The use of interactive screencasts to promote active and engaged learning in the Further Education mathematics classroom: A descriptive case study from North East England

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***Abstract*—This Research-to-Practice Work in Progress paper explores the lifelong learning sector which is an important but often challenging area of education. It can be subject to low and inconsistent levels of funding and can attract students who find certain areas of the curriculum particularly challenging. This can lead to a lack of engagement and disruptive behaviour in the classroom. For over a decade, the UK government have been keen to ensure that all adults have a minimum level of 'functional skills' including mathematics. In England's Further Education Colleges, this means many students have to study mathematics alongside their main subject programme, even though they may not be motivated to do so. The aim of this research study is to investigate if technology and specifically interactive screen casts can motivate and engage these students in their mathematics classrooms. This research adopts a case study action research approach working with a group of learners and their teachers/classroom assistants in a college in North East England. The preliminary results indicate that these learners struggle with motivation and engagement. The adoption of technology in the form of interactive screencasts could bring benefits to these types of learners by providing a more active and individualized learning experience addressing their motivation and engagement issues and accommodating a range of learning styles.**

Keywords— lifelong learning, mathematics education, special educational needs, screencast technology, technology enabled learning.

I. Introduction and Background

Educators across the globe face several challenges within the lifelong learning sector. In the UK these include frequent policy changes, disrupted classrooms, significant cuts in vocational courses hours and a new curriculum for Further Education (FE) colleges making independent study and personalised learning an integral part of all vocational courses in FE colleges [1, 2, 3, 4].

Mathematics is viewed as an essential key skill in modern society and valued by employers [5]. As Smith outlines in [6] "*Our young people therefore need a high-quality mathematics education that develops both the competence to use appropriate mathematics in a variety of work, learning and life contexts, and the confidence with which to do so*." However, providing this in practice can be problematic. Recent government statistics suggest that in England, 49% of the working age population, equivalent to 17 million adults, have the numeracy level of that expected for a primary school child [7].

In England, one approach to tackling this issue has been the introduction of functional skills. Designed to improve England's literacy, numeracy, and ICT skills they were introduced in 2012 following a 3-year pilot study and are a requirement on many FE vocational programmes and apprenticeships unless the students already have an equivalent or higher qualification [8].

However, providing a stimulating and effective functional skills mathematics education in FE is proving to be challenging across the sector. Many of the students are not motivated and/or lack the confidence to study mathematics. Teachers in FE are struggling to engage their students and often report disruptive behaviour in their classrooms. One of the researchers in the team has first-hand experience of the FE sector and has personally witnessed the low student motivation, poor attendance, high drop-out rate, and concerning levels of disrespectful and disruptive behaviour occurring in the classroom.

This is a concern as student engagement is often linked to better educational achievement and improved retention [9, 10]. A seminal review of student engagement identifies three dimensions to student engagement: behavioural, emotional, and cognitive [11], which roughly equate to 'doing', 'feeling' and 'thinking'. However, the distinctions between these can be quite subtle [12]. The implication from this for teachers is how to "*understand and implement engagement strategies in ways that effectively cater for behavioural, emotional and cognitive dimensions of student engagement*" [13] in their classroom practice.

There has been much research conducted on how to provide an engaging learning experience. This includes studies that use constructivist approaches to education building on those from Piaget and Vygotsky [15]. Active learning is one approach that has received a great deal of attention from researchers especially in the Science, Technology, Engineering and Mathematics (STEM) disciplines [16]. Active learning aligns with an engaging learner centered constructivist approach and lends itself to more authentic and engaging learning [17].

To promote active learning, Reece and Walker argue that: "*Integrating Information Learning Technology (ILT) with other learning methods is a vehicle for motivation of our students and therefore enhancing learning"* [18]. In addition, one of the eight principles for effective mathematics teaching promoted by the National Centre for Excellence in Teaching Mathematics is the adoption of appropriate technology *"to present mathematical concepts in dynamic exciting ways that engage and motivate learners"* [4]. To support this further, Petty concluded his argument on the positive impact of using ILT in mathematics classroom with the following typical example: *"one teacher emailed a video clip on algebraic long division to help learners prepare for a lesson on factorising cubic equations. Most learners worked through this before the lesson and so made outstanding progress during the lesson"* [19].

From a student's perspective, ILT can motivate and engage students in the learning process and embed the use of IT skills in their studies. This view and goals are well supported by the UK's Office for Standards in Education, Children's Services and Skills (OFSTED)'s reports and policy for the Lifelong Learning sector [20], the National Centre for Excellence in Teaching Mathematics [21] and the National Council of Teachers of Mathematics [22]. Together these highlight the "*need for more engaging visual resources in teaching and less reliance upon textbooks and poor-quality photocopies"* [3]. Various studies have suggested that screencasting technology can be one of the emerging ILT resources used to promote active learning both in and out of the classroom [23, 24].

However, although the adoption of digital technology can be helpful in creating a more engaging and immersive experience for students, there has been a low adoption of technology in the classroom including screencasts across the FE sector [1, 2, 25, 26]. FE teachers report a growing concern about the lack of availability of good educational resources including videos [4, 23, 27]. As a result, FE teachers just like their counterparts in schools, often use educational YouTube-style videos to support teaching and learning [26]. However, Drew [28] has pointed out the pedagogical flaws in most educational YouTube-style mathematics videos, especially the fact that these videos are not designed or used as cognitive tools to promote a constructivist education experience and often do not support an active and/or personalized learning approach.

II. Research Focus and Theoretical Framework

To address these pedagogical flaws, a new form of screencast video called 'interactive screencasts' video with in-built formative and summative assessments is proposed. This could provide an Information Learning Technology (ILT) visual resource solution to these problems especially during the current Covid-19 pandemic era when educational institutions across the globe are often in lockdown or other forms of social isolation [25, 26, 28].

The aspirational research question, this study seeks to answer is: how can we gain and maintain the interest of FE students who are required to pass mathematics as part of the requirements of their vocational course or to support their future career prospects? To tackle this question, this study focuses on the application of ILT and particularly interactive screen casts to address two key issues: (1) gaining and maintaining students' interests, especially in mathematics for non-cognate students such as Level 3 Health and Social Care students; and (2) motivating FE college students who are required to pass functional skills mathematics as part of the requirement of their vocational course to practice independent, personalised and active learning [3, 18, 29, 30]. A further complexity is that a significant number of these FE students may also have Special Educational Needs and Disability (SEND). FE often has a higher percentage of SEND students compared to the HE sector.

Using the proposed conceptual framework of Collins-McNaught learning engagement model [18], Online engagement framework for higher education [39], Bond and Bedenlier for learner engagement through educational technology [31] and building on concepts from Mayer's Cognitive Theory of Multimedia Learning [14, 32] and the Technology Acceptance Model [33], with recognition of the need to differentiate to accommodate different learning styles, this study seeks to provide answers to the following questions: 1. How can interactive screencast technology be used to provide an interactive learning experience for Functional Skills Mathematics students in FE? 2. To what extent can interactive screencast provide a personalised learning experience for Functional Skills Mathematics SEND students in FE?

III. Research Approach

This research has chosen to adopt a descriptive case study action research approach. Case study research enables the exploration and understanding of complex issues and has proved useful when looking for an in-depth investigation of social behaviours [40, 34, 35]. While a descriptive case study leads to a rich, comprehensive analysis of a specific experience or circumstance and its background [40]. Here it is used to enable an in-depth investigation of a group of FE learners and their motivation and engagement with mathematics functional skills.

The procedure of the descriptive case study involved first, defining the case through the formulation of the research questions which was informed by the literature reviewed and first-hand experience of one of the researchers working in the FE sector. The pre-defined boundary of the case study was established to cover a 16-week academic term due to the impact of Covid 19 on the FE sector resulting to the government closing all institutions of learning across the UK indefinitely. Second, the case for investigation was selected as a single case of a government funded further education college in North-East England which represents a typical instance of a UK FE college since these institutions practise similar classroom pedagogy, mathematics curriculum, regulated by Ofsted and are exemplars of the lifelong learning sector. Hence, the findings from this research can be generalised to these types of government funded colleges. Third, the case study used a pre-test questionnaire and an initial semi-structured group interview to explore the learners' mathematics background on key areas of the functional skills maths curriculum. An extensive semi-structured group interviews and overt participant observations to obtain rich data of the learners' experiences after the post-test will be conducted before the end of the 16 weeks. Fourth, the early analysis and results of the pre-test questionnaires and semi-structured interviews will inform the design of the observations and post-test extensive interviews. After the post-test interviews and observations, the interview sessions will be transcribed using Nvivo software package searching and identifying themes and patterns in the data which will be linked to the conceptual framework of the research. The student engagement in the learning process will be observed and measured using the adapted online student engagement (emotional engagement, behavioural engagement, and cognitive engagement) for higher education framework to match the blended-learning environment the interactive screencast will be implemented [39]. To understand and capture the indicators of the 3 different types of student engagements, each observation session will be divided into 4 stages: 1. Beginning of session 2. During exposition (audio narration), 3. During independent task (online-quiz) and 4. At the end of session.

The descriptive case study research strategy has been combined with an action research approach which is a process of systematic enquiry that looks to improve social issues affecting the lives of people [36, 37]. Through repeated cycles of planning, observing, and reflecting, individuals and groups engaged in action research can implement changes required for social improvement. Within education, action research can be used to provide practitioners with new knowledge and understanding about how to resolve significant issues and/or improve educational practice bridging the gap between research and practice [37, 38].

This study used a group of learners (n = 34) studying functional skills mathematics as part of their vocational programme at a college in North-East England. The anticipated research outcomes of the study include: 1. An in-depth understanding of the issues surrounding student engagement and attitudes to mathematics education in the lifelong learning sector. 2. An evaluation of how screen cast technology can be used effectively to address some of the misconceptions or lack of understanding around some of the more challenging mathematical concepts in FE. 3. Insights into the effectiveness of using digital technology particularly screen casts within the FE classroom to address student motivation and engagement.

This paper reports on the first two stages of the action research cycle – REFLECT and PLAN; the ACT stage will be discussed in the final paper. A set of semi-structured interviews have been undertaken with the learners to explore their background, attitude to mathematics and preferred learning styles. This has been supplemented with an exploration of the current challenges in the classroom from the teacher perspective. Together these have formed the REFLECT stage of the action research cycle. The results from these have been used to inform the development and design of an interactive screencast, the PLAN stage of the action research cycle.

IV. FINDINGS

The initial semi-structured interviews have highlighted that the students' previous experience of mathematics education has been very varied from very enjoyable to quite challenging. The challenges seem to arise from two different aspects. Some of the students have found the teaching itself problematic illustrate with comments such as "*My previous maths learning experience in the classroom was very challenging for me, as the teacher would always move on to things too quickly and they would do too many things at once"* and "*it was really horrible …he called me useless*". The second aspect is a more personal perspective on mathematics with comments such as "*I find it hard to process the information*" and "*I find maths complicated from the start but slowly I am learning how to become better with my maths education, I would need to be prompted and continuously ask to concentrate"*.

In terms of learning styles, the students report a variety of these with a large number reporting that they enjoy videos and practical hands-on approaches. Some also outline how they like to work in a quieter environment and others indicated that they find the pace of teaching challenging at times, reflecting the earlier comment from a student that they find it difficult to keep up.

Hence, before the design of the interactive screencast to address the students' learning needs, the research design started with a pre-test questionnaire to assess the students' initial knowledge about 9 key topic area of the functional skills mathematics curriculum including fractions, decimals, percentages, money, time, scales, weight, capacity, and temperature.

The early analysis and results of the pre-test showed that 9 students passed the pre-test while 25 students failed the pre-test. 17 students passed the section about 'Money' scoring 2 or 3 marks out of 3 marks allocated to this section while 17 students also failed the section about 'Money' scoring 0 or 1 mark out of 3 marks allocated to the section.

The implication of this results meant that 73% of the students lack the required knowledge and skills to pass the upcoming Entry 2 – Level 1 functional skills mathematics exams in June 2021. As a result, a lot of them might be exempted from sitting the upcoming exams in June because they will not achieve the predicted or required grade to move on to the next level of learning which might upset some students (low ability students) in view of their previous negative mathematics learning experience, as well as increase their anxiety levels and low interest in mathematics.

The reflections from the teachers have indicated the current challenges with teaching mathematical functional skills at the college. Using Bond and Bedenlier's framework, these clearly fall into macro, exo, meso and microsystesm levels. Funding issues, government policy and its approach to functional skills lie at the macro level. Exo levels include the lack of a dedicated mathematics department or office for the teaching team including the learning support assistants meaning that it is more difficult to communicate and share resources, ideas and good practice. This also means that strategic and operational planning is more difficult and there is little use of evidence-based practice to inform the educational practice in the department and across the college. The college staff are split over several buildings meaning it is difficult to communicate between different teams and services within the college. At the meso level, the background of the students means that they often need additional support and may be ill prepared for their functional skills lessons. At the micro level, the classroom environment and technology infrastructure could be improved. Key issues include slow and outdated PCs, poor lighting and projection facilities, insufficient numbers of physical resources such as calculators, notebooks, and no specialist mathematical resources such as games, flashcards, or online resources. The IT team is also stretched and therefore is slow to respond to and repair IT issues when they arise.

However, the teaching team itself is keen to support students and provide an effective and positive learning experience for them. They have also indicated that they are willing to support the introduction of new classroom practice including interactive screencasts and there is also management support for this providing it can be integrated effectively and does not create additional work for the teaching team.

Using these results, the research is now focused on designing and developing an interactive screencast for use within the classroom. Due to the impact of Covid-19 on the scheme of work and limited time left to teach and learn before the summer holiday, decision has been taken to focus the interactive screencast only on 'money' aspect of the mathematics curriculum as this is a key area that students will use in their everyday lives.

The design of the interactive screencast will be based on the perceived learning needs of the students evidenced by the pre-test and the evidence gathered from previous active learning research about effective screencast design for mathematics education. The screencast design will follow the conventional mathematics lesson planning and delivery approach by first engaging students with a starter activity to get their attention and check their entry behaviour into the classroom and knowledge about money.

Then the aims and learning outcomes of the session will be introduced to students followed by an explanation of each learning outcomes combined with appropriate active learning activities including a game about money to simulate a scenario of 'cashing in' or shopping at grocery store. Then, each section will conclude with a formative assessment in the form of a short quiz to check student learning. Each section of the screencast will feature active learning elements to motivate and engage students such as animated texts and objects, zoom and pan feature to focus students attention on key details on the screen, annotations to highlight key points on the screen, interactive hotspot to enable students interact with the screencast and navigate to various sections of the screencast, table of contents for easy navigation, feedback during the quiz especially when a student enter or select a wrong answer, and after the quiz to help students master key skills and learning outcomes for each section.

At the end of all sections, a summative assessment in the form of a final test or quiz will be given to students to check their learning to ensure all learning outcomes have been achieved. Then the screencast will conclude with a plenary section asking students to self-assess themselves against the learning outcomes of the session.

Although the screencast will follow and simulate the current conventional mathematics teaching approach in FE classrooms, it will allow individual students to work at their own pace, review or rewind a section of the screencast if they miss vital points during exposition or if the pace of delivery is too fast for them. It will also enable all the students to participate in active and engaged learning by giving students high level of in-video and hands-on tasks to do to sustain their interests in the topic and engage them.

V. Conclusions

The study is using the results from these first two stages of the action research cycle to explore why students have low levels of motivation and engagement with their functional skills mathematics educational provision. The results from this have informed the design and development of a series of interactive screencasts that will be used to change the classroom practice. This is currently being tried within the college with the group of learners and their teachers and classroom assistants. The study will monitor and evaluate the effect of these changes in classroom practice on the learners' motivations and engagement.

The findings and implications from this study are of interest to those working in the FE sector and those investigating effective applications of digital technology in education and particularly within the classroom setting.

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