Using Live Online Communication to Overcome Barriers to Learning

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Outline

1 Online Office Hours
   - Motivation
   - Mathematics Communication
   - enVision Software

2 Learning Outcomes
   - Instructor Observations
   - Quantitative Results
   - Qualitative Results

3 Future Work and Conclusions
   - Open Questions
   - enVision 2.0
   - Conclusion
   - References
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Motivation: Mathematics

Math Anxiety

- Most introductory courses are taught to non-math majors
- Wide range in abilities and motivations of students
- Many of these students fear mathematics
- Surveys suggest 85% of students suffer from some form of math anxiety
- Few students participate in class or attend office hours

Office Hours

- Increased contact outside the classroom correlates positively with student retention, academic performance, satisfaction (Nadler & Nadler 2000)
- However, office hour attendance is very infrequent and superficial with the majority of visits at less than 10 minutes
- Anecdotal evidence suggests that in mathematics, the use of office hours is no better
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Internet-based Communication

According to a study by Jones and Johnson-Yale (2005), based on a survey from May 2004:

- 98 percent of faculty use the Internet to communicate with their students
- 92 percent of faculty use e-mail to communicate with their students
- 73 percent report communication with students has increased as a result of e-mail
- Amount of e-mail vs face-to-face contact: 30% same, 30% more
- 37 percent of faculty use chat-rooms
- Other technologies: IM and blogs

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The Internet is largely text-based:
- e-mail, instant messaging, message boards, blogs, news groups
- Writing inline expression in text is difficult for students
- Ambiguous statements: Does $1/x+y$ mean $\frac{1}{x+y}$ or $\frac{1}{x} + y$?
- Other expressions: $1/2x$, $x^2$, $\alpha$, $\beta$, …

\[
\phi_n(\kappa) = \frac{1}{4\pi^2\kappa^2} \int_0^\infty \frac{\sin(\kappa R)}{\kappa R} \frac{\partial}{\partial R} \left[ R^2 \frac{\partial D_n(R)}{\partial R} \right] dR
\]

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\begin{pmatrix}
a & b & c \\
d & e & f \\
g & h & i
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Visual Mathematical Content

\[ T_\ell(A)/T_\ell(A)_t = T_\ell(A^\vee)_t \]
\[ \varphi \]
\[ T_\ell(B)/T_\ell(B)_t = T_\ell(B^\vee)_t \]
What is enVision?
- Chat/Whiteboard program that makes it easy to input mathematical content
- Loads into a standard browser (IE, Safari, Firefox, Opera, ...)
- Written as a Java 1.1 applet (default in IE)
- 58KB in size

Availability: Free. Can be downloaded from www.xiom.org

Use: Anonymous online office hours. Class message boards.
enVision v1.1 Software

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Quick Install (system administrator)

2. Copy the directory MathServer to anywhere on the Web server and start MathServer with the command "java -jar MathServer.jar".
3. Copy the directory enVision into a Web-accessible directory.
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### Mathematics
\[ \int_0^1 x^2 \, dx = \frac{1}{3} \]

- Plot imported from Maple
- Graph Paper
- Exponents can be created with cursor keys, and fractions, using underscores

### Area
Area = \( \pi r^2 \)

### LaTeX
\[ \mathbb{Z}_2 \times \mathbb{Z}_3 \cong \mathbb{Z}_2 \times \mathbb{Z}_3 \times \mathbb{Z} / \langle (0,0,1) \rangle \]

- \( a_{11} \ldots a_{1n} \\
- \quad \vdots \\
- a_{n1} \ldots a_{nn} \]

- \( \begin{bmatrix} b_1 \\ \vdots \\ b_n \end{bmatrix} \]

- \[ \sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6} \]
From equation (3) we see that we can find an upper bound for the probability (8) by calculating $I(A_1, \ldots, A_k)$ for each possible combination of $A_1, \ldots, A_k$, such that inequalities (6) are satisfied, that is

$$P \leq \sum_{a-1}^{a} \sum_{A_{i_1}=0}^{A_{i_1}} \cdots \sum_{A_{i_k}=0}^{A_{i_k}} \frac{I(A_1, \ldots, A_k)}{a^k}$$

$$< \sum_{a-1}^{a} \sum_{A_{i_1}=0}^{A_{i_1}} \cdots \sum_{A_{i_k}=0}^{A_{i_k}} \frac{1}{a^k} \left( \frac{A_{i_1} + 1}{a - 1} - \frac{A_{i_{k+1}}}{a} \right). \quad (9)$$

For a lower bound, we note that if

$$a - 1 > A_{j_1} > A_{j_2} > \ldots > A_{j_k} > 0,$$

then surely $x_{j_1} > \ldots > x_{j_k}$. Hence, we can establish the following lower bound:

$$P \geq \sum_{a-1}^{a} \sum_{A_{j_1}=1}^{A_{j_1}} \cdots \sum_{A_{j_k}=1}^{A_{j_k}} \frac{I(A_1, \ldots, A_k)}{a^k}$$

"Is this correct?"
Instructor Observations

Observations from first and second-year math classes:

- up to 40% of the class/section can attend a single office hour
- large increase in office hour participation
- a third of students don’t ask any questions
- many students for the entire hour
- a third of students clearly use an alias
- a third of students clearly use a real name
- greater multi-way dialogue
- easier to engage students
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Quantitative Results from Mid-Term Questionnaires

2nd-Year Discrete Mathematics at Trent University:
- \( \approx 25 \) students, mostly computer science
- 19 survey responses (after 4 office hours)
- 47% (9/19) attended office hours
- 16% (3/19) said they wanted to (although not asked)

1st-Year Calculus at Acadia University:
- Two-sections: A — 40 students, B — 30 students
- Section A: 81% (26/32) attended, 3% (1/32) wanted to
- Section A: 3% (1/32) used traditional office hours
- Section B: 43% (9/21) attended, 5% (1/21) wanted to
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- “I myself have logged on and just sat and watched. I actually picked up a lot just sitting there!”
- “I don’t feel nearly as inferior as I used to. Lots of others have the same questions I do!”
- “It’s hard to ask questions in class because [you’re] surrounded by very smart people. You don’t want to be the only one who doesn’t know something”.

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- “Students should have an equal opportunity to ask questions”
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- Do different students feel more strongly about one type than the other?
- Are students just using their online persona or are they trying to be anonymous?
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