Enhancing mathematics support using gaming technology, higher education current perspectives and future considerations

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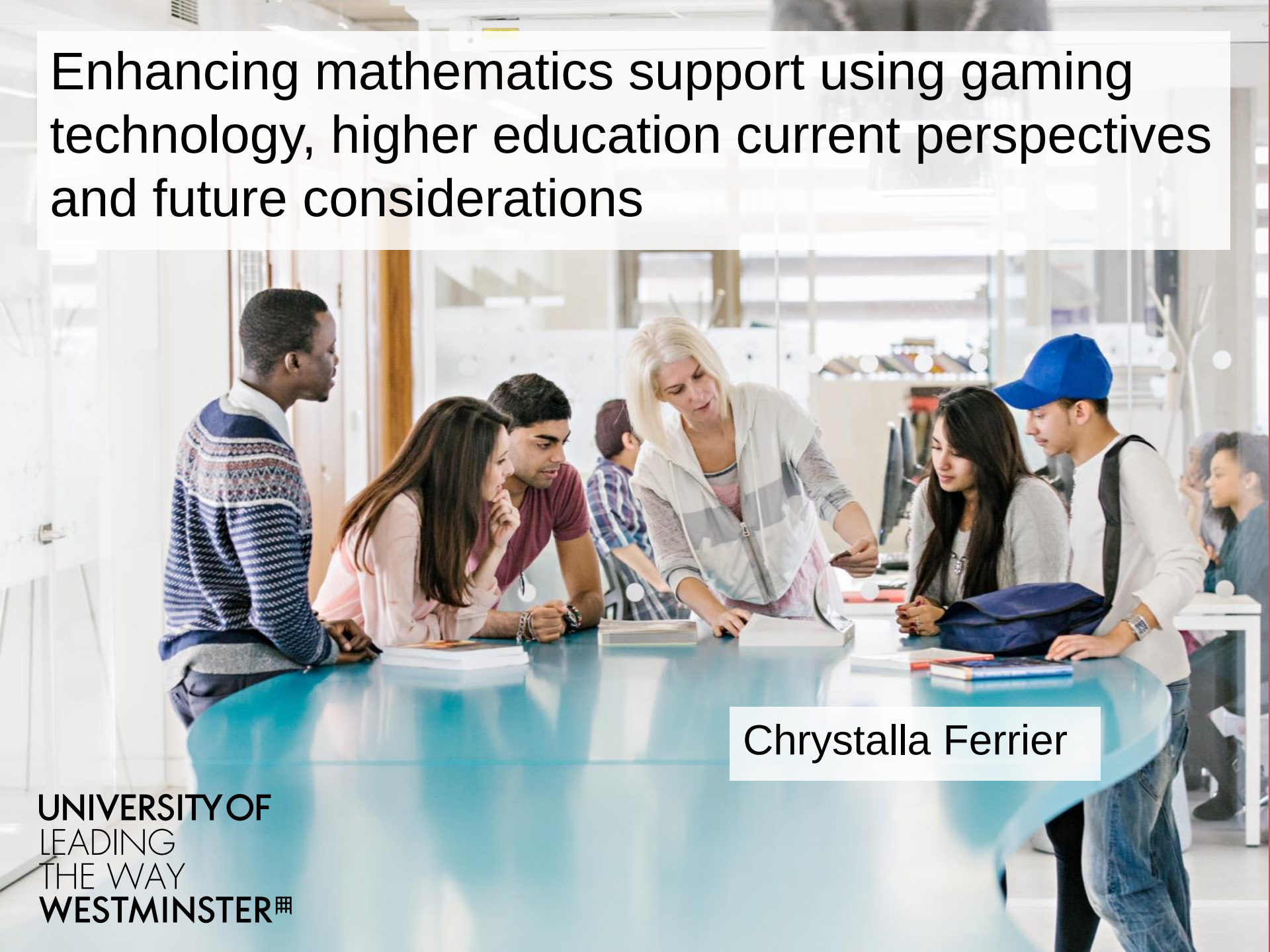

Chrystalla Ferrier

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Existing maths support for life science students

- Locally produced resources on virtual learning environment including initial self-assessment test, Maths You Need booklet, videos and an interactive learning object
- Links to external e-books available from the library
- Links to other external sources on request
- Provision of face-to-face structured drop-in sessions October to December each year

Date	Content
03/10/18	Introductory skills, significant figures
10/10/18	Units of measurement and conversions
17/10/18	Rearranging equations, Beer-Lambert Law
24/10/18	Preparing solutions and making dilutions
07/11/18	Microsoft Excel calculations and graphs
14/11/18	Logarithms, pH calculations
12/12/18	Enzyme kinetics calculations

Justification for mini-review

Member of the Serious Games at Westminster Research Group

- Some previous collaborative work for the productive of core skills serious games

What is the extent and nature of serious games use in undergraduate mathematics support?

Serious Games

Computer games used for purposes other than entertainment for example education and training

Searching…

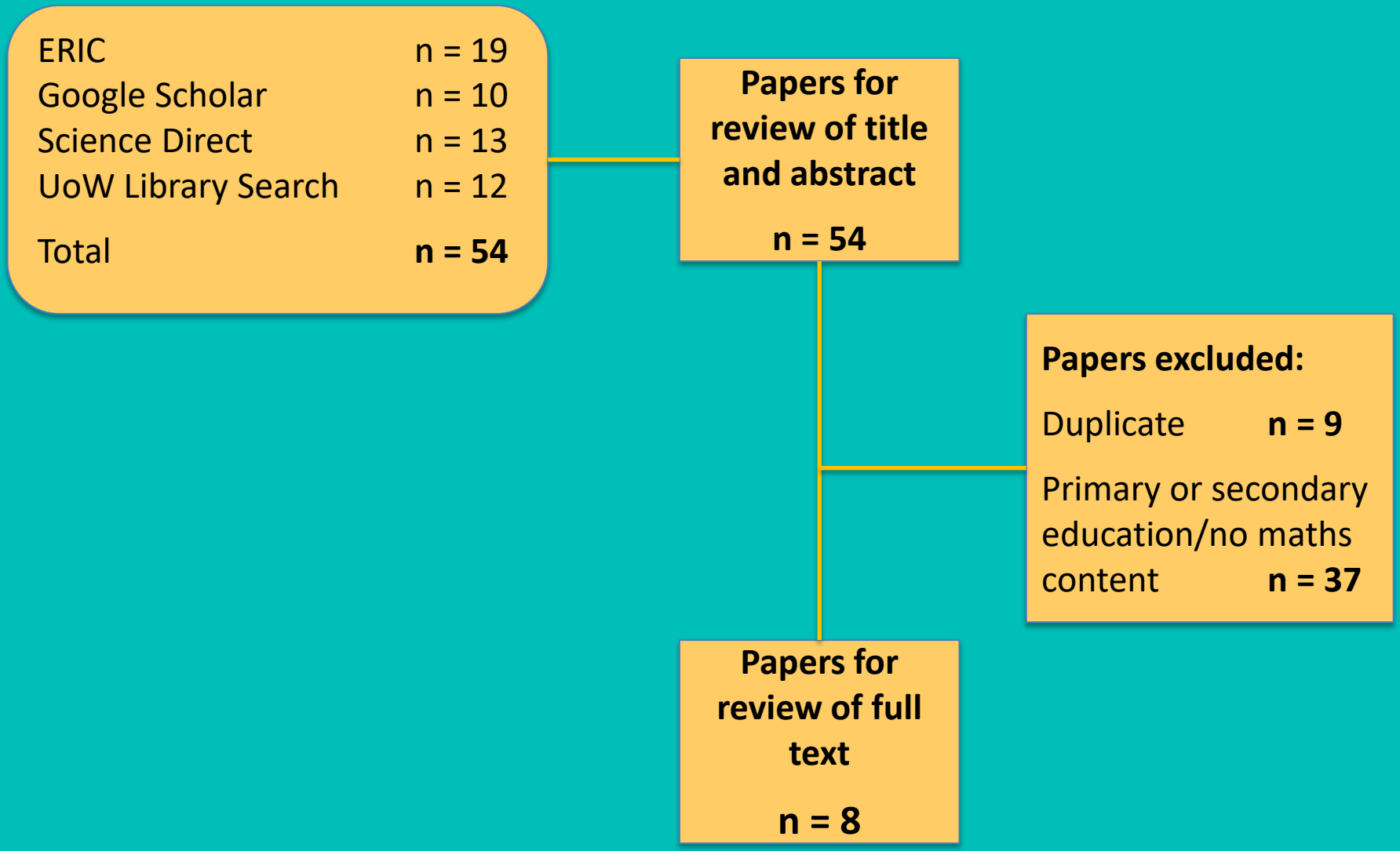
In title, abstract or key words – “serious games” combined with “mathematics”

Articles from 2008 to 2018 in the following search engines:

- Education Resources Information Center (ERIC)
- Google Scholar
- Science Direct
- University of Westminster Library Search

Excluded papers that related to primary or secondary education and papers not including any mathematics content.

Search summary



Design of a mobile mathematics laboratory for contemporary learners

Samuels, P. 2009. Games and Virtual Worlds for Serious Applications.

Applies educational good practice theories to provide the hardware and software specifications of a proposed mathematics laboratory that would enhance mathematics learning for adolescent and adult learners. Early acknowledgement of need to train users primarily on resources. Software selection and use in this order 1. Planning with GeoGebra 2.Virtual visualisation with Phun 3.Physical implementation with a LEGO Mindstorms NXT robot. Emphasis on the benefits of student interaction, project based group learning. With respect to use of serious games authors uncertain of usefulness as would exclude group work and student/student interaction in this case.

Educational games for learning

Noemi, P. *et al.* 2014. Universal Journal of Educational Research, **2** (3)

Generic content but one section studies skills that can be gained by university students by using the 'Island Game', this includes mathematical skills. Undertook 2 year study of 300 university and vocational course students using Island serious game. No detail on control groups. 80% game users on technical degrees or technical vocational training modules. 70% users obtained pass in final assessment. 85% users rated game as good or very good, 15% fair or unsuitable, 90% teachers felt it made a valuable contribution. Emphasis on the importance of initial tutoring prior to use of game.

A technique for mapping mathematics content to game design

Kalloo, V *et al*. 2015. International Journal of Serious Games, 2 (4)

Acknowledged difficulty of mapping mathematics content into serious game. Technique combines game characterisation, mathematics learning theories and past experiences with game design. Mapped their technique to 2007 publication Effective Pedagogy in Mathematics. Provides flowchart guidance and example of use. 9 amateur game designers (min. BSc Computer Science) asked to evaluate the authors technique.

A technique for mapping mathematics content to game design continued

Kalloo V. *et al*. 2015. International Journal of Serious Games, 2 (4)

7 out of 9 successfully followed technique to produce 8 games examples of their work included in paper. All apart from 1 gave high scores (4 and 5) to use of techniques in game production, 6/7 scored 3 or more with respect to the technique making game design easier, all would recommend its use however. Site inexperience of game designers as a limitation to the study, perhaps more detailed feedback available if had selected experienced programmers. Study also references GameFlow technique for evaluating user enjoyment of games.

Using digital games to learn mathematics - what students think?

Yong, S *et al.* 2016. International Journal of Serious Games, **3** (2)

Consideration of negative and positive self-beliefs at start of paper, affective domain. With respect to computer learning must also consider attitude regarding computing skills. Study of 209 students studying Malaysian Foundation Year programmes in engineering, science and social science, students aged from 16 upwards. Initial use of Mathematics and Technology Attitudes Scale (MTAS) to assess affective domain.

Using digital games to learn mathematics - what students think? continued

Yong, S *et al.* 2016. International Journal of Serious Games, **3** (2)

Students given examples of mathematics digital games which were not at university level. Looked at attitudes based on gender and course. In general students with stronger interest in maths more likely to use the digital game. Concluded if students had a previous negative attitude towards mathematics them use of digital games was not appropriate.

Pre-service teacher training on game-enhanced mathematics teaching and learning

Meletiou-Mavrotheris, M. *et al*. 2016. Technology, knowledge and learning, **21** (3)

Concerned with a group of undergraduate trainee primary school teachers undertaking a module/course on the Integration of Modern Technology for the Teaching of Mathematics. 13 final year students aged between 22 and 25. How to embed technology into maths teaching was based on TPCK (technological pedagogical content knowledge (TPCK) conceptual framework (Mishra and Koehler 2006). Very small scale study highlighting requirement for instruction regarding integration of technology into mathematics teaching, discussion of TPCK pros and cons.

SiGMA: A software framework for integrating advanced mathematical capabilities in serious game development

Smith, K. *et al*. 2016. Advances in Engineering Software, **100**

Detailed work on a toolkit specifically for mathematics serious games that aims to overcome challenges of working with and displaying symbols. State existing mathematics software e.g. MATLAB not suitable for integration into games. The toolkit uses Python's C API; Python's SymPy and MatPlotLib libraries and C# DLL. Flowchart summaries and examples of games created included.

Serious mathematics games bolster self-concept and self-efficacy in women learners

Eyster, T. 2017.PhD thesis extract.

Work based on previous findings that adult female university students have lower mathematics efficacy compared to males and younger students. Wanted to explore if playing a mathematics serious game for 30 minutes in a single sitting would improve maths self-concept and self-efficacy. 68 female students general education course, age not stated, randomly assigned gaming and non-gaming (control) groups.

Serious mathematics games bolster self-concept and self-efficacy in women learners continued

Eyster, T. 2017.PhD thesis extract.

No significant difference in maths confidence scale pre-test and post-test between groups used for maths self-concept and no significant difference using maths self-efficacy scale, but when combining both beliefs did find a significant difference with increases in gaming group, not sure if this was due to maths game or gaming in general however and concluded more controlled studies required.

Connecting the ARCS motivational model to games design for mathematics learning

Toussaint, M and Brown, V. 2018. Transformations, **4** (1)

This is an exploration into how John Keller's (1987) ARCS model (Attention, Relevance, Confidence, Satisfaction) can be potentially used to design serious games for all secondary and tertiary mathematics teaching. Authors propose that if this is applied it can overcome lack of success of some previous mathematics teaching programmes/software. It sites motivational issues as barriers to success, either lack of motivation through boredom or through difficulty of tasks. Summary diagram on final page, concept of term 'building the bridge from gaming to learning'

Concluding comments

- Toolkits and guidance are available for the production of mathematics serious games suitable for higher education purposes
- Pedagogic theories such as ARCS should be applied when designing games
- Single or multiplayer games should be considered to suit learner preferences
- Consider computer skills and experience of intended users and provide suitable initial instruction
- No consideration of summative assessment use at present but the serious games represent a means of formative assessment
- This will be a useful addition to our existing repertoire of mathematics support resources

Thank you for listening

Any comments or questions?

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