Windsor
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Planning for Digital Technology in Education

Kirsty Tinsley
Windsor Academy Trust Research Lead

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We believe in digital technology's potential to transform students' learning experience both in the classroom and beyond.

Technology enables new ways of collaborating, developing knowledge and live assessment while preparing students for life in an increasingly digital world. For teachers, opportunities exist to reimagine teaching methods, learning, and working in more efficient ways to support wellbeing. Yet, the case for digital technology in schools has limited research evidence.

The extent to which digital devices have enhanced student engagement and changed ways of teaching teachers' pedagogy is, as yet, not well understood (Diemer et al, 2013 cited in Geer 2017). Hattie's metastudy indicates a use of technology providing moderate effect sizes - 0.57 effect size for SEN and 0.55 effect size for other subjects (Hattie 2020).

Indeed, only 44% of primary and 31% of secondary schools in England report that the implementation of education technology has helped them achieve their original objectives (BESA 2017). However, it is also argued that digital technology has positive impact when it is embedded in a well-designed learning system (US Office of Educational Technology 2014, cited in Lewin et al 2019) with a laser focus on research to inform curriculum, pedagogy and CPD.

Perhaps the lack of success in embracing education technology is because, in many cases, technology has been implemented without the requisite thinking on how it will close gaps for students and how it can enhance teaching and learning.

Education technology should be 'the final piece of the process, not its starting point' (Selwyn, 2019). So, before introducing technology into our schools, we began by reviewing the literature base. This report provides a summary of our literature review, identifying how digital technology in education can be successfully implemented and used to enhance teaching and learning.

Five Key Takeaways

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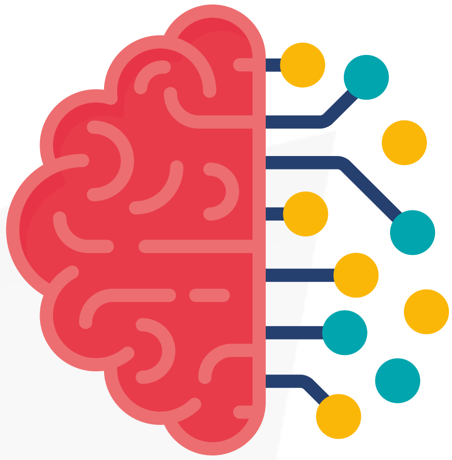
Pedagogical and Cognitive Theory



It is vital to root any learning activity in pedagogical theory, just as in any lesson. Having a secure knowledge base to enable students to select/understand relevant information online is crucial (Fullan 2020, Willingham 2006). Beware of split attention; ensure that students are learning and remembering the content that you intended rather than how to use an exciting new app (Christodulu 2019).

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Teacher and Student Training – Implementation

Poor implementation is a key reason digital technology fails to meet its potential to improve learning (EEF 2019). Teachers require training in the range of pedagogical approaches for use to critically analyse and ascertain the best approach for student learning (Henderson 2012). Surprisingly, although digital technology offers intuitive tools, students take time to learn how to use iPads for their own learning (Lam 2011). Check that all learners have the tech skills to reduce the risk that technology becomes a tool that widens the gap between successful learners and their peers (EEF 2019).

//03

Technology and Assessment

There are areas of real potential here: increased accuracy of assessment, data collection speed informing teachers' decision-making, reduced workload, stealth assessment and e-portfolios. Technology is most beneficial if it supplements and is aligned to other forms of feedback (EEF 2019).

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Technology and Differentiation/ Personalisation

Tutoring systems can provide opportunities for students at risk of falling behind or for those who have missed areas of content and provide adaptive content. Effective delivery requires staff oversight and help with student organisation (EEF 2019, Pane 2017).

//05

Notes of Caution

Unintended and unhelpful impact on existing activity, beware of students wholly replacing previously successful learning techniques (EEF 2019). Multitasking, eg using a number of apps simultaneously, can be a distraction from linear thought and deep thinking (p230 Greenfield 2015, Carr 2006). Only 1 in 9 students are able to distinguish fact from opinion, hence without considerable guidance from teachers, it is unlikely that students will be able to navigate the world of online learning (Fullan 2020, OECD 2018).

1. The importance of Pedagogical and Cognitive Theory

To improve learning, technology must be used in a way that is informed by effective pedagogy. Instead of simply considering what a successful system looks like when considering any new intervention, we should 'consider how humans learn, what causes learning to happen' (p.21 Christodulu 2019).

Technology can help teachers model in new ways and provide opportunities to highlight how experts think and what they do. Still, it may be most effective when used as a supplement rather than a substitute for other forms of modelling (Lewin et al 2019).

The 2019 EEF metastudy (Lewin et al 2019) sees potential for edtech to increase the quality and quantity of practice that pupils undertake, both inside and outside of the classroom, as engaging and motivating for pupils.

Some forms of technology can also enable teachers to adapt practice effectively, for example, by increasing the challenge of questions as pupils succeed or by providing new contexts in which students are required to apply new skills. Using technology to support retrieval practice and self-quizzing can increase retention of key ideas and knowledge (Lewin et al 2019).

While organisations such as Google, Microsoft and Apple have developed project based learning programmes that use apps such as i-movie to promote creativity and individualisation, this is somewhat countered by cognitive science theory which suggests 'memory is the residue of thought' (Willingham 2006). That is, we must be clear on our learning objectives. If students are thinking about how to use the apps that they are using then are they learning the subject content that we had set out to teach?

Henderson (cited in Geer et al 2017) indicates that having quick access to content empowers students to supplement what they may be learning in class with a wider variety of information. Indeed, Google's teacher training resources suggest 'we have access to every bit of info we need at all times.

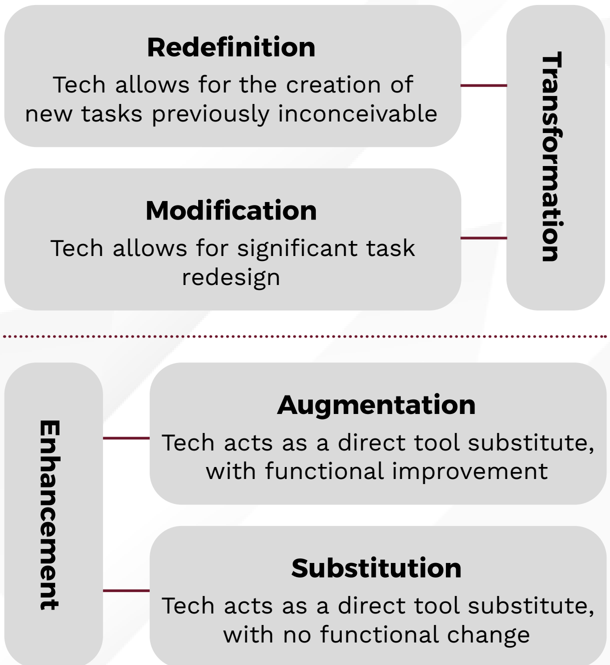
It is therefore no longer relevant to focus on teaching facts.' (Google for Education, Search Smart 2019). However, this does not fit comfortably with cognitive science theory, which states that we need facts in long-term memory to think critically and assess new material sensibly (Kirschner 2006).

The PISA 2018 assessment revealed that even among 15-year-old students, on average across OECD countries, just one in nine students could distinguish between fact and opinion, based on implicit cues about the content or source of information. Thus, without considerable guidance and support from teachers, it is unlikely that students will be able to navigate the world of online learning on their own (Fullan 2020).

2. A framework for EduTech purpose

To date, several frameworks have been used to examine the general adoption and integration of technologies into the classroom eg TPACK framework, Replacement, Amplification and Transformation (RAT) and the framework of Substitution, Augmentation, Modification and Redefinition (SAMR) by Puentedura (2006) (all cited in Geer 2017).

The SAMR Model



The SAMR model (Puentedura 2006), which is used in studies of Geer et al (2017) and Moane (2019), consists of four clearly defined levels for the use of technology where a level can be selected to suit the purpose and need; making education technology use more meaningful for pupils' learning and teacher planning.

This has been exemplified at Sandringham School, which introduced a Bring Your Own Device scheme Years 7 to 11 using the SAMR model to plan for and assess impact.

It integrated blended learning into the whole-school teaching and learning strategy. Their aims were 'to foster independent, creative and resourceful learners, time-shifted and place-shifted learning, to extend learning beyond the confines of the classroom and the school day, to encourage collaborative and active learning, to personalise the curriculum and place no limits upon learning...The student pioneers of the blended learning programme finished their GCSE studies in summer 2018 and achieved excellent results in terms of attainment and progress...over 80% of staff and students and 77% of parents agreed that blended learning had added significantly to learning at school and home' (Moane 2019).

In Geer's (2017) study of four schools, the iPad features and the way the teachers implemented them using the SAMR model enabled the students to use iPads for research, communication and product creation. 'Findings suggest that a structured professional learning program may assist some teachers to move from the enhancement to the transformation stage.

While best practice is not evident as yet, and further research is needed in this emerging field, there are promising signs that iPad use will bring about a pedagogical shift supporting enhanced student learning'. (Geer 2017).

3. Implementation - Teacher Training

Students were clear in The Class of 2030 and the Life-Ready Learning report (cited in Fullan 2020) - they did not want to be taught by a 'computer'. They valued the relationship they had with teachers who knew them and how they learn best.

Teacher-student relationships remain key to success. Education moving forward must not be an agenda of students learning on their own. Teacher-student partnerships and school settings remain essential elements of a future-focused learning model (Fullan 2020).

Poor implementation is a crucial reason that digital technology fails to meet its potential to improve learning (Lewin et al 2019).

Indeed, across OECD countries, only 65% of 15-year-olds are enrolled in schools whose principal considers that their teachers have the necessary technical and pedagogical skills to integrate digital devices in instruction OECD (Fullan 2019), highlighting training needs within education systems.

Across OECD countries, the least commonly implemented effective and valuable practices were:

- having a specific programme to promote collaboration amongst teachers on the use of digital devices (36%)
- having a scheduled time for teachers to meet to share, evaluate or develop instructional materials and approaches that use digital devices (44%)
- having a written statement specifically about the use of digital devices for pedagogical purposes at school (46%) (Fullan 2019).

A cautionary tale exists in the 2013 Los Angeles School District and Apple Pearson $1.3bn project. This project aimed to educate 700,000 students but failed due to limited teacher training and software faults (Lapowsky 2015, cited in Christodulu 2019).

Teachers require exposure to the range of pedagogical approaches that lend themselves to iPad use so that they can critically analyse and ascertain the best approach for student learning (Henderson and Yeow, 2012).

In contrast, Burden et al (2012) suggest that formal training should be kept to a minimum and that the greatest benefits are likely to be evidenced through experimental learning, taking into account the time required for teachers to familiarise themselves with the technology (Geer 2017).

4. Implementation - Student Training

Although iPads are intuitive tools, and consequently, students appear to take little time to learn how to use them, they do not necessarily know how to effectively use them for their own learning (Lam at al, 2011 cited in Greer 2017).

Monitoring how technology is being used, including checking that all learners have the skills they need to use it effectively, is likely to reduce the risk that technology becomes a tool that widens the gap between successful learners and their peers (Lewin et al 2019). Training needs should be built into curriculum plans.

5. Technology and Assessment

Much of the literature suggests feedback and assessment should become more deeply embedded within the teaching process (Whitelock and Warburton, 2011; Pellegrino and Quellmalz, 2010). Indeed, 'stealth assessment', assessments embedded within learning, have been found to reduce test anxiety and be less disruptive to the flow of learning (Shute et al, 2010).

Kleeman et al (2011) describe how embedded assessments can be used formatively as knowledge checks in various multimedia forms, such as wikis, social networking sites, blogs or web pages on computers or mobile devices. In this way, assessment is integrated into the learning process and utilises previous research showing that retrieval practice questions can be powerful motivators for learners (Oldfield et al 2012).

Using technology can increase the accuracy of assessment and the speed with which assessment information is collected. This has the potential to inform teachers' decision-making and reduce workload. Technology can be used to provide feedback directly to pupils via programmes or interventions, but careful implementation and monitoring are necessary in all cases. Feedback via technology is likely to be most beneficial if it supplements, but is aligned to, other forms of feedback (Lewin et al 2019).

Technology can enable e-portfolios to track holistic learning and increase self and peer assessment and more assessment of group work and performance (Whitelock, 2010; Peacock, A; Berger, R). e-portfolios have been seen as a significant improvement over previous paper-based portfolios, both for practical (more time-efficient) and pedagogical (increased reflection and quicker feedback) reasons (Stone, 2012).

Technology can be used to solve the 'the abstraction between what the teacher intends, and what the pupil understands' by feedback (Lewin et al 2019). For example, St Margaret's CE Primary, Withern, developed an approach using tablet computers to record verbal feedback over videos of annotations of pupils' work. The pupils get two improvement points: a photo of their work side by side with an image of a model text and when improving their text, pupils can replay the teacher's voice as often as they like.

Unlike other modes of delayed feedback, the only intended audience is the pupil, so the feedback is focused on their needs and moving their learning forward (Lewin et al 2019).

However, results from other EEF trials illustrate that technology alone is not enough. The Learner Response System trial looked at hand-held electronic clickers' regular use in Key Stage 2 mathematics lessons in 2014 and 2016. In response to the teacher's questions, pupils could input the answer on the handset, and both pupils and teachers received immediate feedback. The high-quality study found no impact on Key Stage 2 results and identified teachers' concerns about the feedback's accuracy (Lewin et al 2019).

6. Technology and Collaboration

Collaboration is an interesting area for the creative use of technology. Burden et al (2012 cited in Geer 2017) found that having iPads in the classroom caused teachers to rethink their professional role leading to greater collaboration as co-learners and pioneers with their students.

In Geer et al's study of four schools adopting iPads (2017) data analysis from teacher and student interviews/surveys relating to pedagogy identified four main themes; collaboration, communication, self- reliance/autonomy and authenticity, which were evidenced throughout the data as being aspects of change due to iPad use.

7. Technology and Differentiation/ Personalisation of Learning

As advocated by Bloom (1984), personalising learning through one-one tuition showed students receiving one-one tuition made gains of two standard deviations compared to groups in classrooms, is cited by Zuckerberg as showing the value of personalised learning that is equivalent to eight additional months (Christodulu 2019).

However, the RAND paper on personalisation of learning shows some of the negative effects when students are given too much control over their own learning. Some students were unable to organise their time to pace themselves through the work to completion. (Pane 2017).

Tutoring systems can provide additional learning opportunities for pupils at risk of falling behind or those who have missed content areas. These programmes offer an opportunity to provide cost-effective personalised support, and some claim to accurately assess pupils' understanding and provide adaptive content.

Effective delivery requires some level of staff oversight, although a teacher can supervise the practice of pupils simultaneously. This is supported by a meta analysis of 84 reading programmes showing a small positive impact, but only with teacher supervision (Cheung 2012). However, most programmes are designed to be used as additional support, replacing other forms of catch-up intervention. In these cases, the evidence suggests that they are unlikely to be more effective than other support, and schools should consider what support is the most efficient and appropriate (Lewin et al 2019).

8. Technology and Learning Skills

The ability for technology to enhance students' learning skills with the aim of developing 21st Century citizens is explored by Summit Learning, an online learning platform which is funded by the Chan-Zuckerberg Foundation, as praised by Bill Gates. While Michael Fullan's 6 competencies for future citizens (Collaboration, Creativity, Critical Thinking, Citizenship, Character, Communication) are articulated in the 'Deep Thinking for New Pedagogies' project (Fullan 2020).

9. Notes of Caution

Even when technology is introduced as an additional strategy outside of the classroom, it is valuable to consider whether it will have an unintended and unhelpful impact on existing activity. For example, the result recommending an online quiz website could lead students to cut back on other forms of revision unless the site was introduced with some guidance about an appropriate mix of revision strategies (Lewin et al 2019).

Monitoring how technology is being used, including checking that all students have the skills they need to use it effectively, is required to reduce the risk that technology becomes a tool that widens the gap between successful learners and their peers (Lewin et al 2019).

It is noteworthy that students attending schools with more computers per student scored lower in the PISA assessment than their peers in schools with fewer computers per student. Across OECD countries, one additional computer per student in a school was associated with a 6-point decline after accounting for socio-economic profiles (OECD 2020), suggesting that it takes more than providing technology to improve learning.

Greenfield warns against multitasking which is promoted by tech devices eg hyper-text within reading, or using several apps simultaneously as a distraction from linear thought and deep thinking. Greenfield also notes that students seem to prefer the medium of print rather than screen for 'effortful learning' (p230 Greenfield 2015; Carr 2006).

In short, in seeking to introduce digital technology, it is vital to plan for and monitor the use of technology carefully during implementation to support effective pedagogy and discover unintended consequences.

How we have introduced digital technology to power up learning

Across Windsor Academy Trust, we launched iPads for Learning in winter 2020. This project introduced iPads as one to one devices for all Year 7 and Year 4 students. Taking learning from the research discussed here, we ensured that our initial staff training focused on employing iPads to support our existing pedagogical focus.

This has been streamlined with student training through the computing curriculum to enable students to confidently use the most valuable learning applications and develop their independence as learners. A number of our teachers act as digital subject leads to ensure that digital learning opportunities are embedded within our work schemes to power up the curriculum.

Early indications highlight some exciting areas of strength in digital learning. Teachers have noted improved collaboration between students, deeper thinking and powerful whole class learning checks. We look forward to continuing our digital journey and learning more about the impact of 1:2:1 devices on our students' learning.

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Appendix 1: Examples of successful technology programmes

MathsFlip (EEF RCT) sought to improve the mathematics attainment of pupils in Years 5 and 6. Each participating class had a personalised web page that included an area for shared resources, videos and documents, and a space for communication between pupils and teachers. Where pupils did not have access to the internet at home, schools provided lunchtime, before-school and after-school sessions when pupils could complete activities.

The evaluation found that pupils following the approach made the equivalent of one additional month's progress in mathematics, compared to pupils in comparison schools. The technical and professional support provided to participating teachers was identified by the report as a key feature of the project. This underlines the need to devote time and resources to implementation.

Mathematical Reasoning is a programme developed by academics for Year 2 pupils, which integrates lesson content for teachers with the use of online games that pupils play outside of the lesson. Two EEF evaluations have suggested that this integrated approach has a positive impact on attainment in mathematics.

Virtual environment Quest Atlantis uses a game-based curriculum that supports students to develop inquiry in ecological sciences. A study of two classes using Quest Atlantis found that the classes had larger gains in ten Technology Enhanced Assessment: Review of the Literature understanding and achievement than those that did not.
Students that engaged more with the environment's formative feedback showed even greater gains (Hickey et al, 2009).

The AsTTLE project in New Zealand is a software application that enables educators in schools across the country to create tests by selecting items from an online system. Teachers have access to large, calibrated banks of test items and can select those which reflect the test purpose and their own teaching.

While AsTTle was developed in higher education, it is used by school teachers and administrators. Performance data is entered into the system, allowing teachers and administrators can access valid, reliable information of student performance, as well as relevant teaching resources.

While meeting national standardised requirements, the system also provides feedback for teachers and ultimately supports assessment for learning, rather than just assessment of learning (Ripley et al, 2009; Hattie and Brown, 2007-2008).

REAP (Re-engineering Assessment Practices) project aimed to redesign feedback and assessment practices across HE institutions based on a conceptualisation of assessment via a self-regulation model, which asserts that learning is deeper and more meaningful when students actively share responsibility for their learning and assessment.

The REAP project redesigned 19 classes at three Scottish institutions between 2005 and 2007. Each institution worked to a set of articulated principles that conceptualised their understanding of assessment and feedback, which were then transformed into new practices that involved regular peer and self-evaluation opportunities.

The DIAGNOSER project maps student knowledge through guided enquiry in physics. The project assesses students' understanding of physics and supports them to identify their misconceptions through immediate and cumulative feedback.

Teachers receive the assessment results and can choose how to continue instruction based on students' performance and identified misconceptions. A US study validating this project showed that students who have used it did better on the state science test than other students who had not used the programme.

SimScientists uses simulation-based science assessments as summative assessments that include complex 21 Technology Enhanced Assessment: Review of the Literature models of science concepts and offer difficult enquiry activities. This project also examines how simulations can be used for formative assessment within the curriculum and instruction, as they give individualised feedback on students' metacognitive and self-evaluation competences.

ASSISTment system This project features an online testing programme that acts as a 'pseudo-tutor' and provides feedback for students working on middle school level mathematics. The system gives students specific, tailored feedback based on responses to questions through hints, messages and scaffolding questions.

Summative and formative data is also shared with teachers, in terms of how students complete the overall test and specific feedback on particular areas. Evaluation of the programme suggests positive benefits, including student perceptions that the programme helps them with the test and predicted test scores that are better than the average (Whitelock et al 2006).

TRIADS system The TRIADS system was developed by the University of Derby and is a flexible and easy-to-use assessment system that includes various question styles in different formats to help evaluate 'higher-order learning skills.'

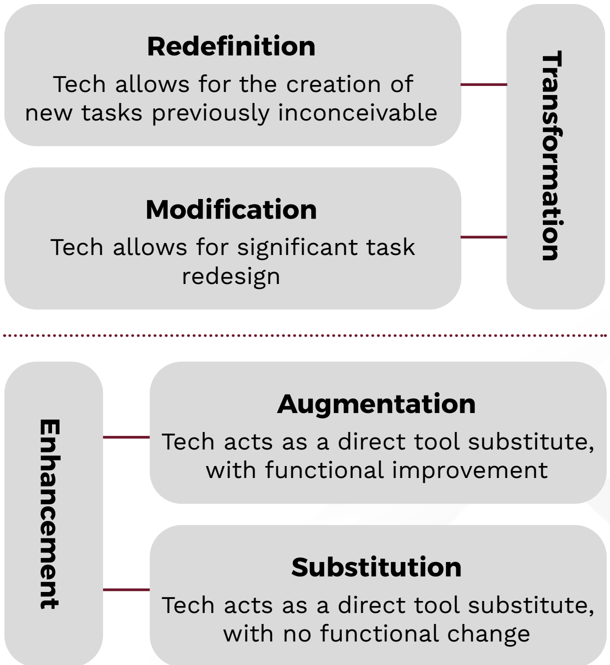
The system has been used for formative and summative assessment purposes at both the University of Derby and others around the UK (at Derby, it is used to deliver more than 10,000 medium to high stakes summative assessments each year). (Whitelock, et al 2006:26).

Audience response systems Hancock (2010) describes the use of audience response systems (ARS), most commonly used for formative purposes, for summative assessment. He identifies an apt place to use such tools are large university courses that often contain important foundational knowledge but can leave students feeling anonymous and 'lost in the crowd'.

ARS have been used successfully to provide formative assessment within such large lectures, but Hancock reports on their use to replace standard paper-based summative tests.

Such use provided greater efficiency and security for teachers though did not essentially change the nature of the basic multiple choice question tests. Additionally, students experiencing the use of ARS for formative and summative assessment responded favourably to its use for formative feedback but were significantly more sceptical about the use and fairness for summative purposes.

Appendix 2 - The SAMR Model



Substitution - At this level, teachers might choose to keep a pupil task the same but change the tool used.

For instance, learning might be presented using PowerPoint, but this is changed to Google Slides. The slides are created and shared in the same way, no additional functionality is utilised, but the tool is changed because of, perhaps, the ease with which it can be used.

Augmentation - At this level, we're still exchanging one tool for another but this time, we make use of the added functionality so that new things can be achieved.

For instance, notes are made by a pupil in a notepad and these are photocopied as part of group collaboration.

The notepad is exchanged for Microsoft OneNote and the notes made here can be easily shared with group members at the click of a button. This substitution provides additional functionality so that weblinks, images, and videos can be added to the notes when required.

Modification - At this level, we move beyond technology doing the same task but use it to redesign learning.

For instance, pupils frequently create revision flashcards for exams but don't always make use of them in the most effective ways.

Use of an online flashcard tool means that the teacher can reduce the time taken by individual students in creating their own cards by creating a class set. Evidence-based revision habits can be modelled with the use of the tool and the added functionality means that in-class group quizzes, as well as at-home individual tests, can be generated by the tool to encourage effective revision.

Redefinition - At this level, tasks can be redefined to the point they're unrecognisable to anything that could be achieved outside of the use of technology.

For instance, pupils could record one another on tablet devices in a sports class whilst practising a certain aspect of practice.

The video could then be analysed by the individual by comparing it to the same skill being practised by an experienced athlete; tracing the arc of the ball and the swing of the bat with a built-in pen to identify the change that would need to be made in the future. Here, the technology is achieving something not possible in any other way.

WAT Central
Trinity Point
High Street
Halesowen
B63 3HY

0121 602 7594
info@windsoracademytrust.org.uk
windsoracademytrust.org.uk
@winacadtrust