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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,

The ratio test shows that the series  $\sum_{n=1}^{\infty} \left(\frac{4}{5}\right)^n n^2$

1. Is convergent;
2. Is divergent;
3. Can't be established;
4. Do not know.

Option	Percentage
1. Is convergent	36%
2. Is divergent	41%
3. Can't be established	9%
4. Do not know	14%

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

The ratio test shows that the series  $\sum_{n=1}^{\infty} \left(\frac{4}{5}\right)^n n^2$

1. Is convergent;
2. Is divergent;
3. Can't be established;
4. Do not know.

Option	Percentage
1. Is convergent	56%
2. Is divergent	36%
3. Can't be established	0%
4. Do not know	8%

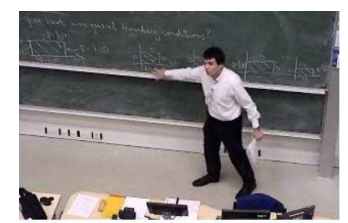
### V. paper-show (5) and...

$$u_n = \frac{100^{n+1}}{n!}$$

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

$$\therefore \lim_{n \rightarrow \infty} \frac{u_{n+1}}{u_n} = \lim_{n \rightarrow \infty} \frac{100}{n+1} < 1 \Rightarrow \text{series convergent by ratio test.}$$

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



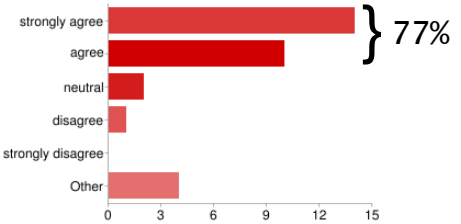
$$\lim_{n \rightarrow \infty} \frac{u_{n+1}}{u_n} = \lim_{n \rightarrow \infty} \frac{100}{n+1} = 0 < 1$$

$$\therefore \text{series convergent by ratio test.}$$

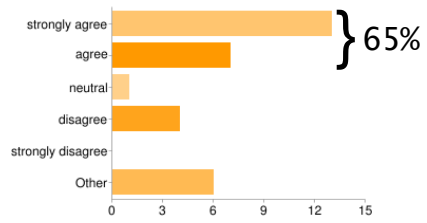
### VIII. word cloud from students' written feedback



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



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



### VII. Student feedback

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

(#) 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.