ReflectED: St Mary's Journal of Education ISSN 2046-6986
Special Edition: Sharing Stories, Nov 2024, p. 26-31.

Exploring the connection between Design and Technology and Computing: Enhancing Learning Opportunities in Primary Education

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Abstract:
This practice paper examines the intersection of Design and Technology (D&T) and Computing within the Bachelor of Arts (BA) Primary Education programme at St Mary's University, highlighting the introduction of a combined elective module for undergraduate Year Three students. This article has been written to summarise the new module and help support teachers of D&T and Computing in Initial Teacher Education (ITE). It reflects on the historical devaluation of D&T in England's National Curriculum and its ongoing identity crisis. The uncertain future of D&T is contrasted with the evolving pedagogical approaches and international perspectives on technology in education, particularly within STEM fields. The authors advocate for enhancing subject knowledge and teaching quality in both D&T and Computing, exploring pedagogical practices to enrich trainee teachers' understanding of these subjects. The alignment of D&T and Computing in the National Curriculum supports broader STEM objectives, emphasising the importance of encouraging problem-solving through real-world applications. Design in D&T education is increasingly influenced by computational thinking, providing an ideal opportunity for meaningful integration of both subjects. The paper closes with reflections from the authors and other stake holders in the module concluding that its success is a starting point for further reflections in this area.

Keywords: Design and Technology, Computing, primary school teaching, pedagogy, problem-solving behaviours

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The Rationale

This practice paper contextualises the different pedagogical approaches to two National Curriculum subjects taught within the BA Primary Education (with Qualified Teacher Status) programme at St Mary's University. By reviewing the literature related to Design and Technology (D&T) and Computing, we explore and reflect on a new module. Our rationale and context for the new module lie in interdisciplinary integration, aimed at enhancing student engagement within D&T and Computing. This approach bridges the gap between these subject skills, with the aim of better preparing students for their careers in teaching. This module marked the introduction of the first ever combined elective module for our Year Three undergraduate students.

Design and Technology and Computing

Over the years, D&T education in England has experienced a loss of value and purpose, prompting significant discourse regarding its aims and objectives (Hardy, 2018; Bell, 2017). A pivotal moment in political history occurred when the inclusion of D&T in the National Curriculum was debated (Department for Education, 2011). The panel questioned whether D&T possessed sufficient disciplinary knowledge to remain a curriculum subject (Atkinson, 2017). Subsequently, there was fear that the subject might lose its identity entirely, a concern that persists today as ongoing discourse continues to question its existence and rethink its future (Spendlove, 2023). Despite navigating four educational reforms and debates about its name on a semantic level, some core values established since the 1988 Education Reform Act have persisted and make up the National Curriculum (DfE, 2013) that English school systems use today.

The future of D&T as a subject in the curriculum is uncertain. However, reflecting on current teacher training, government policy and relevant literature provides some insight. There is a particular interest in the international perspective on 'technology' in education, especially within STEM (science, technology, engineering and maths). The evolving context of D&T has prompted us to further explore the National Curriculum objectives to enhance subject knowledge in both D&T and Computing, ultimately aiming to improve teaching quality (Barber and Mourshed, 2017).

Similar turbulence to subject identity has also been seen in Computing. This introduction of the 2013 National Curriculum saw the shift of ICT (Information and Communication Technology) to Computing. Advisors from technology companies stated that the old ICT curriculum did not allow children to develop the skills of innovations, creativity or computer science (Livingstone and Hope, 2011). The shift to Computing saw the addition of computer science at primary level. This addition had an assumed knowledge in the teaching community, when in reality it left teachers with insufficient subject knowledge (Larke, 2019). Consequently, this led to the teachers being gatekeepers to the curriculum and only teaching what they were confident with, which in most cases were the old ICT elements (The Royal Society, 2017; Larke, 2019). Current students on BA Primary Education (with Qualified Teacher Status) programme are likely to have been taught by teachers who were gatekeeping the computer science elements of the curriculum. Therefore, our ensuring the students on the programme understand computer science, its applications to real world circumstances and how to effectively teach it, is vital.

With an aim to improve teaching quality, underpinned by pedagogical practices and adhering to the values we are passionate about, we began to explore ways to enlighten our trainee teachers' thinking around D&T and Computing.

Moving Forward: How do Computing and Design and Technology intersect?

The primary National Curriculum in England for D&T states the importance of children drawing on a broad range of subjects such as Computing and Engineering (DfE, 2013).

Within the Computing National Curriculum, it explicitly reinforces the subject's links with D&T (DfE, 2013). The alignment of these two subjects affirms the significance of broader STEM goals, with D&T and Computing highlighting maths and science in the curriculum. STEM education has evolved into a pedagogical approach where pupils solve real-world problems by presenting academic concepts in 'realistic and meaningful situations' (Kalogiannakis and Ampartzaki, 2022, p. 3). Previous objectives in the field of D&T education indicate that 'design' is driven by computational nature of thinking (Blom, 2023) and the ability to find solutions to people's needs (Visser, 2009). Therefore, the links between D&T and STEM remain strong. Before planning this module, we recognised the importance of establishing a strong foundation in STEM-based cognitive activity, as this provides necessary skills for children. By ensuring this solid foundation, we allow D&T and Computing to flourish as integrated subjects.

The D&T and Computing curricula (DfE, 2013) encourage STEM-based cognitive activities and go as far as suggesting 'purposeful design' in Computing and 'control technology' in the study of D&T. However, through closer examination, the connections between our subjects are at a deeper level; there are connections between the pedagogy and desired skills we want students to understand and gain. Computational thinking is a set of skills and approaches to learning that equip pupils with a framework for solving problems (Wing, 2006). Skills such as algorithmic thinking, abstraction and debugging are promoted through computational thinking, which we use with our trainee teachers. Despite the term *computational* thinking, it is widely argued that the skills promoted can be applied away from technology and computers (Morris et.al., 2017). The approaches and concepts outlined by Barefoot Computing (n.d.) link to D&T and the iterative design process, highlighted as an illustrative model by the Design and Technology Association (DATA, n.d.). This pedagogical design model has evolved over time; however, it continues to hold significance within primary education, as teachers play a crucial role in helping to develop children's iterative processes, which are further built upon in Key Stage Three (KS3). One approach that best encapsulates this link between the two subjects is 'tinkering'. Tinkering, as it is termed in Computing education, is the process of exploring and testing opportunities, before final design choices are made (Resnick, 2017). The iterative nature of tinkering promotes the desired skills of the iterative design process.

Facilitating projects within learning allows children to see the process of creating from an initial idea to the finished product (Resnick, 2017). Resnick (2017) outlines how structuring a project can allow children to apply computational thinking skills to real-world and practical contexts (The Royal Academy of Engineering, 2014), which is similar to the iterative design process as outlined by DATA (no date). These connections and shared skills (as seen in Figure 1 below) are elements that we celebrate and highlight within the projects we showcase within the new module.

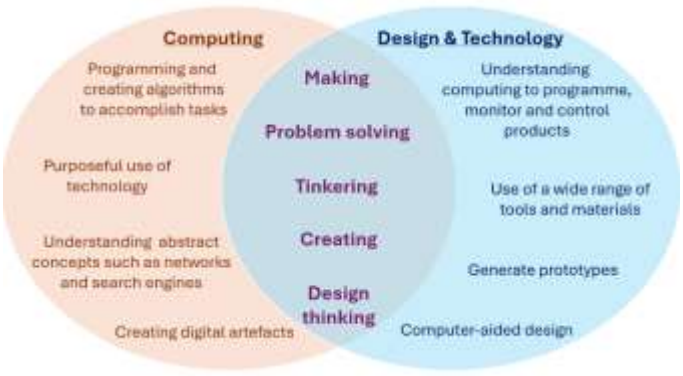

Figure 1: Shared Skills

Learning Opportunities for our Trainee Teachers

In our module, we aim to provide trainee teachers with opportunities to enhance their subject knowledge while also experiencing effective pedagogy and understanding the connections between subjects. To enable this, we decided to explore two projects throughout the ten weeks: designing and making a car using small programmable devices, such as Crumble boards, and a textile project designed using Computer Aided Design (CAD). The facilitation

of the trainee teachers to complete the projects, meant they were exposed to computational thinking and the iterative design process as a learner and could reflect on the connections and skills explored above. They decomposed, tinkered, created and debugged in an iterative nature as they created, whilst we modelled the desired pedagogy that would allow children to be brave, tinker and create within the primary classroom. With frequent reflections, the pedological choices we made as lecturers were explained to our trainee teachers. In this way, we are highlighting how iteration and tinkering can be utilised and supported when teaching Computing and D&T, and lessons where the subjects meaningfully combine.

Alongside the projects we visited the Design Museum to reflect on the opportunities a trip like this may present primary aged pupils. We also invited subject leaders for D&T and Computing from two local partnership schools, to share their experiences of leading in these subjects. Finally, our trainee teachers had the chance to apply their newly acquired skills and experiences in a partnership school. Working in groups, they designed a one-hour lesson for Year Six children with the specific aim of creating a prototype steady-hand machine using a micro:bit to develop the game. Providing children with these links allowed them to understand the importance of the subjects working together within a design process.

An important aspect of the trainee teachers' lessons involved planning for deliberate errors in the steady-hand machine design, challenges that the children had to address. For instance, once the children had set up the game on the micro:bit, they had to figure out how to clear the micro:bit screen to restart the game. This underscored the collaborative and resilient nature of the lesson, with our trainee teachers encouraging the children to persevere and tinker, as part of a trial-and-error approach. This allowed our trainee teachers to model the pedagogy they had seen during taught sessions at university.

Reflections on the Combined Module

To evaluate our practice and ensure that our module made an impact on the trainee teachers' experience and recognition of the two subjects, we sought to gather feedback from stakeholders as well as formalise our personal reflections. To support this process, elements of Gibb's (1993) reflective cycle were applied, allowing us to systematically reflect on the experiences of the module and use the analysis to identify improvements.

We believe that the module was pitched appropriately and effective in purposefully integrating the subjects in a meaningful way (Kalogiannakis and Ampartzaki, 2022) that allowed our students to develop confidence in teaching subjects in which experienced teachers are not confident in teaching (DfE, 2023). Trainee teacher engagement in the module was high, and the work they created during the projects was at an exceptionally high level, as commented by subject leaders from local schools. It was pleasing to see them show resilience when applying programming skills previously learned in earlier modules to the new Crumble environment. The children in the school were enthusiastic, excited and engaged throughout the teaching. Teachers from the school were pleased with the lessons and praised our trainee teachers' professional approach to teaching, which highlighted the need for further professional development within the school.

To further support our personal reflections, we gathered feedback from our trainee teachers and the teachers from the school-based elements of the module. Feedback from the trainee teachers was anonymous and via the university's end-of-year reflections. The responses we received enabled us to gain deeper insights for refining our approach in the upcoming academic year. Three core themes emerged from the feedback: skill development, where a hands-on approach to learning was effectively integrated into the module; practical applications of the projects, where real-world problems made the learning process more engaging and provided concrete examples; and confidence in teaching the subject, which influenced their ability to inspire and engage children.

Trainee teacher feedback supported our personal reflections that we had an effective balance of theory and practical. One trainee teacher reported that '*the practical work was great',* but the discussions beforehand helped with *'the understanding of what we are doing and why we are doing it'*. It was rewarding to see that this translated into our trainee teachers' teaching with children. The teacher from the school commented that our trainee teachers' teaching supported her pupils to *'explore new technology and acquire valuable skills*'.

Both our trainee teachers and the teachers explained that the projects explored in the sessions provided them with ideas to support their teaching in schools. One trainee teacher suggested that the learning in the module facilitated their ability to explore *'meaningful and purposeful'* projects for children. After attending our trainee teachers' exhibition, which was an assessment point where they showcased their learning from the module, a teacher commented that they were excited to '*incorporate some of their ideas into projects*' they were teaching.

Finally, our trainee teachers also mentioned that engaging with the module helped develop their confidence in how the two subjects can meaningfully combine to bring value and purpose to both. One trainee teacher reported that the module '*integrated two 'scary' subjects in a meaningful and innovative way*'. This *meaningful integration* was further supported by another student who discussed that they now felt '*very confident*' in delivering projects in schools. It was pleasing that the trainee teachers felt more confident in teaching the subjects due to engaging with the module.

Conclusion: What Next?

Reflections from trainee teachers, experienced teachers and from our personal perspective support the successful delivery of this new module. To revisit our main objectives, informed by the subject's political history, current literature and our future values driven by our passion for D&T and Computing, we aim for the module to continue evolving. Although the future of both subjects remains unknown, the incorporation of STEM-based cognitive activities, plus the link between both subject's design thinking, has meant that our trainee teachers feel confident to explore and refine their pedagogical approaches to teaching the two subjects (Kalogiannakis and Ampartzaki, 2022). We recognise that the areas of the National Curriculum highlighted in this paper can be challenging to teach; however, we want to alleviate these challenges by prioritising the development of these skills. We seek to continually engage our students and local schools, exploring the positives of meaningfully bringing together D&T and Computing. As an ITT institution, we respond to the needs presented by our partnership schools and aim to prepare our students to be the best teachers they can be.

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