Adults Learning Math Online: A Surprising Harmony

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Abstract: Adults returning to school face challenges including overcoming math anxiety. Many choose online courses as they balance life and work schedules. Online math courses therefore can be restructured to prevent math anxiety by catering to individual learning styles, providing tools that aid concept attainment, and using problem-based learning strategies.

Adults returning to school face many challenges from balancing life and work schedules, to overcoming age-old math anxiety (Hembree, 1990). Math anxiety is defined as “an inability by an otherwise intelligent person to cope with quantification” (Krantz, 1999, p. 100). Students who suffer with math anxiety start by doing poorly in mathematical courses, then avoiding such courses, and eventually choosing careers that require minimal math (Betz, 1978). At college level, math anxiety has many causes, including mathematics presented as fixed rules, passive classrooms, teaching styles that do not match learning styles, and students’ lack of confidence and inability to see the relevance of the mathematical topics (Trujillo & Hadfield, 1999). Students who are too shy to ask questions or view mathematics as only for men may also experience math anxiety (Trujillo & Hadfield, 1999). Betz (1978) found 61% to 68% of students feeling anxious over math tests with older women reporting higher levels than younger women. Although no definitive cure for math anxiety exists, there are ways of restructuring the classroom to prevent situations that foster anxiety (Sloan, Daane, & Giesen, 2002). To prevent math anxiety, information needs to be related to what adults already know. As Betz (1978) found, more positive views of the relevance of math were associated with lower math anxiety levels. Sloan et al. (2002) found that students had lower anxiety levels when strategies were geared to their learning styles. Students’ learning styles vary significantly with some learners preferring to relate to peers instead of the instructor who is viewed as an authority figure; some like to reflect deeply before doing anything; some prefer practical projects, and others opt for less people-interaction (Ally & Fahy, 2002). These learning styles can be supported by using learner-centered activities, encouraging student participation in the learning process, and making learning relevant to students’ experiences, all of which raise confidence and the sense of accomplishment (Migliette & Strange, 1998). Such learner-centered activities can make use of problem-based learning strategies where students learn by solving real-world problems while reflecting on the procedures they use and their experiences (Hmelo-Silver, 2004).

As adults balance the demands of work and life, many are opting for online courses (Illeris, 2004). An online course is defined as having at least 80% of the content delivered via the Internet (Allen & Seaman, 2008). Thus, a student can participate in the online course from any location that has Internet access. Benefits to taking courses online include being able to interact with the instructor or other students at times convenient to the student (Moisey, Neu, & Cleveland-Innes, 2008), having the tools to access research materials easily (Guri-Rosenblit, 2005), having access to a variety of instructional formats such as audio, video, web, or team collaboration solutions (Felix, 2008), and being able to complete assignments in a more relaxed environment (Illeris, 2004). Indeed, enrollments in online courses have risen dramatically in the

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US, from 9.6% of the total college population in 2002 to 21.9% in 2007 (Allen & Seaman, 2008), of which 33.9% are adults over 25 years of age (Snyder, Dillow, & Hoffman, 2009).

Mathematical courses are also being offered online as mathematics is a required course for many degree programs. The purpose of this paper, therefore, is to show how an online math course can be structured to prevent or reduce math anxiety issues for adults by (a) catering to a variety of learning styles, (b) providing tools that aid in concept attainment, and (c) making mathematical procedures meaningful with problem-based learning strategies. A variety of online database articles, books and Internet resources were reviewed that spoke about online education, math education, math anxiety, learning styles, learner psychology, discussion groups, online tools, teaching methods, and best practices. Each section of the paper includes findings from studies done over the years and a description of online environment features that have been found to address the issues. The paper concludes with implications for faculty and the institutions offering online courses.

Catering To a Variety of Learning Styles

The andragogical model describes adults as self-directed learners with experience they are willing to share and which is beneficial to others (Knowles, Holton, & Swanson, 1998). Such learners can take an active role in the online learning process (Palloff & Pratt, 1999). Providing a forum for communication and the building of community goes further to enhance learning outcomes (Palloff & Pratt, 2005). Online courses use the threaded discussion board as a major tool for interaction and communication. A threaded discussion board is an *asynchronous* interface for asking questions and getting answers (Markel, 2001). Asynchronous means that the participants do not need to be online at the same time. One can post a comment and another can respond when convenient. These discussion boards, therefore, provide opportunity for students to discuss solutions, get help from other answers even if they were too shy to pose the question, and update their responses as they get a clearer understanding. Students are able to build a collaborative learning environment in which they share intellectual, academic, and personal information (Cox, 2008). In the process of sharing and commenting on each others' postings, students are actively engaged in social interaction, reflection and re-constructing knowledge, the kind of actions depicted in Vygotsky's models of learning (Markel, 2001). Furthermore, students have time to reflect before answering questions, and, with the gender of the responder being unclear, students need not feel intimidated, nor hesitant lest someone recognize them (Markel, 2001). Such an environment will appeal to learners who prefer to relate to peers or who like to reflect before acting.

Adults susceptible to math anxiety and in need of scaffolding can bounce ideas off a peer before presenting them for all to see (Markel, 2001). The instructor should encourage active, meaningful dialogue between participants, reminding them to give examples from their experience. Discussions should elicit deeper thought, not just give the student the correct answer right away and the instructor should model correct postings with his/her responses. Feedback is important as students explore real-world problems and should be specific, noting what the student did well and what needs to be corrected. Collaborative groups should be kept small with about three to six participants (Scripture, 2008).

Providing Tools to Aid Concept Attainment

For online math courses, students also have easy access to tools like Geometer's Sketchpad or ALEKS®. Geometer's Sketchpad is a dynamic geometry computer program that is used to construct, measure and manipulate shapes. Shapes can be rotated, enlarged, mirrored, and manually resized (Olive, 1998). In exploring shapes and their properties, students must be consistent in how they label shapes, be able to troubleshoot when shapes do not turn out as expected, and discuss the geometrical operations in use (Forsythe 2007). Students using the Sketchpad did better than other students on the test, and their mathematical vocabulary also increased (Forsythe 2007). ALEKS® is another interactive computer program for performing practice exercises on many mathematical topics and uses adaptive questioning to give step-by-step instructions on how to work problems. It can also show the textbook page or get help as needed. Adults in remedial math programs experienced reduced anxiety levels and maintained higher math scores by using ALEKS® (Taylor, 2008). Students' perceptions of various concepts were significantly corrected with the Animation Tutor Project™ software that provides interactive experiments to supplement coursework in intermediate algebra (Reed, 2005). Tice (1997) asserts that "application and active experimentation are essential to true acquisition of knowledge" (p. 19). Such interactive learning is recommended for adult learners (Snyder, 2009) and will help prevent math anxiety by helping students grasp concepts more easily (Sloan et al., 2002).

The online environment also has features that simulate face-to-face interactions. With vSpace™ students can use "breakout rooms," work on the whiteboard, take web tours, share applications, use polls, take quizzes, and share multimedia content during a synchronous session between other students or with the teacher (Felix, 2008). When used with students in a health science course, Elluminate was found to improve students' perceptions of their learning (Carbonaro et al., 2008). The various delivery formats are ideal for live lectures or one-on-one help. Sessions can be recorded so students are able to review repeatedly at their convenience. Adults plagued by math anxiety can privately build up their skills or recapture the missed moment in the lecture, so they need not fear looking foolish to others (Cox, 2008). The multimedia format available in online courses also facilitates describing and modeling real-world problems and supporting student exploration.

Making Mathematical Procedures Meaningful Using Problem-Based Learning Strategies

Coben, O'Donoghue, and Fitzsimons (2002) emphasize the need for adults from all social contexts to learn mathematics that is applicable to their culture and can be used to help their communities. Indeed, using ethnomathematics, the mathematics curriculum built around the needs of the community including such topics as debt profile and production issues, resulted in an increase in adult student motivation leading to greater success in math (Coben et al., 2002). Also known as problem-based learning, mathematical problems based on real-world scenarios are used as exploration examples. Real-world scenario data may include difficult numbers to manipulate or non-specific information (Verhovsek & Striplin, 2003). Students work in teams to separate out the irrelevant information and then apply the relevant mathematical principles. Groups can meet in private online meeting rooms, yet have access to the full suite of products available in the course. Discussions between team members can be recorded so that they can review repeatedly as they progress through each problem. Working in this style promotes the self-acquisition of knowledge and makes use of a variety of learning strategies, while encouraging teamwork and building problem-solving abilities (Verhovsek & Striplin, 2003).

Problem-based learning is ideal for those adults who need to see the relevance of what they are learning. Those who need short-term satisfaction (Knowles et al., 1998) will be learning information they can use immediately. In solving real-world problems adults are starting with information that is relevant to them; they can build on prior knowledge and use their own learning styles (Kinney & Robertson, 2003; Verhovsek & Striplin, 2003). Students get the scaffolding they need, and information is based on prior knowledge that is restructured through discussions (Markel, 2001). Presenting these problems in the discussion forums means the students will be writing about, or verbalizing, what they have learned - a necessary step in the learning process as implicit knowledge becomes explicit knowledge (Yang, 2003). *Implicit knowledge* refers to the behaviors exhibited as one learns a concept by exploration or rote. *Explicit knowledge* occurs when knowledge is transformed from a behavioral reaction to a cognitive revelation that can be used to synthesize the knowledge further for application to other scenarios (Yang, 2003).

With the added complexity of real-world problems care must be taken not to confuse the learner more (Scripture, 2008). So, instructions for assignments should be specific with clear expectations noted. Problems should be well thought out, realistic, and challenging. Instructors should allow room in the problem descriptions for students to identify their own information and methods, but give clear guidelines about what is to be accomplished. Assignments should also be interactive with ample opportunity to use computer tools to explore during the formative stage when students are getting used to the concept. Skills-building programs can be used later on to fine-tune understanding of the concepts (Taylor, 2008).

For those learners with test anxiety, other formats of assessments can be used, such as letting the user submit answers to the *dropbox* instead of doing a timed assessment. A dropbox is a private area on the web to which only the student and instructor have access. Alternatively the assessment could be an exploration activity where computer tools are used (Scripture, 2008). Detailed feedback should be provided promptly so that students do not go down the wrong path for too long. Such effective feedback will help students become better self-directed learners (Kinney & Robertson, 2003). Assessments should have clear rubrics, and feedback can be provided promptly using the grade book. Lecture material should be provided in manageable chunks that are related to the problems they will be solving.

In closing, math anxiety needs to be addressed in online courses to accommodate the increase in enrollments. Prevention is better than cure, so the first step is to provide an environment in which adults are so engaged that they are more focused on learning math than remembering past negative experiences (Sloan et al., 2002). Although online can provide a comfortable forum for adults to learn successfully without fear, much of the burden of this success lies with the faculty. As such, it is imperative that research continues to support findings and create methods that will make the online facilitation process an easy one. Many still believe the myth that an excellent, traditional, face-to-face instructor can easily transition this success to the online environment (Molnar & Armentano, 2006). Online facilitation has its own unique rules, challenges, and rewards. As such, faculty training needs to be top priority for any institution that hopes to succeed with online learning. Bowling Green University recognized the need for faculty to be trained and launched a quality online training program that addresses "technical and pedagogical aspects of teaching online" (Molnar & Armentano, 2006). Molnar and Armentano (2006) also shared that

> Several faculty who had no experience in an online environment, and who were skeptical prior to the training have now become strong advocates and leaders for distance education. In addition, many have commented that taking this seminar produced some carry-over effects in their face-to-face courses. (p. 1)

While some may still not have access to online, the restructuring of math courses will ensure that those who do have access will enjoy an enriching, successful experience as they work on math online - a surprising harmony.

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