students: 2-year diploma students studying Health Information Management (HIM) at George Brown College, and degree students in Nursing at George Brown College and York University all in Toronto, Canada.

HIM students have a one-semester course in foundations (developmental) math while Nursing students have no direct mathematics instruction as part of their coursework. In both cases the professors noticed that those students who struggled with basic math skills (e.g. fractions and percents) also struggled within the programs in general and in the introduction to statistics courses in particular. The hypothesis that strong basic math skills are a good predictor of success in introductory statistics was validated in research (Johnson&Kuennen 2006), thus our project was born. Introductory statistics is a key part of the program of study in HIM and Nursing even though their roles in the delivery of health care cannot be different. As front line patient care providers, nurses nevertheless need to be numerate and research savvy. HIM professionals as information managers, not only collect and prepare data for analysis, but participate in its dissemination and presentation as well.

Although the researchers recognize that some aspects of constructivist pedagogy are legitimate, especially in introductory statistics education (real data, problem based learning, emergent solutions to problems) this project has as one of its pillars the notion that many basic mathematical skills which are needed for introductory statistics education (e.g. fractions), need direct instruction and practice. The key seems to be in distinguishing which skills are biologically primary vs. secondary (Geary 1995).

> *"When one considers the pattern of ability development in children across cultures, it becomes clear that many cognitive abilities (e.g. language comprehension, habitat representation) are universal, whereas other abilities (e.g. word decoding in reading, geometry) only emerge in specific cultural contexts."* (Geary 1995 pg. 26)

Universal abilities are categorized as biologically primary and emerge without formal instruction and practice, whereas biologically secondary activities would be less likely to occur without instruction and practice. Counting the number of apples in a bag and dividing them among 3 friends is much closer to biologically primary than $3.572 \div \underline{\qquad}$.

We are firm believers in practice and formal instruction where warranted, and some of our students were actually demanding more practice. Instead of churning out paper practice sheets, we scoured the internet and for web-sties that could be accessible to our students. The only quality on-line practice vehicles that we encountered were tied to textbooks that were not appropriate to our students, and with a myriad web-instruction math sites providing only 5 or so practice questions, we embarked on the development of our own online resource. With funding from George Brown College, York University and the Inukshuk Foundation, a web-site On-line Math review Tool (OMT) was designed and developed in order to provide practice as well as instruction/review in basic mathematics skills.

We thought the OMT to be innovative, but were not sure about its utility. How to measure effectiveness of the site was a natural next step. Because no evaluation model existed for an educational technology that was unique in itself, we created our own. A review of the literature found many models for the evaluation and effectiveness of online courses, but not one geared specifically to on-line stand-alone educational technologies. We have reproduced our model below. Given the computing power available in contemporary web-site technologies, many aspects of our evaluation model were built into the OMT itself. It is important to note that we have recently discovered a paper by leading researchers in statistics education, Ooms and Garfield (2008) which describes a model that fits with ours very closely.

Basic principles of the On-line Math review Tool (OMT) (www.mathessentials.ca)

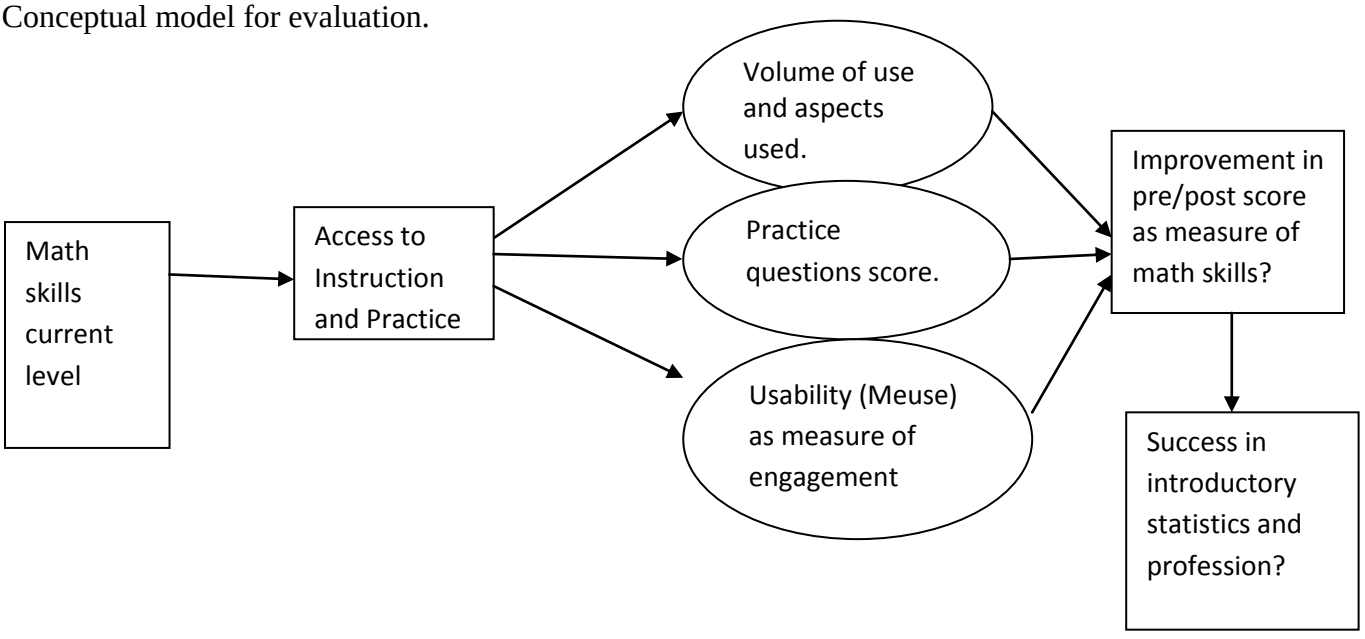
Format: Our basic principle in the development of the OMT was to make the site use voluntary, easily accessible (online and free), to provide the student with an experience that is individualized (choose which topics needed) and interactive (with multiple modes of interaction) and to provide the student

with many randomly generated practice questions (at a variety of levels of difficulty) to work with. It was also necessary to develop an OMT that could be integrated into the curriculum of a course in foundational mathematics, or as an external add on to an introductory course.
The reasons for the format parameters, stem from the experience of teaching developmental math at the college level. Even among those students who come into post secondary math (or math oriented) courses with solid foundations, many have gaps in one or another of the basic topics, and come to us with a myriad of learning styles and educational backgrounds. The OMT must be flexible and accommodating of the diversity of those who will use it.
Content: Since our focus was on improving the mathematics skills of students preparing for introductory statistics the content consisted of topics identified by research (and the investigators) as good predictors of success in introductory statistics. (Johnson&Kuennen 2006) A total of 17 modules with 6 submodules became the content of the mathessentials site.

Research Questions: a model for evaluating the On-Line Math review Tool (OMT)

1. Peer evaluation: used the *electronic Learning Object Peer Evaluation* questionnaire (eLOPE) designed by the researchers .
2. Volume of use.
3. Which aspects will students use?
4. Percent score in practice question usage broken up by difficulty level.
5. How do students see the site's usefulness? Utilized the *Math Essentials usability* (Meuse) tool developed by our team.
6. Improvement in test score (post – pre) based on (Johnson&Kuennen 2006).
7. Can we predict improvement in the pre/post test scores using any combination of 2,3,4 from above?
8. Will the tool be effective in improving the mathematical skills in the pre/post test?
9. Will student perceptions of OMT usefulness (Meuse) be related to any combination of ?

Conceptual model for evaluation.



Preliminary Results: The results are very preliminary as data collection is ongoing, with this round ending in December 2010. Currently a class of 58 students has been invited to use the site in a research capacity and we have 56 registered. We can report on the volume and aspects of use, while the more interesting questions will be answered after the end of semester and can be presented thereafter.

Volume and aspects of use as of Oct. 7, 2010.

Practice questions. 2284 practice questions attempted, 1160 of those are by 1 user, which is unexpected to say the least. The top 10 users make up 90.67% of the usage of the practice question portion of the site. 35 users have registered and completed the pretest, but have not tried any practice questions at all.

Videos: there were 43 video views in all, 2 students viewed all or part of >2 videos (16, 18) and 52 students watched 0 videos,

Games: 10 games were played in total as of Oct.7, 2010

Implications for teaching practice or further research

The implications presented herein come from the literature and from immersing ourselves in the process of developing and test running the OMT. We will be adding to the list as results become more firm.

For teaching:

1. We suggest that the results from a variation of the evaluation model by Ooms and Garfield(2008) be presented before we introduce new technologies in the classroom, or as peripherals to the classroom experience. All too often, we are expected to implement technologies based on anecdotal evidence.
2. We must be wary about the introduction of new technologies and strive as much as possible to study the way our students use these technologies. The surprising preliminary 'volume of use' results (e.g. 1 person responsible for over 50% of the usage) are any indication, simply providing access to learning technologies is not enough.
3. There is a potential for expanding the scope and capacity of the mathessentials.ca model, but we need to have evidence that it is needed.

For research:

1. Although Ooms and Garfield's (2008) iterative evaluation model may need to be adapted to make it useful to a wider range of educational technologies, we suggest that some form of hybrid of our model and theirs become the 'gold standard' by which research into online educational resources be evaluated.

References

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