**RESEARCH Proposal submission cover sheet (MSC APPLIED E-LEARNING)**

**This sheet should be completed and signed and should accompany your research proposal submission for the Research Methods module.**

|  |
| --- |
| **Module Title:** Research Methods**ECTS credits:** 10 ECTS |
| **Participant name: Mark Keyes****Participant Student Number: D14124434** **Programme of Study: MSc Applied eLearning**  **Date of Research Proposal Submission: 30/06/2015** **Module Tutor Name(s): Claire McAvinia and Claire McDonnell** |
| For reference, the programme learning outcomes are provided below. **Programme Learning Outcomes** On successful completion of this programme, graduates will be able to:**Knowledge**1.       Demonstrate a thorough understanding of the theory of, and best practice in, eLearning in a range of educational contexts;2.       Demonstrate an awareness and understanding of current eLearning technologies and the challenges and opportunities associated with each.**Know-how and Skill**1.       Identify instances and conditions where eLearning would be appropriate and evaluate its potential, and use, within different contexts;2.       Apply a thorough grounding in the theory and practice of eLearning in a range of contexts;3.       Create and evaluate strategies for the effective use of eLearning in a range of Higher Education learning environments;4.       Conduct critically focused literature reviews relevant to the use of eLearning within their selected discipline area;5.       Design a constructively aligned module integrating the appropriate use of eLearning technologies;6.       Design specific eLearning applications/resources and evaluate them to determine their value according to specified criteria;7.       Sustain from the research evidence obtained from the undertaking of an eLearning project, a reasoned argument and draw consistent and coherent conclusions;8.       Reflect self-critically on the process and outcomes of a development and eLearning implementation project. **Competence**1.       Manage the design, development, implementation and evaluation of a number of appropriate eLearning resources;2.       Engage in research to evaluate the effective use of eLearning resources within a Higher Education environment. |
| **Submission Checklist and Declaration**To ensure that the focus of the assessment of your assignment will be on the development of the higher order skills and competences associated with a level 9 qualification, please complete the checklist and declaration below. The checklist specifies the mechanical and lower order concerns that need to have been met before you can submit your work.  I declare that the assignment I am submitting; |
| Has been proofread thoroughly for typographical errors. Meets the word count specification.Follows the recommended structure and format.Contains citations and references that have been formatted according to the guidelines provided.I understand that my work can be returned uncorrected if the criteria above have not been fulfilled. | Yes Yes Yes Yes Yes  |
| Signature:  | Date: 30/06/2015  |

# DIT MSc in Applied eLearning

# The Mathematics Problem – An eLearning Support

# Research Proposal 2015

## Mark Keyes

## Student Number: D141424434

## Date: 29/06/2015

## Word Count: 2,979 (including heading and citations)

**Table of Contents**

[**Introduction** 1](#_Toc423428845)

[**Context and Rationale** 1](#_Toc423428846)

[**Research Aims and Objectives** 2](#_Toc423428847)

[**Literature Review** 2](#_Toc423428848)

[A Learner Centred Approach in eLearning 2](#_Toc423428849)

[The Scaffolding of eLearning 4](#_Toc423428850)

[Examples of Web-Based Mathematics Learning Supports 5](#_Toc423428851)

[**Research Design** 6](#_Toc423428852)

[Theoretical Perspective 6](#_Toc423428853)

[Research Methodology 7](#_Toc423428854)

[Research Methods 7](#_Toc423428855)

[**Ethical Considerations** 8](#_Toc423428856)

[**Delimitations and Limitations** 9](#_Toc423428857)

[**Timescale of Research** 9](#_Toc423428858)

[**References** 11](#_Toc423428859)

[**Appendix 1: Description of E-Learning Resource** 15](#_Toc423428860)

[**Appendix 2: Declaration of Research Ethics** 17](#_Toc423428861)

# **Introduction**

This paper outlines a proposal for a pilot project implementing online mathematics learning supports with first year engineering students at a higher education institution. This study aims to explore the potential of e-learning in helping to address the ‘Mathematics Problem’ which is widely recognised as hampering student retention and success at third level, particularly in the STEM disciplines.

The following sections provide the context for the research, a literature review of publications relevant to the study and an outline of the research methodology and methods to be employed. Consideration is also given to research ethics and the logistics for undertaking the study over a single academic year.

# **Context and Rationale**

In recent years, poor levels of mathematics at third level in Ireland have been cited as impacting on student success rates (OECD, 2004). The issue, often labelled as the ‘Mathematics Problem’, has been noted to affect students in Ireland, the UK and beyond (Lawson et al., 2012; Gill et al., 2010). This has led to strategic efforts to provide dedicated mathematics learning support centres at a number of higher education institutions (HEIs) in Ireland (Gill et al., 2010). Indeed, the Irish Mathematics Learning Support Network (IMLSN) was founded in 2009 at NUI Maynooth, with the objective of coordinating these initiatives at a national level.

The recent IMLSN Report on *Student Evaluation of Mathematics Learning Supports: Insights from a large-scale multi-institutional survey* provides a comprehensive study of engagement/non-engagement with mathematics learning support (MLS) that encourages further research into the area (O’ Sullivan et al., 2014). The report acknowledges that MLS has a positive impact on success at examinations, yet only 36% of respondents were engaging with them. While it is accepted that almost half of those not engaging do not require additional support with their studies, this still leaves approximately one third of the student population that would potentially benefit from the supports who are *not* engaging.

Interestingly, the reasons cited by respondents for non-engagement include: availability of face-to-face supports at suitable times; unawareness of availability of supports; embarrassment to be seen to need support (O’ Sullivan et al., 2014, p. 47). It is reasonable to conclude that online supports *could* potentially address some if not all of these issues. However, the report also found that the *“ICT enabled supports were the least positively endorsed”,* leading to a recommendation for future work that investigates the potential to optimise online MLS for student usage.

# **Research Aims and Objectives**

The aim of this research is to evaluate the impact of a pilot of online MLS introduced to complement existing face-to-face lectures and tutorials available to first year engineering students at a HEI.

The research question proposed is: “How effective are multimodal e-learning supports in scaffolding the learning of mathematics for new entrant third level engineering students?” Over the course of this study it is also intended to address a number of related sub-questions as follows: (1) Does the use of multimodal presentation of online content affect the motivation of learners to engage with the supports?; (2) Does engagement with the online supports improve the preparedness of students for formal lectures?; (3) What are the factors affecting engagement/non-engagement with online MLS?

# **Literature Review**

## A Learner Centred Approach in eLearning

Increasingly in education and training, there is a recognition that learners are not all the same. Constructivist teaching and learning theories have put forward the importance of meaning attachment and a need for a learner centred approach to instruction (Vygotsky, 1978; Bruner, 1966). This requires an acknowledgement that “Learners have different strategies, approaches, and capabilities for learning that are a function of prior experience and heredity” (Bonk & Cunningham, 1998, p. 29).

David Kolb’s (1984) learning cycle theory asserts that all learners must complete a four stage process, whereby new information is linked with existing knowledge in order for it to be meaningful and therefore retained. He explains that a new experience provides a basis for a learner to observe and reflect. This develops meaning attachment (assimilation) from which conclusions may be drawn and actively tested to develop new learning. The value of this strategy has also been noted in mathematics education, with recommendation to *“Situate problem-solving tasks within meaningful, realistic contexts in order to facilitate transfer of learning”* (Ginsburg & Gal, 1996, pp.13-14).

Honey and Mumford (2000) developed on Kolb’s theory (see Figure 1) to define four distinct learning style preferences: Activist – those that learn by doing; Theorist – those that feel the need to know the theory behind what they are doing; Pragmatist – those that prefer to see learning put into practice before they ‘believe’; Reflector – those that prefer to stand back and observe.



Figure 1: Kolb’s Learning Cycle related to Honey & Mumford Learning Styles

Felder and Soloman developed an index of learning styles which introduced further categories, such as visual and verbal learners (Felder & Silverman, 1988). They share the belief that learners move between styles depending on the situation rather than favouring one category exclusively.

Gardner’s theory of multiple intelligences (2006) proposes eight categories of intelligence that he believes we all possess to some extent: linguistic intelligence – natural ability with words; logical mathematical intelligence – natural ability with numbers; spatial intelligence – ability to imagine and visualise; bodily-kinesthetic intelligence – physical abilities and actions.; musical intelligence – sensitivity to sounds; interpersonal intelligence – sensitivity to the needs of others; intrapersonal intelligence – deep understanding of oneself; naturalistic intelligence – aware of one’s natural surroundings. It is Gardner’s view that an individual may be stronger in some categories over others.

Advances in technology offer the possibility of employing multimedia in teaching to provide multiple representations of content and opportunities for interaction. This makes it possible to provide multimodal learning environments which cater for different learning styles and engage the learner through active participation (Sankey et al., 2010; Cisco, 2008). Significantly, in light of a body of ‘at risk’ students struggling with mathematics at third level (Mac An Bhaird et al., 2010), *“the literature indicates that multimodal learning may be of greater benefit to lower-achieving students”* (Sankey et al., 2010, p. 858).

## The Scaffolding of eLearning

The concept of scaffolding of learning was first introduced by Wood, Bruner and Ross in 1976. They described the role of a tutor in *“a kind of “scaffolding” process that enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts”* (Wood et al., 1976, p.90).

The benefit of employing scaffolding in e-learning is widely acknowledged (Salmon, 2004; Rourke & Coleman, 2010). Indeed, the basis of Salmon’s five stage model of e-learning is that a *“structured learning scaffold offers essential support and development at each stage as they* (the learners) *build up expertise in learning online”* (Salmon, 2004, p. 10). For online learning to be successful in providing this scaffolding, design should be led by sound pedagogy rather than the capabilities of the technology adopted (Rourke & Coleman, 2010, p. 56).

Anghileri (2006) has identified the potential for scaffolding practices to be applied to mathematics teaching. She proposes a three tier hierarchy of scaffolding that specifically supports the learning of mathematics: Level 1 – Environmental provisions; Level 2 – Explaining, reviewing and restructuring; Level 3 – Developing conceptual thinking. Examples of restructuring include the provision of meaningful contexts to abstract situations, simplifying a problem and negotiating meanings. This is consistent with principles identified for development of mathematical skills, *“Develop understanding by providing opportunities to explore mathematical ideas with concrete or visual representations and hands-on activities”* (Ginsburg & Gal, 1996, p.4). It has also been noted that *“Because mathematics is cumulative in nature, with later methods building quite rigorously on earlier methods, mathematics is particularly unforgiving on gaps in background knowledge”* (Smith & Ferguson, 2005, p.330).

However, it should be noted that there is an increasing movement towards categorising scaffolding in online learning as either ‘soft’ or ‘hard’ (Chen & Law, 2015, pp.1-3; Brush & Saye, 2002, p.2). ‘Soft scaffolds’ refer to support provided by interaction with tutors or peers, i.e. learning facilitated by online socialisation, while ‘hard scaffolds’ are described as those static supports designed in advance, mostly associated with computer-based learning, e.g. question prompts, hints. Significantly, for online learning of mathematics, there have been questions raised in relation to the effectiveness of soft scaffolds. It has been highlighted that *“Threaded discussions are not very useful for math courses, where problem-solving is more important than discussion”* (Smith & Ferguson, 2005, p.331)

## Examples of Web-Based Mathematics Learning Supports

There is an array of online MLS currently available, including those offered specifically by HEIs to support their courses as well as a number of independent websites (Mac An Bhaird & O’ Shea, 2011, pp.30-31). The majority of institutional online supports are in the form of centralised repositories of worksheets/exercises made available online to download, e.g. DCU Mathematics Learning Centre, DIT Mathematics Learning Support Centre, CIT Maths Online. Some also include links to videos which cover mathematics topics relevant to the courses offered. These videos are usually either recordings of lectures or video tutorials with a lecturer explaining a concept while working through an example on a board (example at: <http://www.mathcentre.ac.uk/types/video/fractions/>).

It is notable that a number of web-based resources are “static” in nature, providing content that is similar in format to mathematics textbooks and thereby missing an opportunity to provide rich, interactive learning environments (Cherkas & Welder, 2012, p.275). Recent review of online supports emphasises that *“It is important to note that there are many different learning styles and learning needs, and using a variety of appropriate presentation methods is essential”* (Mac An Bhaird & O’ Shea, 2011, p.30).

There are a number of online MLS which offer combinations of video tutorials, text based resources, interactive exercises and animations. Mathtutor (<http://www.mathtutor.ac.uk/>) is one such example, covering a limited number of topics which are aligned to bridge the gap between second and third level education. Khan Academy (<https://www.khanacademy.org/>) also incorporates multimodal formats to teach concepts and provide opportunity for practice. The creator, Salman Kahn, explained at TED 2011 that the concept originated from videos that he posted to Youtube for the use of his relatives. He was surprised that his cousins preferred the videos to him in person as they could pause/rewind and they were able to avoid the embarrassment of asking ‘simple’ questions. This may be significant in light of embarrassment being cited as a reason for non-engagement with MLS (O’ Sullivan et al., 2014).

Both Mathtutor and Khan Academy provide rich, multimodal learning environments where users can work through topics at their own pace, progressively mastering concepts before moving onto more advanced levels, i.e. consistent with a scaffolding approach.

# **Research Design**

## Theoretical Perspective

This research is grounded in constructivist theory of learning, focussing on meaning attachment for the learner (Vygotsky, 1978). Constructivism sees learning as an active process in which the learner synthesises new information with existing knowledge and experience in order to 'construct' their own meaning (Jordan, Carlile & Stack, 2008).

This study will employ a combination of both quantitative and qualitative methods. While this approach may appear to adopt two opposing philosophical epistemologies, i.e. positivism often being associated with quantitative research and constructivism with qualitative (Weston, 2013), this is considered to be most appropriate for the research question. A deeper investigation of the ‘how’ and ‘why’ behind the effectiveness of online supports will require qualitative methods, consistent with an interpretivist epistemology (Carson et al., 2001) and a subjectivist ontology, i.e. knowledge cannot exist without people to construct it.

## Research Methodology

A case study research approach will be employed, appropriate to a small-scale research project of this nature which explores the impact of a pilot learning intervention. The selection of a pilot, testing the impact of the learning supports in order to generalise on the findings, is consistent with an instrumental case study (Stake, 1995).

This study will provide a contextual analysis of the implementation of an e-learning support with 1st year engineering students, i.e. a study of a specific case and student cohort in order to provide an insight into issues concerning third level students in STEM disciplines generally (Cousin, 2005, p. 422). This focus on a small-scale pilot of a learning intervention will provide opportunity for deeper exploration of a specific phenomenon. According to Yin (2009), case studies are most suited to the following situations: Where how or why questions are being asked (see research question for this study); When the researcher has little direct control over the events (in this case, the researcher is not a member of academic staff teaching the research subjects); When the focus is on a contemporary phenomenon (as in the ‘Mathematics Problem’).

## Research Methods

This study aims to explore the reasons behind engagement/non-engagement and experiences with online learning supports beyond an analysis of statistics. Therefore, a mixed methods approach is justifiable and consistent with case study research. Mixed methods utilises a combination of quantitative and qualitative strategies.

This study will initially utilise informal interviews with lecturing staff involved in the delivery of a maths module for 1st year students to identify the key areas requiring supports. These unstructured interviews are included as an acknowledgement that *“allowing interviewees to ‘speak their minds’ is a better way of discovering things about complex issues”* (Denscombe, 2007, p. 176).

Quantitative methods will be applied for the entire group of 1st year engineering students (anticipated to be 140-150 subjects). Learning analytics of student engagement with the e-learning supports will provide data relating to patterns of usage and preferences of learners for specific aspects of the resources. A comparison of exam resultsfor the maths module with historical data will also be included to establish if there are any significant impacts or trends.

It is intended to adopt the Mathematics Learning Support Survey questionnaire, as included in the appendices of the IMLSN 2014 Report, to gather data on the student group such as Leaving Certificate maths grades, opinions on the maths learning supports provided and reasons for engagement/non-engagement with them. The use of this questionnaire is advantageous as it allows for consistency of comparison with existing and future research and allows this study to gather a body of data from standardised answers for analysis (Denscombe, 2007, p. 169).

Semi-structured one-to-one interviewswith 7-8 students will be used to provide a deeper exploration of attitudes of learners to the learning supports. Purposive sampling will be employed in order to ensure representation from students in the ‘at risk’ category who have both engaged and not engaged with the online MLS (Cohen et al., 2011, pp. 156-158). Interviews will be audio recorded and transcribed for analysis (Denscombe, 2007, pp. 195-199). Questions will be selected which are open-ended, inviting the interviewee to explore their experiences (Cohen et al., 2011, pp. 411-419).

# **Ethical Considerations**

This research will follow BERA guidelines (BERA, 2011): to ensure that informed consent is secured by providing information upfront to participants on the details of the project and its objectives; to clearly communicate the arrangements for ensuring anonymity and protection of identity for research participants; informing participants of their right to withdraw from the study at any time; following conventions for working with participants under 18 years old by requiring written consent from parents/guardians; through compliance with active data protection legislation.

Permission will be sought from the relevant Head of School within my organisation before commencement of the research. The relevant form “Application for ethical clearance of a project” will be completed and submitted for approval and the guidelines provided in the “Research ethics and code of good research practice” guidance document will be adhered to throughout the duration of the study.

# **Delimitations and Limitations**

The scope of the online MLS will be limited by the time constraints to have the resources available for the implementation phase in September 2015 and the time generally available for their development. It is also acknowledged that the richness of the data collected may be affected by the level of engagement with the supports. While students will be encouraged to utilise the available resources, there is no direct requirement relating to assessment to motivate this. However, it is a specific objective of the study to consider reasons for non-engagement as well as exploring the experiences of those that utilise the online supports.

The possibilities for generalising the findings of the study in a broader context are limited by the small scale nature of the pilot. It is accepted that this project may raise questions that require larger scale exploration to facilitate more generalizable findings and conclusions.

# **Timescale of Research**

The research will commence, subject to ethics approval, with preliminary work in August 2015. This will include the informal interviews with lecturing staff to identify the topics to be covered by the online supports and commencement of their design. The development of the resources will continue throughout September and October 2015, with lecturing staff providing feedback and recommendations throughout the process.

The implementation phase will take place through September – December 2015 (Semester 1) with the students introduced to the online supports at induction. The resources will be made available incrementally over the twelve weeks of delivery of the engineering maths module, as appropriate to support the topics being covered at weekly lectures.

Over the course of the implementation phase, the engagement with the e-learning resources will be tracked via Moodle. This data will be analysed in January 2016 to identify and interpret patterns of engagement. The IMLSN survey questionnaire will be circulated to students in February 2016, i.e. post implementation and exams for the module. The one-to-one student interviews will also be conducted in early February.

The results of the interviews and questionnaires will be analysed during March 2016 along with the comparison of exam results with historical data. The journal paper recording the research project and findings will be written up in April/May 2016, informed by feedback from MSc programme participants and research supervisor. A summary of the research timeline is provided in Figure 2.

Figure : Timeline of Research Plan

# **References**

Anghileri, J. (2006). Scaffolding practices that enhance mathematics learning. *Journal of Mathematics Teacher Education*, 9, pp. 33-52.

Bonk, C. & Cunningham, J. (1998). Searching for Learner-Centered, Constructivist, and Sociocultural Components of Collaborative Educational Learning Tools. *Electronic collaborators: Learner - centered technologies for literacy, apprenticeship, and discourse,* p. 25-50. New York: Lawrence Erlbaum Associates.

British Educational Research Association. (2011). *Ethical Guidelines for Educational Research.* BERA: London, England. Retrieved online May 19th 2015 from <https://www.bera.ac.uk/wp-content/uploads/2014/02/BERA-Ethical-Guidelines-2011.pdf>

Bruner, J. (1966). *Toward a Theory of Instruction.* Cambridge, Mass.: Bellkapp Press

Brush, T. A. & Saye, J. W. (2002). A Summary of Research Exploring Hard and Soft Scaffolding for Teachers and Students Using a Multimedia Supported Learning Environment. *The Journal of Interactive Online Learning,* 1 (2), pp. 2-12.

Carson, D., Gilmore, A., Perry, C., & Gronhaug, K. (2001). *Qualitative Marketing Research.* London: Sage.

Chen, C. -H. & Law, V. (2015). Scaffolding individual and collaborative game-based learning in in learning performance and intrinsic motivation. *Computers in Human Behavior.* Retrieved online May 15th 2015 from <http://dx.doi.org/10.1016/j.chb.2015.03.010>

Cherkas, B. & Welder, R. M. (2012). Interactive Web-based Tools for Learning Mathematics: Best Practices. In A. A. Juan, M. A. Huertas, S. Trenholm, & C. Steegmann (Eds.), *Teaching Mathematics Online: Emergent Technologies and Methodologies* (pp. 276-310). Hershey, PA: IGI Global. Retrieved online May 7th 2015 from <http://www.rachaelwelder.com/research/Interactive_Web-based_Tools_files/Official%20Printed%20Chapter_juan%20book.pdf>

Cisco. (2008). *Multimodal Learning Through Media: What the Research Says.* Retrieved online June 2nd 2015 from <http://www.cisco.com/web/strategy/docs/education/Multimodal-Learning-Through-Media.pdf>

Cohen, L., Manion, L. & Morrison, K. (2011). *Research Methods in education.* 7th Edition. Routledge: New York.

Cousin, G. (2005). Case Study Research. *Journal of Geography in Higher Education*, 29(3), pp. 421-427

Denscombe, M. (2007). *The Good Research Guide for small scale social research projects.* 3rd Edition. Open University Press: Berkshire, England.

Felder, R. M. & Silverman, L. K., (1988). Learning and Teaching Styles in Engineering Education, *Engr. Education*, 78(7), 674-681.

Gardner, H. (2006). *Multiple Intelligences: New Horizons*. Basic Books: USA.

Gill, O., Mac an Bhaird, C. & Ní Fhloinn, E. (2010). The Origins, Development and Evaluation of Mathematics Support Services*. Irish Mathematical Society Bulletin*, 66, 51‐64.

Ginsburg, L., & Gal, I. (1996). *Instructional strategies for teaching adult numeracy skills.* Philadelphia: National Center on Adult Literacy. Retrieved June 5th 2015 from <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.29.5676&rep=rep1&type=pdf>

Honey, P. & Mumford, A. (2000). *The learning styles helpers guide*, Maidenhead: Peter Honey Publications Ltd.

Jordan, A., Carlile, O., & Stack, A. (2008)*Approaches to Learning: A Guide for Teachers.* Milton Keynes: OU Press/McGraw Hill.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development (Vol. 1).* Englewood Cliffs, NJ: Prentice-Hall.

Lawson D., Croft, T. & Waller, D. (2012). *Mathematics support past, present and future. Innovation, Practice and Research in Engineering Education.* Retrieved on May 19th 2015 from <http://www.academia.edu/2715773/Mathematics_support_past_present_and_future>

Mac an Bhaird, C., Grehan, M. & O'Shea, A. (2010). *What type of student avails of mathematics support and extra mathematics initiatives?* Proceedings of the 15th SEFI MWG Seminar and 8th Workshop GFC, Mathematical education of Engineers.

Mac an Bhaird, O'Shea, A. (2011). *The Development of Mathematics Resources.* Proceedings of the NDLR Fest 2011, 2(8). Retrieved on May 19th 2015 from <http://www.ndlr.ie/fest2011proceedings/volume2/vol2_8.pdf>

Organisation for Economic Co‐operation and Development (OECD). (2004). *Learning for Tomorrow’s World – First Results from PISA 2003.*  Paris, OECD.

O’ Sullivan, C., Mac An Bhaird, C., Fitzmaurice, O. & Ní Fhloinn, E. (2014). *An Irish Mathematics Learning Support Network (IMLSN) Report on Student Evaluation of Mathematics Learning Support: Insights from a large scale multi‐institutional survey.* NCE – MSTL: Limerick, Ireland.

Rourke, A. J. & Coleman, K. (2010). A learner support system: Scaffolding to enhance digital learning, *The International Journal of Technology, Knowledge & Society,* 6(1), 55-70.

Salmon, G. (2004). *E-tivities: The key to active online learning*. London and New York: Routledge.

Sankey, M., Birch, D. & Gardiner, M. (2010). *Engaging Students through multimodal learning environments: The journey continues.* Proceedings ascilate Sydney 2010. Retrieved online June 6th 2015 from <http://ascilite.org.au/conferences/sydney10/procs/Sankey-full.pdf>

Smith, G.G. & Ferguson, D. (2005). Student Attrition in Mathematics E-Learning. *Australasian Journal of Educational Technology,*21(3), 323-334.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.

Vygotsky, L.S. (1978). *Mind in Society: The Development of Higher Psychological Processes. Cambridge*, Massachusetts: Harvard University Press.

Weston, D. (2013). A Positive Constructivist: An Internal Debate on Opposing Educational Philosophies. *Teaching & Learning,* 8 (1), 1-19. Retrieved May 15th 2015 from <http://brock.scholarsportal.info/journals/teachingandlearning/home/article/viewFile/407/375>

Wood, D., Bruner, G. S., & Ross, G. (1976). The Role of Tutoring in Problem Solving. *Journal of Child Psychology and Psychiatry*. 17 (2), pp. 89-100. Pergamon Press: Great Britain.

Yin, R. K. (2009). *Case study research: Design and methods*. 4th Edition. Thousand Oaks, CA: Sage Publications.

# **Appendix 1: Description of E-Learning Resource**

The e-learning supports for this project will be designed on the basis of a persona which is representative of a typical 1st year engineering student. This persona will be aligned with the characteristics of ‘at risk’ students who are considered most likely to benefit from mathematics learning supports (Mac An Bhaird et al., 2010).

The topics covered will be finalised through consultation with 1st year engineering maths tutors. Initial discussions indicate that a narrow scope, covering an introduction to algebra and manipulation (transformation) of mathematical formulae, would be most beneficial to support the topics covered in lectures in the initial weeks of the module delivery. The design will follow a scaffolding approach to the learning of the mathematical concepts by building expertise gradually at each stage (Salmon, 2004; Rourke & Coleman, 2010; Anghileri, 2006).

The resources will be made available through the provision of a link located on the Moodle page for the engineering maths module. The link will lead to a dedicated website which will introduce the objective of the resources, instructions on how to use them most effectively and provide the navigation to the resources for each topic. The resources will be released incrementally over the semester, aligned with the delivery schedule for the topics covered in the module lectures, in recognition of the risks of cognitive overload with new entrant students (Sankey et al., 2010, p. 860).

The topics covered will be split into small ‘chunks’, which will be designed to systematically build up understanding from basic to a level consistent with adequate preparedness for face-to-face maths lectures. The users will be afforded the option to choose their own starting point, in recognition of differing pre-existing mathematics competence, but may be redirected to earlier levels on failure to successfully progress (Rourke & Coleman, 2010, p. 61).

The resources will be designed to incorporate multimodal presentations which provide narrative descriptions of mathematical concepts through a combination of text, graphics, animations and audio descriptions. These descriptions will be followed by possibilities to practice worked examples through interactive exercises including drag and drop, fill in the blanks, point and click to expose further explanations/hints. Examples will be chosen for their relevance to engineering applications to further maintain user motivation.

Users will be provided the opportunity to work through the presentations and exercises for each topic/concept culminating in a quiz where they can test their level of understanding. Feedback on performance for each quiz will include positive messages of achievement (awarding of badges/completion of level) or, for low performance, opportunity to link to further example, previous presentations or hints on questions posing difficulties.

The Successive Approximation Model (SAM) of instructional design will be employed for this project (Allen, 2012). This is an agile approach to ID which will allow for evaluation of the resources throughout their development, appropriate for working within the time constraints of a single semester for implementation. Storyboards and initial versions of resources will be forwarded to the module tutors for testing and evaluation and revised accordingly. At this point, it is anticipated that either Adobe Captivate or Articulate Storyline 2 software will be used to develop the resources.

**References:**

Allen, M. (2012). *Leaving ADDIE for SAM.* ASTD Press.

Anghileri, J. (2006). Scaffolding practices that enhance mathematics learning. *Journal of Mathematics Teacher Education*, 9, pp. 33-52.

Rourke, A. J. & Coleman, K. (2010). A learner support system: Scaffolding to enhance digital learning, *The International Journal of Technology, Knowledge & Society,* 6(1), 55-70.

Salmon, G. (2004). *E-tivities: The key to active online learning*. London and New York: Routledge.

Sankey, M., Birch, D. & Gardiner, M. (2010). *Engaging Students through multimodal learning environments: The journey continues.* Proceedings ascilate Sydney 2010. Retrieved online June 6th 2015 from: <http://ascilite.org.au/conferences/sydney10/procs/Sankey-full.pdf>

Mac an Bhaird, C., Grehan, M. & O'Shea, A. (2010). *What type of student avails of mathematics support and extra mathematics initiatives?* Proceedings of the 15th SEFI MWG Seminar and 8th Workshop GFC, Mathematical education of Engineers.

# **Appendix 2: Declaration of Research Ethics**

**DECLARATION OF**

**RESEARCH ETHICS AND/OR ASSESSMENT OF RISK**

All research and scholarship proposals, whether funded or not by internal or external funds, must submit a Research Ethics/[Assessment Of Risk](http://www.dit.ie/DIT/graduate/ethics/ethicsf.doc) Form to the DIT Research Ethics Committee.

This is a self-declaration process. The researcher is asked to formally identify any possible ethical issues or risks that might arise in the course of the work, and to sign the documentation.

Please refer to the Guiding Principles and Procedures indicated on the DIT Research Ethics website prior to completing this form:

* <http://www.dit.ie/DIT/graduate/ethics/index.html>

**PLEASE NOTE**

* You are requested to attach a copy of your research application to this form.
* The Research Ethics /[Assessment Of Risk](http://www.dit.ie/DIT/graduate/ethics/ethicsf.doc) Form must be signed by the applicant(s)
* Ethical Approval must be granted prior to start of any research/scholarly activity or prior to funding being released for the project, as appropriate.
* No postgraduate research student will normally be registered until the proposal is cleared by the DIT Research Ethics Committee.

**Completed forms should be returned to: Research Ethics Committee, c/o Office of Graduate Studies, DIT, 143-149 Lower Rathmines Road, Dublin 6.**

|  |
| --- |
| **Title of the proposed project:****THE MATHEMATICS PROBLEM – AN E-LEARNING SUPPORT** |
| Applicant Details (Use Block Capitals): |
| Surname: KEYES  | Forename: MARK | Title: MR |
| Present appointment: INDUSTRY TRAINING COORDINATOR  |
| School/Department/Centre: THE LINC, INSTITUTE OF TECHNOLOGY BLANCHARDSTOWNFaculty: DEVELOPMENT Work Tel: 8851035 Fax: E-mail: mark.keyes@itb.ie  |

|  |
| --- |
| Other departments/organisations/individuals involved:a) DEPARTMENT OF ENGINEERING ITBb)c) |
| Source of Funding: N/A |
| Has the current research project already received approval from another research ethics committee? NOIf so, please enclose relevant information and documentation |
| **Generic Projects:**Researchers may receive approval for a cluster of similar research activity by approval of a *generic protocol* to cover repetitive methodologies or activities. A *generic protocol* should comprise a covering letter setting out the circumstances and rationale for generic approval, outlining the procedures to be followed in all such projects, in addition to completion of the appropriate appendices. If this project is part of a cluster of research with similar methodology, please tick here and submit a generic protocol to cover all such projects. 🞐 |

|  |
| --- |
| **Insurance** Normally, DIT insurance covers standard research activity, including fieldtrips. Are you aware of any unusual or exceptional risks or insurance issues to which DIT’s insurance company should be alerted? If so, please list the issues: NO UNUSUAL RISKSPlease note that no contract should be entered into for clinical/medical (including drug testing) or surgical trials/tests on any human subject until written confirmation has been received from the DIT’s insurers that the relevant insurance cover is in place.  |
| Are you or any members of the research team a member of any organisation that provides professional indemnity insurance? No Name of the organisation: Please provide written confirmation of the terms of insurance cover.  |

|  |
| --- |
| **Professional Code of Conduct**Please reference, if appropriate, the Code of Ethical Conduct produced by your relevant professional organization(s), which also informs your research. INSTITUTE OF TECHNOLOGY BLANCHARDSTOWN: 3RD01 - Research ethics and code of good research practice**Please note that: Where those requirements conflict with DIT requirements, the latter will normally be followed. In all such circumstances, please contact the Office of Research Ethics for clarification.** |

All researchers must confirm with the Data Protection Act 1988. Please consult the DIT Data Protection Officer for advice.

**IDENTIFICATION OF ETHICAL ISSUES AND/OR RISK**

|  |
| --- |
| **Do any of the following ethical issues or risks apply in your research? If so, tick all box(es) which apply and complete the relevant Appendix, which can be downloaded from** [**http://www.dit.ie/DIT/graduate/ethics/index.html**](http://www.dit.ie/DIT/graduate/ethics/index.html) |
| **Yes** | **No** | **Does your research involve…** |
| ✓ |  | Impact on human subject(s) and/or the researcher(s) [[Appendix 1](file:///F%3A%5CMSc%20DIT%201%5CModule%204%20Research%20Methods%5CAppendix%201.doc)] |
| ✓ |  | Consent and advice form given to subjects prior to their participation in the research [[Appendix 2](file:///F%3A%5CMSc%20DIT%201%5CModule%204%20Research%20Methods%5CAppendix%202.doc)] |
| ✓ |  | Consent form for research involving ‘less powerful’ subjects or those under 18 years [[Appendix 3](file:///F%3A%5CMSc%20DIT%201%5CModule%204%20Research%20Methods%5CAppendix%203.doc)] |
|  | ✓ | Conflict of interest [[Appendix 4](file:///F%3A%5CMSc%20DIT%201%5CModule%204%20Research%20Methods%5CAppendix%204.doc)]  |
|  | ✓ | Drugs and Medical Devices [[Appendix 5](file:///F%3A%5CMSc%20DIT%201%5CModule%204%20Research%20Methods%5CAppendix%205.doc)]  |
|  | ✓ | Ionising Radiation [[Appendix 6](file:///F%3A%5CMSc%20DIT%201%5CModule%204%20Research%20Methods%5CAppendix%206.doc)]  |
|  | ✓ | Neonatal Material [[Appendix 7](file:///F%3A%5CMSc%20DIT%201%5CModule%204%20Research%20Methods%5CAppendix%207.doc)]  |
|  | ✓ | Animal Welfare [[Appendix 8](file:///F%3A%5CMSc%20DIT%201%5CModule%204%20Research%20Methods%5CAppendix%208.doc)] |
|  | ✓ | General Risk Assessment [[Appendix 9](file:///F%3A%5CMSc%20DIT%201%5CModule%204%20Research%20Methods%5CAppendix%209.doc)] |
|  | ✓ | Hazardous Chemical Risk Assessment [[Appendix 10](file:///F%3A%5CMSc%20DIT%201%5CModule%204%20Research%20Methods%5CAppendix%2010.doc)] |
|  | ✓ | Biological Agents Risk Assessment [[Appendix 11](file:///F%3A%5CMSc%20DIT%201%5CModule%204%20Research%20Methods%5CAppendix%2011.doc)] |
|  | ✓ | Work involving Genetically Modified Organisms Risk Assessment [[Appendix 12](file:///F%3A%5CMSc%20DIT%201%5CModule%204%20Research%20Methods%5CAppendix%2012.doc)] |
|  | ✓ | Field Work Risk Assessment [[Appendix 13](file:///F%3A%5CMSc%20DIT%201%5CModule%204%20Research%20Methods%5CAppendix%2013.doc)] |
| If other risk and/or ethical issues are identified please provide a written submission which outlines the issues and the manner in which they are being addressed. |
| **Please tick the appropriate box below*** **No, there are no** ethical issues and/or risks involved in your research project, **please tick here, and sign the declaration on page 5.**

✓**Yes,** **there are ethical** issues and/or risks involved in your research, **please tick here and complete the appropriate forms identified above.**  |

*In accordance with the Principles of the Declaration of Helsinki and DIT Principles and Procedures, I declare that the information provided in this form is true to the best of my knowledge and judgement.*

*I will advise the* DIT Research Ethics Committee *of any adverse or unforeseen circumstances or changes in the research which might concern or affect any ethical issues or risks, including if the project fails to start or is abandoned.*

**

*Signature of applicant 1:*

*Signature of applicant 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

*Signature of applicant 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

**(An electronic signature is permissible)**

**Checklist**

**Please ensure the following, if appropriate, are attached:**

|  |  |  |
| --- | --- | --- |
| **Documents to be attached** | **Tick if attached** | **Tick if not appropriate** |
| Research Proposal  | ✓ |  |
| Letters (to subjects, parents/guardians, GPs, etc) |  |  |
| Questionnaire(s) |  |  |
| Advertisement/Poster |  |  |
| Ethical clearance from other ethical research committees |  |  |
| Copy of signed agreement of professional indemnity |  |  |
| Generic Protocol |  |  |
| Other (please specify) |  |  |

**Appendix 1**

**SUBJECTS AND/OR RESEARCHERS**

|  |  |
| --- | --- |
| **Researcher’s Name**: MARK KEYES(use block capitals) | **Title:** MR |
| **Faculty/School/Department**: The LINC, Institute of Technology Blanchardstown |
| **Title of Study**: The Mathematics Problem – An eLearning Support |
| **2.1** **Please specify the types of subjects involved in this study, e.g. healthy subjects, in-patients, clinic attendees, minors, and indicate the number of each type.** NB. Names of Student Subjects receiving payment in commercially sponsored research must be notified to the Research Ethics Committee***.*** |
| 130 – 150 1st year engineering students at a higher education institution, a proportion may be under 18 years old |
| **2.2**. **How will you be recruiting subjects for the study?** If controls are to be included please state how they are to be selected and attach a copy of the advertisement if used. |
| Random Sampling, other sampling?Random sampling for survey questionnaire, purposive sampling for one-to-one interviews to ensure representation from a range of pre-existing mathematics competencies (to be established via survey questionnaire)  |
| **2.3**. **Specify the number of subjects to be used in this project, the selection criteria and the exclusion criteria.** |
| 130 – 150, i.e. all 1st year Engineering students for academic year 2015/2016 |
| **2.4.** **Specify whether any of the following procedures are involved:** |
| * Any invasive procedure NO
* Physical contact NO
* Any procedure that may cause mental distress NO

 **(Delete yes or no as necessary)** |
| Outline the procedures involved in your study. (If samples are to be taken state **type**, **frequency** and **amount** and whether this is part of their normal treatment. If Radiological Investigations are partof the procedure please indicate the number and frequency of exposures and total calculated dosage.) |
| Learning Analytics (via VLE), one survey questionnaire – random samplingOne-to-one interviews with 7-8 subjects - purposive sampling for one-to-one interviews to ensure representation from a range of pre-existing mathematics competencies (to be established via survey questionnaire) |
| **2.5.** **State the procedures which may cause discomfort or distress and the degree of discomfort or distress likely to be endured by the subjects.** |
| N/A |
| * 1. **State the potential risks, if any (to both the investigator, subjects, the environment and/or participants), and the precautions being taken to meet them.**

 **Include information on hazardous substances that will be used or produced, and the steps** **being taken to reduce risks.**  **For any projects using Ionizing Radiation see** [SECTION 7](http://www.dit.ie/admin/graduate/ethics/section7.doc)**.** It is a requirement that a formal signed Risk Assessment Form be provided-see [SECTION 10](http://www.dit.ie/admin/graduate/ethics/section10.doc) (i) to (v) |
| N/A |
| **2.7** **Is written consent to be obtained? YES**  **(Delete yes or no as necessary)**If so, please use the CONSENT FORM ([section 3](http://www.dit.ie/admin/graduate/ethics/consent.doc))If a form other than the Research Ethical Committee consent form is to be used, please attach a copy*.* |
| **2.8. Are subjects to be included under the age of 18? YES**  **(Delete yes or no as necessary)**If yes, please fill in the CONSENT FORM ([section 4](http://www.dit.ie/admin/graduate/ethics/section4.doc)) for Research Involving ‘less powerful subjects’ and those under 18 years of age |
| **2.9. Is neonatal material to be used in this study? NO**  **(Delete yes or no as necessary)**If yes, please fill in [SECTION 8](http://www.dit.ie/admin/graduate/ethics/section8.doc) for Research Involving Neonatal Material |
| **2.10. Will any payments be made to subjects? NO** **(Delete yes or no as necessary)**If **YES** give details: |
|  |
| * 1. **Is any proportion of this payment being paid by a commercially sponsored organisation and if so by whom?**
 |
| N/A |
| **2.12 Signature details****Researcher’s Signature Title\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_****Date** *29/06/2015* |

**Appendix 2**

**CONSENT FORM**

|  |  |
| --- | --- |
| **Researcher’s Name**: MARK KEYES (use block capitals) | **Title:** MR |
| **Faculty/School/Department**: The LINC, Institute of Technology Blanchardstown |
| **Title of Study**: The Mathematics Problem – An eLearning Support  |
| **To be completed by the:****subject/patient/volunteer/informant/interviewee/parent/guardian *(delete as necessary)*** |
| 3.1 Have you been fully informed/read the information sheet about this study? YES/NO3.2 Have you had an opportunity to ask questions and discuss this study? YES/NO3.3. Have you received satisfactory answers to all your questions? YES/NO* 1. Have you received enough information about this study and any associated health and

 safety implications if applicable? YES/NO* 1. Do you understand that you are free to withdraw from this study?
* at any time
* without giving a reason for withdrawing
* without affecting your future relationship with the Institute YES/NO
	1. Do you agree to take part in this study the results of which are likely to be published?

 YES/NO* 1. Have you been informed that this consent form shall be kept in the confidence

 of the researcher? YES/NO  |
| Signed\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Name in Block Letters \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Signature of Researcher Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

**Please note:**

* For persons under 18 years of age the consent of the parents or guardians must be obtained or an explanation given to the Research Ethics Committee and the assent of the child/young person should be obtained to the degree possible dependent on the age of the child/young person. **Please complete the Consent Form (section 4) for Research Involving ‘Less Powerful’ Subjects or Those Under 18 Yrs.**
* In some studies, witnessed consent may be appropriate.

The researcher concerned must sign the consent form after having explained the project to the subject and after having answered his/her questions about the project

**Appendix 3**

**CONSENT FORM**

**FOR RESEARCH INVOLVING ‘LESS POWERFUL’ SUBJECTS OR THOSE UNDER 18 YRS**

|  |  |
| --- | --- |
| **Researcher’s Name**: MARK KEYES(use block capitals) | **Title**: MR  |
| **Faculty/School/Department**: The LINC, Institute of Technology Blanchardstown  |
| **Title of Study**: The Mathematics Problem – An eLearning Support |
| * 1. **In what way, if any does the proposed study benefit the individual subject?**
 |
| *N/A* |
| **4.2** **Has parent's/guardian's consent to be obtained? YES** **(Delete yes or no as necessary)** |
| In written form. |
| **4.3** **Will the child's or young person's assent be sought? YES** **(Delete yes or no as necessary)** |
| **4.4 Are the risks of the investigation judged to be minimal or nil? YES** **(Delete yes or no as necessary)****Please attach a risk assessment form (**[form 10.i](http://www.dit.ie/admin/graduate/ethics/section10.doc) **) if necessary** |
| **Researcher’s Signature Title\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_****Date** *29/06/2015* |