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# Chalk, Talk, Digital Pens and Audience Response Systems

## Combining tradition and technology to improve maths learning

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### I. Aim

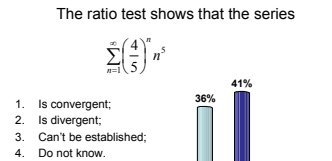
To enhance maths learning by facilitating student interaction and peer instruction in problem classes using Turning Point™ audience response systems -“clickers”- and PaperShow™ digital -“optical”- pen(#).



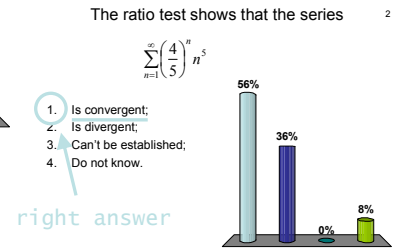
### II. Interactive problem classes: combined Mazur/Dufresne sequences involving peer instruction

- (1) Set question + 5 min.s of individual work
- (2) Click answer
- (3) Discuss answer with other students
- (4) Re-click answer
- (5) Paper-show and chalk and talk right answer

### III. Click (2) answer,



### IV. re-click (4) answer,



### V. paper-show (5) and...

$$u_n = \frac{100^{n^2}}{n!}, \quad u_{n+1} = \frac{100^{(n+1)^2}}{(n+1)!} = \frac{100^{n^2+2n+1}}{(n+1)!}$$

$$\therefore \lim_{n \rightarrow \infty} \frac{u_{n+1}}{u_n} = \lim_{n \rightarrow \infty} \frac{100^{n^2+2n+1}}{(n+1)!} \cdot \frac{n!}{100^{n^2}} = \lim_{n \rightarrow \infty} \frac{100^{2n+1}}{(n+1)}$$

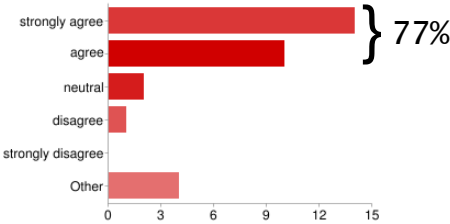
$$\lim_{n \rightarrow \infty} \frac{200 \cdot 100^n}{n+1} = \lim_{n \rightarrow \infty} \frac{200}{1} = 200 > 1 \Rightarrow \text{series divergent by ratio test.}$$

$$\lim_{n \rightarrow \infty} \frac{u_{n+1}}{u_n} = \frac{1}{4} < 1 \Rightarrow \text{series convergent by ratio test.}$$

$$u_n = \frac{100^n}{n!}, \quad u_{n+1} = \frac{100^{n+1}}{(n+1)!} = \frac{100^n \cdot 100}{(n+1)n!} = \frac{100}{n+1} \cdot \frac{100^n}{n!}$$

$$\frac{u_{n+1}}{u_n} = \frac{100}{n+1} \rightarrow 0 < 1 \Rightarrow \text{series convergent!}$$

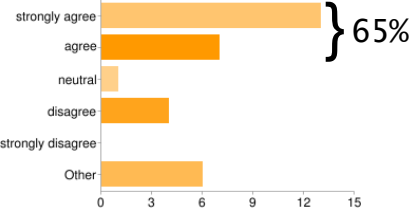
«I think the optical pen is a useful tool for interactive learning and its use improved my learning experience.»



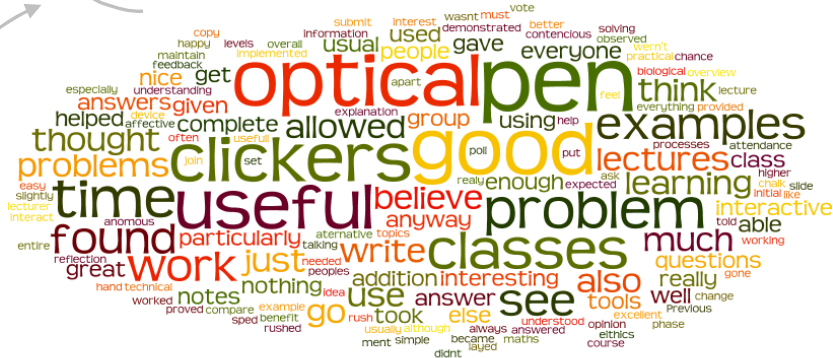
### VII. Student feedback

Questionnaire(b) results (31 responses from approx. 40 students attending problem classes)

«I think clickers are a useful tool for interactive learning and their use improved my learning experience.»



### VIII. word cloud(\*) from students' written feedback



### VI. ...Chalk and talk (5) correct answer.



(#) More information on these and other Classroom Technologies can be found at the blog <http://go.bath.ac.uk/ct>;  
 (Я) Image captured using Panopto™;  
 (b) Questionnaire designed, delivered and analysed via Google™ Forms;  
 (\*) Word cloud produced via [www.wordle.net](http://www.wordle.net): the word size within the cloud is proportional to its frequency within the processed text.